CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

(Autonomous)
Kokapet (Village), Gandipet, Hyderabad, Telangana – 500075
www.cbit.ac.in

1.1.3 Average percentage of courses having focus on employability/ entrepreneurship/ skill development offered by the institution during the last five years

1.1.3.1 Number of courses having focus on employability/ entrepreneurship/ skill development year-wise during the last five years.

Year	2021-22	2020-21	2019-20	2018-19	2017-18
Number	1166	1106	985	922	984

List of courses courses having focus on employability/ entrepreneurship/ skill development offered by the institution during 2018 - 19 from S. No. 3265 - 3515

S.No	Course Name	Code
3265	Mathematics -I	18MTC01
3266	Introduction To Mechanics and Electromagnetic Theory	18PYC03
3267	Programming for Problem Solving	18CSC01
3268	English	18EGC01
3269	Mechanics And Electromagnetic Lab	18PYC06
3270	Programming for Problem Solving Lab	18CSC02
3271	Workshop/Manufacturing Practice	18MEC02
3272	English Lab	18EGC02
3273	Mathematics -II	18MTC03
3274	Chemistry	18CYC01
3275	Engineering Mechanics	18CEC01
3276	Engineering Graphics and Design	18MEC01
3277	Basic Electrical Engineering	18EEC01
3278	Basic Electrical Engineering Lab	18EEC02
3279	Chemistry Lab	18CYC02
3280	Engineering Mathematics-III	16MT C05
3281	Material Science and Metallurgy	16ME C04
3282	Mechanics of Materials	16ME C05
3283	Fluid Dynamics	16ME C06
3284	Machine Drawing	16ME C07
3285	Engineering Economics and Accountancy	16MB C01
3286	Material Science and Metallurgy Lab	16ME C08
3287	Mechanics of Materials Lab	16ME C09
3288	Computer Drafting Lab	16ME C10
3289	Kinematics of Machines	16ME C14
3290	Thermodynamics	16ME C15
3291	Hydraulic Machinery and Systems	16ME C16
3292	Manufacturing Processes	16ME C17
3293	Electrical Machines and Microcontroller Applications	16EE C14
3294	Hydraulic Machinery and Systems Lab	16ME C18

3295	Manufacturing Processes Lab	16ME C19
3296	Soft Skills and Employability Enhancement Lab	16EG C03
3297	Dynamics of Machines	16ME C20
3298	Applied Thermodynamics & Heat Transfer	16ME C21
3299	Design of Machine Elements	16ME C22
3300	Refrigeration and Air Conditioning	16ME E01
3301	Mechanical Vibrations	16ME E02
3302	Product Design and Process Planning	16PE E02
3303	Principles of Industrial Engineering	16PE E05
3304	Fuels, Combustion and Environment	16ME E03
3305	Non-Destructive Testing and Evaluation	16PE E03
3306	Plastics, Ceramics and Composite Materials	16PE E04
3307	Probability and Numerical Methods	16MT E04
3308	Dynamics & Vibrations Lab	16ME C23
3309	Applied Thermodynamics & Heat Transfer Lab	16ME C24
3310	Electrical Machines & Microcontroller Applications Lab	16EE C22
3311	Industrial Visit	16ME C25
3312	CAD and CAM	16ME C26
3313	Metal Cutting and Machine Tool Engineering	16ME C27
3314	Thermal Turbo Machines	16ME C28
3315	Machine Design	16ME C29
3316	Advanced IC Engines	16ME E05
3317	Computational Fluid Dynamics	16ME E06
3318	Automobile Engineering	16ME E07
3319	Digital Manufacturing	16PE E10
3320	Heat and Mass Transfer	16ME E08
3321	Object Oriented Programming With C++	16ME E09
3322	Modern Machining and Forming Methods	16PE E08
3323	Surface Engineering	16PE E09
3324	CAD and CAM Lab	16ME C30
3325	Metal Cutting and Machine Tool Engineering Lab	16ME C31
3326	Thermal Engineering Lab	16ME C32
3327	Thermal Turbo Machines	ME 411
3328	Metrology and Instrumentation	ME 412
3329	Finite Element Analysis	ME 413
3330	Operations Research	ME 414
3331	Renewable Energy Sources	ME 461
3332	Computational Fluid Dynamics	ME 462
3333	Automobile Engineering	ME 463
3334	Entrepreneurship	ME 464
3335	Robotics	PE 461
3336	Disaster Mitigation and Management	CE 461
3337	Thermal Engineering Lab	ME 415
3338	Metrology and Instrumentation Lab	ME 416
3339	Computer Aided Engineering Lab	ME 417
3340	Project Seminar	ME 418
3341	Industrial Administration and Financial Management	ME 419

3342	Production and Operations Management	ME 421
3343	Production Drawing	ME 422
3344	Power Plant Engineering	ME 471
3345	Intellectual Property Rights	ME 472
3346	Mechatronics	ME 473
3347	Mechanics of Composite Materials	ME 474
3348	Supply Chain Management	ME 475
3349	Manufacturing Systems and Simulation	PE 471
3350	Modern Machining and Forming Methods	PE 412
3351	Micro Manufacturing	PE 481
3352	Non - Destructive Testing and Evaluation	PE 482
3353	Product Design and Process Planning	PE 483
3354	Nano Materials and Technology	PE 484
3355	Information Security	CSE 481
3356	Seminar	ME 423
3357	Project	ME 901
3358	Mathematics -I	18MTC01
3359	Introduction To Mechanics And Electromagnetic Theory	18PYC03
3360	Programming for Problem Solving	18CSC01
3361	English	18EGC01
3362	Mechanics And Electromagnetic Lab	18PYC06
3363	Programming for Problem Solving Lab	18CSC02
3364	Workshop/Manufacturing Practice	18MEC02
3365	English Lab	18EGC02
3366	Mathematics -II	18MTC03
3367	Chemistry	18CYC01
3368	Engineering Mechanics	18CEC01
3369	Engineering Graphics and Design	18MEC01
3370	Basic Electrical Engineering	18EEC01
3371	Basic Electrical Engineering Lab	18EEC02
3372	Chemistry Lab	18CYC02
3373	Engineering Mathematics-III	16MT C05
3374	Material Science and Metallurgy	16ME C04
3375	Mechanics of Materials	16ME C05
3376	Fluid Dynamics	16ME C06
3377	Machine Drawing	16ME C07
3378	Engineering Economics and Accountancy	16MB C01
3379	Material Science and Metallurgy Lab	16ME C08
3380	Mechanics of Materials Lab	16ME C09
3381	Computer Drafting Lab	16ME C10
3382	Kinematics of Machines	16ME C14
3383	Thermodynamics	16ME C15
3384	Metal Casting and Welding	16PE C01
3385	Metal Forming Technology	16PE C02
3386	Electrical Machines and Microcontroller Applications	16EE C14
3387	Metal Casting and Welding Lab	16PE C03
3388	Metal Forming Technology Lab	16PE C04

3389	Soft Skills and Employability Enhancement Lab	16EG C03
3390	Dynamics of Machines	16ME C20
3391	Applied Thermodynamics & Heat Transfer	16ME C21
3392	Design of Machine Elements	16ME C22
3393	Refrigeration and Air Conditioning	16ME E01
3394	Mechanical Vibrations	16ME E02
3395	Product Design and Process Planning	16PE E02
3396	Powder Processing	16PE E01
3397	Hydraulic Machines	16ME E04
3398	Non-Destructive Testing and Evaluation	16PE E03
3399	Plastics, Ceramics and Composite Materials	16PE E04
3400	Probability and Numerical Methods	16MT E04
3401	Dynamics & Vibrations Lab	16ME C23
3402	Applied Thermodynamics & Heat Transfer Lab	16ME C24
3403	Electrical Machines & Microcontroller Applications Lab	16EE C22
3404	Industrial Visit	16PE C05
3405	CAD and CAM	16ME C26
3406	Machine Tool Engineering	16PE C06
3407	Additive Manufacturing	16PE C07
3408	Machine Design	16ME C29
3409	Work System Design	16PE E06
3410	Computational Fluid Dynamics	16ME E06
3411	Automobile Engineering	16ME E07
3412	Quality and Reliability Engineering	16PE E07
3413	Turbo Machines	16ME E10
3414	Object Oriented Programming with C++	16ME E09
3415	Modern Machining and Forming Methods	16PE E08
3416	Surface Engineering	16PE E09
3417	CAD and CAM Lab	16ME C30
3418	Machine Tool Engineering Lab	16PE C08
3419	Additive Manufacturing Lab	16PE C09
3420	Production Drawing Practice	PE 411
3421	Metrology & Instrumentation	ME 412
3422	Operations Research	ME 414
3423	Modern Machining & Forming Methods	PE 412
3424	Robotics	PE 461
3425	Renewable Energy Sources	ME 461
3426	Computations Fluid Flows	ME 462
3427	Automobile Engineering	ME 463
3428	Entrepreneurship	ME 464
3429	Disaster Mitigation & Management	CE 461
3430	Computer Aided Production Drawing Lab	PE 413
3431	Metrology & Instrumentation Lab	ME 416
3432	Manufacturing Engg. Lab	PE 414
3433	Creative & Innovative Project	PE 415
3434	Production And Operations Management	ME 421
3435	Tool Design	PE 421

3436	Power Plant Engineering	ME 471
3437	Intellectual Property Rights	ME 472
3438	Mechatronics	ME 473
3439	Mechanics of Composite Materials	ME 474
3440	Supply chain Management	ME 475
3441	Manufacturing Systems & Simulation	PE 471
3442	Micro Manufacturing	PE 481
3443	Non-Destructive Testing & Evaluation	PE 482
3444	Product Design & Process Planning	PE 483
3445	Nano Materials & Technology	PE 484
3446	Total Quality Management	PE 485
3447	Information Security	CSE 481
3448	Seminar	PE 422
3449	Project	PE 423
3450	Automation	16MEC101
3451	Computer Aided Modelling and Design	16MEC102
3452	Computer Integrated Manufacturing	16MEC103
3453	Failure Analysis and Design	16MEE101
3454	Engineering Research Methodology	16MEE107
3455	Theory of Elasticity and Plasticity	16MEE111
3456	Integrated Mechanical Design	16MEE102
3457	Robotic Engineering	16MEE103
3458	Programming Methodology and Data Structures	16MEE104
3459	Optimization Techniques	16MEE105
3460	Vibrations Analysis and Condition Monitoring	16MEE106
3461	Tribology In Design	16MEE108
3462	Advanced Mechanics of Materials	16MEE109
3463	CAD/CAM Lab (Lab –I)	16MEC106
3464	Seminar – I	16MEC108
3465	Soft Skills Lab	16EG C104
3466	Computer Aided Mechanical Design and Analysis	16MEC104
3467	Finite Element Techniques	16MEC105
3468	Computational Fluid Dynamics	16MEC205
3469	Mechanics of Composite Materials	16MEE110
3470	Product Design and Process Planning (PDPP) - (Elective)	16MEE 121
3471	Experimental Techniques and Data Analysis	16MEE112
3472	Design for Manufacture	16MEE113
3473	Data Base Management Systems	16MEE114
3474	Fracture Mechanics	16MEE115
3475	Design of Press Tools	16MEE116
3476	Design of Dies	16MEE117
3477	Rapid Prototyping Principles & Applications	16MEE118
3478	Flexible Manufacturing Systems	16MEE119
3479	Non-Traditional Machining & Forming	16MEE120
3480	Computation Lab (Lab –II)	16MEC107
3481	Seminar – II	16MEC109
3482	Mini Project	16MEC110

3483	Project Seminar	16MEC111
3484	Project work	16MEC112
3485	Advanced Thermodynamics	16MEC 202
3486	Advanced Heat & Mass Transfer	16MEC 203
3487	Advanced I.C. engines	16MEC 204
3488	Thermal & Nuclear Power Plants	16MEE 215
3489	Computer Aided Graphics and Design	16MEE201
3490	Engineering Research Methodology	16MEE107
3491	Design of Gas Turbines	16MEE 205
3492	Advanced Energy Systems	16MEE 206
3493	Fuels and Combustion	16MEE 207
3494	Power Plant Control and Instrumentation	16MEE 208
3495	Design of Pumps and Compressors	16MEE 209
3496	Numerical Methods	16MEE 210
3497	Thermal Systems Laboratory (Lab – I)	16MEC 206
3498	Seminar – I	16MEC 208
3499	Soft Skills Lab	16EG C104
3500	Finite Element Techniques	16MEC 105
3501	Fluid Flow and Gas Dynamics	16MEC 201
3502	Computational Fluid Dynamics	16MEC 205
3503	Optimization Techniques	16MEE 105
3504	Turbo Machines	16ME E 202
3505	Fuels and Combustion	16MEE 207
3506	Fluid Power Systems	16MEE203
3507	Environmental Engineering and Pollution	16MEE 211
3508	Refrigeration Machinery & Components	16MEE 212
3509	Energy Management	16MEE 213
3510	Convective Heat Transfer	16MEE 214
3511	CFD Lab (Lab – II)	16MEC 207
3512	Seminar-II	16MEC 209
3513	Mini Project	16MEC 210
3514	Project Seminar	16MEC 211
3515	Project work	16MEC 212

18-19

CBIT (A)

With Effect from academic year 2018-19

18MT CO1

MATHEMATICS– I

(Common to all branches and except for Bio-Tech)

Instruction	3 L+1T Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation:	30 Marks
Credits	4

Course Objectives:

1. To solve linear system of equations using Matrix Methods.
2. To know the convergence of the Series.
3. To represent the function in series form.
4. To know the Partial Derivatives and use them to interpret the way a function of two variables behaves.
5. To learn Vector Differential Operator and its Physical interpretations on Scalars and vector functions.
6. To solve improper integrals.

Course Outcomes: On the successful completion of this course student shall be able to

1. Solve system of linear equations and identify the Eigen values and Eigen vectors in engineering problems.
2. Check the series convergence.
3. Find the evolutes of the given curves.
4. Expand and find extreme values of functions of two variables.
5. Understanding the significance of gradient, divergence and curl.
6. An ability to solve the problems and interpret in geometrical approach.

UNIT-I: Matrices;

Rank of the matrix, Echelon form, System of linear equations, Linearly dependence and independence of vectors, Eigenvalues, Eigenvectors, Properties of eigenvalues, Cayley-Hamilton theorem, Quadratic forms, Diagonalization of Matrices, Reduction of quadratic form to canonical form by linear transformation, Nature of quadratic forms.

UNIT-II: Sequences and Series:

Definition of Convergence of sequence and series. Tests for convergence of series: comparison test, limit comparison test, D'Alembert ratio test, Raabes test, Cauchy's n^{th} root test, logarithmic test, alternative series, absolute and conditional convergence.

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UNIT-III: Calculus:
Rolle's Theorem, Lagranges Mean value theorem, Cauchy's mean value theorem (without proofs). Curvature, radius of curvature, Evolutes and involutes , Fourier series, half range sine and cosine series.

UNIT-IV: Multivariable Calculus (Differentiation):
Functions of two variables, Partial derivatives, Total differential and differentiability, Derivatives of composite and implicit functions (Chain rule), Change of variables, Jacobian, Higher order partial derivatives, Taylor's series of functions of two variables, Maximum and minimum values of functions two variables, Lagrange's multipliers method.

UNIT-V: Vector Calculus (Differentiation):
Scalar and vector fields, Gradient of a scalar field, Directional derivative, Divergence and Curl of a vector field, vector identities. Improper integrals: Beta and Gamma functions and their properties.

Text Books:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
2. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
3. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.

Suggested Reading:

1. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
2. R.K. Jain, S.R.K. Iyengar, Advanced engineering mathematics Narosa Publications, 5th edition, 2016. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.

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18PY C03

INTRODUCTION TO MECHANICS AND ELECTROMAGNETIC THEORY
(for Civil, Mech & Prod)

Instruction:	3L+1T Hours per Week
Duration of Semester End Examination:	3 Hours
Semester End Examination:	70 Marks
Continuous Internal Evaluation:	30 Marks
Credits:	4

Course Objectives:

The objectives of the course is to make the student

1. Understands the fundamentals of oscillations and ultrasonics.
2. Gains knowledge of rigid body dynamics.
3. Learns the basics of electrostatics.
4. Understands the fundamentals of magnetostatics.
5. Familiar with electromagnetic waves.

Course Outcomes:

At the end of the course, the student will be able to

1. Describe the types of oscillations and analyze them.
2. Develop the concepts of dynamics and apply them to solve the related problems.
3. Analyze the role of different laws in electrostatics.
4. Discuss the significance of magnetostatics.
5. Develop the concepts related to electromagnetic behavior.

UNIT- I :Oscillations:

Simple harmonic motion, Harmonic oscillator; Damped harmonic motion – over-damped, critically damped and lightly- damped oscillators; Forced oscillations and resonance.

Ultrasonics: Production of ultrasonics by piezoelectric and magnetostriction methods – Detection of ultrasonics — Determination of ultrasonic velocity in liquids – Applications.

UNIT-II: Rigid body Dynamics:

Definition and motion of a rigid body in the plane; Rotation in the plane; Kinematics in a coordinate system rotating and translating in the plane; Angular momentum about a point of a rigid body in planar motion; Euler's laws of motion, their independence from Newton's laws, and their necessity in describing rigid body motion; Examples. two-dimensional motion in terms of (a) Angular velocity vector, and its rate of change and (b) Moment of inertia tensor.

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UNIT- III :Electrostatics in Vaccum:

Calculation of electric field and electrostatic potential for a charge distribution; Divergence and curl of electrostatic field; Laplace's and Poisson's equations for electrostatic potential and uniqueness of their solution and connection with steady state diffusion and thermal conduction, Boundary conditions of electric field and electrostatic potential.

UNIT - IV : Magnetostatics:

Bio-Savart law, Divergence and curl of static magnetic field; vector potential and calculating it for a given magnetic field using Stokes' theorem; the equation for the vector potential and its solution for given current densities: ferromagnetic, paramagnetic and diamagnetic materials, B-H curve.

UNIT- V : Electromagnetic Waves:

The wave equation; Plane electromagnetic waves in vacuum, their transverse nature and polarization; relation between electric and magnetic fields of an electromagnetic wave; energy carried by electromagnetic waves, Maxwell's equation in vacuum and non-conducting medium; Energy in an electromagnetic field; Flow of energy and Poynting vector with examples.

TEXT BOOKS:

1. B.K. Pandey and S. Chaturvedi, *Engineering Physics*, Cengage Publications, 2012.
2. M.N. Avadhanulu and P.G. Kshirsagar, *A Text BookEngineering Physics*, S. Chand Publications, 2014.
3. M. Arumugam, *Materials Science*, Anuradha Publications, 2015.
4. S.L. Gupta and Sanjeev Gupta, *Modern Engineering Physics*, Dhanpat Rai Publications, 2011.

SUGGESTD READING:

1. R. Murugeshan and Kiruthiga Sivaprasath, *Modern Physics*, S. Chand Publications S. Chand Publications, 2014.
2. V. Rajendran, *Engineering Physics*, McGahill Education Publications, 2013.
3. P.K. Palanisamy, *Engineering Physics*, Scitech Publications, 2012.
4. V. Raghavan, *Materials Science and Engineering*, Prentice Hall India Learning Private Limited; 6th Revised edition, 2015.

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Reddy
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18CS C01

Programming for Problem Solving
(Common to All Programs)

Instruction	3 Periods per week
Duration of Semester-End Examination	3 Hours
Semester-End Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives

1. Identification of computer components, Operating environments, IDEs
2. Understanding the steps in problem solving and formulation of algorithms to problems.
3. Develop programming skills as an means of implementing an algorithmic solution with appropriate control anddata structures.
4. Develop intuition to enable students to come up with creative approaches to problems.
5. Manipulation of text data using files.

Course Outcomes: At the end of the course, students will be able to:

1. Identify the computing environments.
2. Formulate solutions to problems and represent them using algorithms/ Flowcharts.
3. Choose proper control statements and data structures to implement the algorithms.
4. Trace the programs with test the program solution.
5. Decompose a problem into modules and use functions to implement the modules.
6. Develop applications using file I/O.

UNIT -I

Introduction to computers and Problem Solving: Components of a computer, Operating system, compilers, Program Development Environments, steps to solve problems, Algorithm, Flowchart / Pseudocode with examples.

Introduction to programming: Programming languages and generations, categorization of high level languages.

Introduction to C: Introduction, structure of C program, keywords, identifiers, Variables, constants, I/O statements, operators, precedence and associativity.

UNIT – II

Introduction to decision control statements: Selective, looping and nested statements.

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Functions: Introduction, uses of functions, Function definition, declaration, passing parameters to functions, recursion, scope of variables and storage classes.

Case study:

UNIT – III

Arrays: Introduction, declaration of arrays, accessing and storage of array elements, 1-dimensional array, Searching (linear and binary search algorithms) and sorting(selection and Buble) algorithms, 2-D arrays, matrix operations.

Strings: Introduction, stringsrepresentation, string operations with examples.

Case study:

UNIT – IV

Pointers: Understanding computer's memory, introduction to pointers, declaration pointer variables, pointer arithmetic, pointers and strings, array of pointers, function pointers, array of function pointers, dynamic memory allocation, advantages and drawbacks of pointers.

Structures: Structure definition, initialization and accessing the members of a structure, nested structures, structures and functions, self- referential structures, unions and enumerated data types.

UNIT-V

Files: Introduction to files, file operations, reading data from files, writing data to files, error handing during file operations.

Preprocessor Directives: Types of preprocessor directives, examples.

Suggested Reading:

1. A K Sharma "**Computer Fundamentals and Programming**", 2nd Edition, University Press, 2018.
2. PradeepDey and Manas Ghosh, "**Programming in C**", Oxford Press, 2nd Edition, 2017.

References:

1. Byron Gottfried, Schaum's"**Outline of Programming with C**", McGraw-Hill.
2. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.
3. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill.
4. ReemaTharaja "**Introduction to C Programming**", Second Edition, OXFORD Press,2015.
5. https://www.tutorialspoint.com/cprogramming/index.htm
6. https://onlinecourses.nptel.ac.in/noc18-cs10/preview.

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18EG C01

ENGLISH

(Common to all branches)

Instruction	2Hours per week
Duration of Semester End Examination	2 Hours
Semester End Examination	50 Marks
Continuous Internal Evaluation:	20 Marks
Credits	2

Course Objectives:

1. To enable the students to understand the role and importance of communication and to develop their basic communication skills in English.
2. To equip the students with basics of writing correct sentences to coherent paragraphs.
3. To equip the students with techniques of writing a précis and an essay by using accurate grammar and appropriate vocabulary.
4. To train the students to describe, define and classify processes and to draft formal reports by adhering to the proper structure.
5. To develop the reading skills and reading comprehension techniques of the students.
6. To develop the students reading, writing, grammatical, lexical and communicative competence.

Course Outcomes:

1. The students will understand the nature, process and types of communication and will communicate effectively without barriers.
2. The students will write correct sentences and coherent paragraphs.
3. The students will know how to condense passages by writing précis and write essays by using accurate grammar and appropriate vocabulary.
4. The students will demonstrate advanced writing skills by drafting formal reports.
5. The students will apply their reading techniques and analyze reading comprehension passages.
6. The students will become effective communicators and will display their advanced skills of reading and writing and use correct grammar and appropriate vocabulary in all contexts.

UNIT-IUnderstanding Communication in English:

Introduction, nature and importance of communication.Process of communication.Basic types of communication - verbal and non-verbal.Barriers to communication.Intrapersonal and interpersonal communication.Johari Window

Vocabulary &Grammar: The concept of Word Formation. Importance of proper punctuation.Articles.

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UNIT- II Developing Writing Skills I:
Types of sentences.Use of phrases and clauses in sentences.Cohesion and coherence.Paragraph writing.Organizing principles of paragraphs in documents.Vocabulary & Grammar: Cohesive devices. Root words from foreign languages and their use in English. Prepositions.

UNIT- III Developing Writing Skills II:
Techniques for writing precisely. Précis Writing. Essay Writing.
Vocabulary and Grammar: Subject-verb agreement, Noun-pronoun agreement Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives, Redundancies, Clichés.

UNIT- IV Developing Writing Skills III:
Describing, Defining, Classifying, Providing examples or evidence.Writing introduction and conclusion.
Report writing – Importance, structure and elements of style of formal reports.
Vocabulary and Grammar: Misplaced modifiers. Synonyms, antonyms.

UNIT-VDeveloping Reading Skills:
The reading process, purpose, different kinds of texts. Reading comprehension.Techniques of comprehension – skimming, scanning, drawing inferences and conclusions.
Vocabulary and Grammar : Words often Confused. Standard abbreviations.

Text Books:

1. Language and Life: A Skills Approach, Board of Editors, Orient Black Swan, 2017.
2. Swan Michael,Practical English Usage.OUP. 1995.

Suggested Readings:

1. Wood F.T,Remedial English Grammar, Macmillan,2007
2. Zinsser William,On Writing Well, Harper Resource Book, 2001
3. Sanjay Kumar and PushpLata,Communication Skills.Oxford University Press, 2011.

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18PY C06

MECHANICS AND ELECTROMAGNETIC LABORATORY
(for Civil, Mech & Prod)

Instruction:	3 Hours per Week
Duration of Semester End Examination:	3 Hours
Semester End Examination:	50 Marks
Continuous Internal Evaluation:	25 Marks
Credits:	1.5

Course Objectives:

The objectives of the course is to make the student

1. Apply theoretical physics knowledge in doing experiments.
2. Understand the various kinds of oscillators.
3. Analyze the behavior of magnetic and dielectric materials.

Course Outcomes:

At the end of the course, the student will be able to

1. Understand the concept of errors and find the ways to minimize the errors
2. Demonstrate the various kinds of oscillations.
3. Determine the loss of energy of a ferromagnetic material and its uses in electrical engineering .
4. Understand the suitability of dielectric materials in engineering applications.
5. Use LCR circuits in different applications.

Experiments

1. *e/m* of Electron by Thomson's Method.
2. B-H curve – Determination of Hall coefficient, carrier concentration & mobility of charge carriers of given semiconductor specimen.
3. Stewart & Gee's.
4. Mutual induction.
5. Dielectric constant – Determination of dielectric constant of given PZT sample.
6. Error analysis – Estimation of errors in the determination of time period of a torsional pendulum.
7. Helmholtz's resonator.
8. Compound pendulum.
9. Flywheel.
10. Coupled oscillator.
11. LCR circuit.
12. Melde's experiment.
13. Young's modulus.
14. Viscosity by oscillating disc (Lamp scale method).

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15. Ultrasonic interferometer – Determination of velocity of ultrasonics in a given liquid.

SUGGESTED READING:

1. *Engineering Physics Manual* by Department of Physics, CBIT, 2016.
2. S.K. Gupta, *Engineering Physics Practical*, Krishna's Educational Publishers, 2014.
3. O.P. Singh, V. Kumar and R.P. Singh, *Engineering Physics Practical Manual*, Ram Prasad & Sons Publications, 2009.
4. Indu Prakash, Ram Krishna and A.K. Jha, *A Text Book of Practical Physics*, Kitab Mahal Publications, 2012.

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18CS C02

Programming for Problem Solving
(Programming Lab – I)
(Common to All Programs)

Instruction	4 Periods per week
Duration of Semester-End Examination	3 Hours
Semester-End Examination	50 Marks
Sessional	25 Marks
Credits	2

Course Objectives

1. Setting up programming environment.
2. Develop Programming skills to solve problems.
3. Use of appropriate C programming constructs to implement algorithms.
4. Identification and rectification of coding errors in program.
5. Develop applications in a modular fashion.
6. Manage data using files.

Course Outcomes:

At the end of the course students will be able to:

1. Identify and setup program development environment.
2. Implement the algorithms using C programming language constructs.
3. Identify and rectify the syntax errors and debug program for semantic errors.
4. Analyze the results to evaluate the solutionsof the problems.
5. Solve problems in amodular approach using functions.
6. Implement file operations with simple text data.

Lab experiments

1. Familiarization with programming environment.
2. Simple computational problems using arithmetic expressions.
3. Problems involving if-then-else structures.
4. Iterative problems e.g., sum of series.
5. 1D Array manipulation.
6. 2D arrays and strings.
7. Matrix problems, String operations.
8. Simple functions.
9. Recursive functions.
10. Pointers and structures.
11. Dynamic memory allocation and error handling.
12. File handling.

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Design the experiments in such a way that the students will be able to end up the solution for a real world problem that uses most of the concepts of C programming language. For example: A banking application where it uses the concepts of operators, control structures, switch case for menu, structures, functions, error handling, files etc.

Suggested Reading:

1. Pradeep Dey and Manas Ghosh, "**Programming in C**", Oxford Press, 2nd Edition, 2017.
2. ReemaTharaja "**Introduction to C Programming**", Second Edition, OXFORD Press,2015.

References:

1. https://www.tutorialspoint.com/cprogramming/index.htm
2. https://www.w3resource.com/c-programming/programming-in-c.php
3. https://www.w3schools.in/c-tutorial/

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18ME C02

WORKSHOP/ MANUFACTURING PRACTICE

Instruction	1T+4P Hours per week
Duration of End Examination	3 Hours
Semester End Examination	50 Marks
Continuous Internal Evaluation:	25 Marks
Credits	3

Course Objectives:

1. Give a feel of Engineering Practices & develop holistic understanding of various Engineering materials and Manufacturing processes.
2. Develop skills of manufacturing, safety, precision, quality, intelligent effort, optimization, positive & team work attitude to get things right the first time.
3. To provide basic knowledge of Steel, Plastic, Composite and other materials for suitable applications.
4. Study of Principle and hands on practice on techniques of fabrication, welding, casting, manufacturing, metrology, and allied skills.
5. To advance important hard & pertinent soft skills, productivity, create skilled manpower which is cognizant of industrial workshop components and processes and can communicate their work in a technical, clear and effective way.
6. Engineering Skill development with regard to making components, system integration and assembly to form a useful device.

Course Outcomes – (Laboratory): Student will be able to

1. Fabricate components with their own hands.
2. Get practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.
3. Assembling different components, student will be able to produce small mechanisms/devices of their interest.
4. Gain practical skills of carpentry, tinsmithy, fitting, house wiring.
5. Gain knowledge of different Engineering Materials and Manufacturing Methods.
6. Understand trades and techniques used in Workshop and chooses the best material/ manufacturing process for the application.

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18EG C02

ENGLISH LAB

(Common to all branches)

Instruction	2 Hours per week
Duration of Semester End Examination	2 Hours
Semester End Examination	35 Marks
Continuous Internal Evaluation:	15 Marks
Credits	1

Course Objectives:

1. To introduce students to phonetics and the different sounds in English.
2. To familiarize the students with the software and give them sufficient practice in correct pronunciation.
3. To enable students to speak English correctly with focus on stress and intonation.
4. The students will enhance their listening skills by practicing IELTS and TOEFL material.
5. To help students overcome their inhibitions while speaking in English and to build their confidence. The focus shall be on fluency rather than accuracy.
6. To help students to understand team work, role behavior and to develop their ability to discuss in groups and make oral presentations.

Course Outcomes:

1. The students will differentiate the speech sounds in English.
2. The students will interact with the software and understand the nuances of pronunciation in English.
3. The students will speak with the proper tone, intonation and rhythm and apply stress correctly.
4. The students will demonstrate their listening skills by analyzing the IELTS and TOEFL listening comprehension texts.
5. The students will speak with clarity and confidence.
6. The students will work in teams and discuss various topics and demonstrate their presentation skills through posters.

Exercises

1. **Introduction to English Phonetics**: Introduction to auditory, acoustic and articulatory phonetics, organs of speech: the respiratory, articulatory and phonatory systems.
2. **Sound system of English**: Phonetic sounds and phonemic sounds, introduction to international phonetic alphabet, classification and description of English phonemic sounds, minimal pairs . The syllable: types of syllables, consonant clusters.
3. **Word stress**: Primary stress, secondary stress, functional stress, rules of word stress.

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4. **Rhythm &Intonation** : Introduction to Rhythm and Intonation. Major patterns, intonation of English with the semantic implications.
5. **Listening skills** – practice with IELTS and TOEFL material.
6. **Situational dialogues and role play** – Dialogue writing, – Role behavior and role enactment.
7. **Group Discussions** - Dynamics of a group discussion, group discussion techniques, body language.
8. **Public speaking** – Speaking with confidence and clarity in different contexts on various issues.
9. **Poster presentation** – Theme, poster preparation, team work and presentation.

Suggested Reading

1. T Balasubramanian. A Textbook of English Phonetics for Indian Students, Macmillan, 2008.
2. J Sethi et al. A Practical Course in English Pronunciation (with CD), Prentice Hall India, 2005.
3. PriyadarshiPatnaik. Group Discussions and Interviews, Cambridge University Press Pvt Ltd 201.
4. ArunaKoneru, Professional Speaking Skills, Oxford University Press, 2016.

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18MT CO3

MATHEMATICS– II

(Common to all branches and except for Bio-Tech)

Instruction	3 L+1T Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation:	30 Marks
Credits	4

Course Objectives

1. To evaluate double and triple integrals of various functions and their significance.
2. To evaluate vector line, surface and volume integrals.
3. To know the relevant method to solve higher order differential equations.
4. To evaluate complex integration.
5. To evaluate real and definite integrals.
6. To know the methods to solve real life problems.

Course Outcomes: On the successful completion of this course student shall be able to

1. Find the areas, volumes and surface of solids revolution.
2. Use Greens, Gauss and Stoke's theorems to find the surface and volume integrals.
3. Able to solve solutions of differential equations with initial and boundary value problems.
4. Solve the problems on analytic functions, Cauchy's theorem and Cauchy's integral formula.
5. Real and complex integrals by using Cauchy's theorems.
6. Solve physical and engineering problems.

UNIT-I: Multivariable Calculus (Integration):

Applications of definite integrals to evaluate surface areas and volumes of revolutions. Double integrals, Change of order of integration, Triple integrals, Change of variables in integrals, Applications: areas and volumes, Centre of mass and Gravity (constant and variable densities).

UNIT-II: Vector Integral Calculus:

Line, Surface and Volume integrals, Green's theorem in a plane, Gauss's divergence theorem and Stroke's theorem (without proof).

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First Order Ordinary Differential Equations: Exact first order differential equations , Integrating factors, Linear first order equations , Bernoulli's, Riccati's and Clairaut's differential equations ,Orthogonal trajectories of a given family of curves.

UNIT-III: Ordinarydifferential equations of higher orders:
Solutions of higher order linear equations with constants coefficients, Method of variation of parameters, solution of Euler-Cauchy equation. Ordinary point, singular point and regular singular point, Power Series solution. Legendre Polynomial of first kind (without proof), Rodrigues formula, Generating function, recurrence relations, orthogonality of Legendre polynomials, Bessel's function of first kind (without proof), recurrence relations and problems.

UNIT- IV: Complex Variables –I :
Differentiation, analytic functions, Cauchy-Riemann equations, harmonic functions, finding harmonic conjugate, elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties. Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof).

UNIT- V: Complex Variables – II:
Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, Laurent's series, zeros of analytic functions, singularities, Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine. Improper real integrals with singular points on the upper half plane.

Text Books:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
2. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

Suggested Reading:

1. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
2. R.K. Jain, S.R.K. Iyengar, Advanced engineering mathematics Narosa Publications,5th edition,2016.
3. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.

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18CY C01

CHEMISTRY

(Common to all branches)

Instruction:	3L+1T Hours per Week
Duration of Semester End Examination:	3 Hours
Semester End Examination:	70 Marks
Continuous Internal Evaluation:	30 Marks
Credits:	4

Course Objectives

1. The aim of framing the syllabus is to impart intensive and extensive knowledge of the subject so that students can understand the role of chemistry in the field of engineering.
2. This syllabus helps at providing the necessary introduction of the inorganic chemistry principles and concepts of chemical bonding involved in a comprehensive manner understandable to the students aspiring to become practicing engineers.
3. Thermodynamic and Electrochemistry units give conceptual knowledge about spontaneous processes and how can they be harnessed for producing electrical energy and efficiency of systems.
4. To teach students the value of chemistry and to improve the research opportunities knowledge of stereochemistry and organic reactions is essential.
5. New materials lead to discovering of technologies in strategic areas like defense and space research for which an insight into nano and composite materials of modern chemistry is essential.

Course Outcomes

The concepts developed in this course will aid in quantification of several concepts in chemistry that have been introduced at the 10+2 levels in schools. Technology is being increasingly based on the electronic, atomic and molecular level modifications. Quantum theory is more than 100 years old and to understand phenomena at nanometer levels; one has to base the description of all chemical processes at molecular levels. The course will enable the student to:

1. Analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.
2. Rationalize bulk properties and processes using thermodynamic considerations & Ionic Equilibria.
3. List major chemical reactions that are used in the synthesis of molecules.
4. Apply the various methods used in treatment of water for domestic and industrial use.

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5. Discuss the various Engineering materials & Drug synthesis & their applications.

UNIT-I Atomic and molecular structure:

Molecular Orbital theory - atomic and molecular orbitals.Linear combination of atomic orbitals (LCAO) method. Molecular orbitals of diatomic molecules. Energy level diagrams of diatomics (H_2, He_2^+, N_2, O_2, O_2^-, CO, NO). Pi- molecular orbitals of butadiene , benzene and their aromaticity. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties.

UNIT-II Use of free energy in chemical equilibria and Ionic Equilibria:

Use of free energy in chemical equilibria : Thermodynamic functions: Internal energy, entropy and free energy. Significance of entropy and free energy(criteria of spontaneity).Free energy and emf (Gibbs Helmholtz equations and its applications). Cell potentials –electrochemical series.Nernst equation and its applications.Potentiometric Acid base & Redox Titrations.Numericals.

Ionic Equilibria: Solubility product, Determination of solubility product, Applications of solubility product- Determination of solubilities of sparingly soluble salts; Predicting precipitation reactions; Precipitation of an insoluble salt; Precipitation of soluble salts ; Inorganic analysis .Numericals.

UNIT- III Stereochemistry and Organic reactions

Stereochemistry: Representations of 3 dimensional structures , Symmetry and chirality, Stereoisomers - Configurational isomers (Geometrical&Optical isomers), Conformational isomers - Newman and sawhorse representations of n-butane ,enantiomers (lactic acid), diastereomers (Tartaric acid) , optical activity, absolute configurations , Sequence rules for R&S notation.

Organic reactions

Types of Organic reactions:

Substitution Reactions- Electrophilic substitution (Nitration of Benzene) ;Nucleophilic Substitution(S_N1& S_N2) ; Free Radical Substitution(Halogenation of Alkanes)

Additions Reactions:

Electrophilic Addition – Markonikoff's rule

Nucleophilic Addition – (Addition of HCN to carbonyl compounds)

Free radical Addition - Anti Markonikoff's rule (Peroxide effect)

Eliminations-E_1 and E_2 (dehydrohalogenation of alkyl halides)

Oxidation with $KMnO_4$, $K_2Cr_2O_7$; **Reduction** with $LiAlH_4$,$NaBH_4$

Cyclization (Diels - Alder reaction)

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UNIT–IV Water Chemistry:

Hardness of water – Types, units of hardness, Disadvantages of hard water , Boiler troubles - scales & sludge formation , causes and effects , Softening of water by ion exchange method and Reverse Osmosis. Specifications of potable water & industrial water. Disinfection of water by Chlorination , Ozonisation & UV radiation.

UNIT-V Engineering Materials and Drugs:

Nano materials-Introduction to nano materials and general applications, basic chemical methods of preparation- Sol gel method. Carbon nanotubes and their applications.

Composite materials- Definition, types of composites, fibre reinforced, glass fibre reinforced and carbon fibre reinforced composites and applications.

Conducting polymers- Definition, classification and applications.

Drugs-Introduction,Synthesis and uses of Aspirin (analgesic), Paracetamol (Antipyretic), Atenolol (antihypertensive).

TEXT BOOKS

1. P.C. Jain and M. Jain, "Engineering Chemistry", Dhanpat Rai Publishing Company Ltd., New Delhi,16th edition (2015).
2. W.U. Mali, G.D.Tuli and R.D.Madan, "Selected topics in Inorganic Chemistry", S Chand & Company Ltd, New Delhi, reprint (2009).
3. R.T. Morrison, R.N. Boyd and S.K. Bhattacharjee, "Organic Chemistry", Pearson, Delhi, 7th edition(2011).
4. G.L. David Krupadanam, D. Vijaya Prasad, K. Varaprasad Rao, K.L.N. Reddy and C. Sudhakar, "Drugs", Universities Press (India) Limited, Hyderabad (2007).

SUGGESTED READINGS

1. B. H. Mahan, "University Chemistry", Narosa Publishing house, New Delhi, 3rd edition (2013).
2. B.R. Puri, L.R. Sharma and M.S. Pathania, "Principles of Physical Chemistry", S. Nagin Chand & CompanyLtd.,46th edition(2013).
3. T.W. Graham Solomons, C.B. Fryhle and S.A. Snyder, "Organic Chemistry", Wiley,12th edition (2017).
4. P.W. Atkins, J.D. Paula, "Physical Chemistry", Oxford, 8thedition (2006).

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18CE C01

ENGINEERING MECHANICS

Instruction:	3L+1T Hours per Week
Duration of Semester End Examination:	3 Hours
Semester End Examination:	70 Marks
Continuous Internal Evaluation:	30 Marks
Credits:	4

Course Objectives:

1. The objective of this course is to understand the resolution of forces and to obtain resultant of all force systems, to understand moment of a force and equilibrium conditions of static loads for smooth and frictional surface
2. To obtain centroid, centre of gravity and moment of inertia for various regular and composite areas and bodies.
3. To understand the basic structural analysis, principles of virtual work and energy methods.
4. To know the basic concepts of dynamics and analysis as a particle and rigid bodies.
5. To understand the work energy principles, impulse momentum and their applications and to know the concept of simple harmonic motion and free vibration.

Course Outcomes: The students will be able to

1. Solve problems dealing with forces in plane and space force systems, draw free body diagrams to analyze various problems in equilibrium, for smooth and frictional surface.
2. Determine centroid and moment of inertia for elementary, composite areas and bodies.
3. Analyze simple trusses for forces in various members of a truss.
4. Solve problem in kinematics and kinetics of particles and rigid bodies.
5. Analyze body motion using work energy principles, impulse and momentum approach and able to apply the concepts of simple harmonic motion and free vibrations in dynamics.

Unit–I: Resolution, Resultant and Equilibrium of force system and Friction: Concepts of force, System of forces, components of forces in a plane and in space systems.Resultant of force systems.Moment of forces and its applications.Couples and its applications.Equilibrium of Force systems. Free body diagrams, equation of equilibrium of coplanar and spatial force systems. Static indeterminacy. Types of friction, Laws of friction, application of friction to a single body & connecting systems, wedge friction.

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Unit–II: Centroid, centre of gravity and moment of Inertia:
Centroid of simple figures from first principle, centroid of composite sections. Centre of gravity and its implications, Definition of Area moment of Inertia, Moment of inertia of plane section from first principles, Theorems of moment of inertia, moment of inertia of standard sections and composite sections, Mass moment of inertia of rectangular and circular plates, cylinder, cone & sphere.

Unit–III: Analysis of simple trusses, Virtual work and Energy methods:
Analysis of simple trusses using method of joints, methods of sections. Determine if a member is in tension or compression, zero force members. Virtual displacements, Principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom.Conservative forces and potential energy, energy equation for equilibrium.

Unit–IV: Particle Dynamics:
Rectilinear and curvilinear translation using rectangular, normal and tangential components.Relative and constrained motion. Newton's 2nd Law, rectangular and path coordinates. Basic terms, general principles in dynamics, D' Alembert's principle and its application in plane motion and connected bodies.Instantaneous centre of rotation in plane motion and simple problems.

Unit–V: Work- Energy, Impulse-momentum and Mechanical Vibrations:
Equation of work energy for translation and fixed axis rotation, work energy principles applied to particle motion, connected systems. Introduction to linear impulse momentum, principle of conservation of linear momentum, Impact, direct and oblique. Introduction to vibration, free and forced vibrations, simple harmonic motion, simple pendulum and compound pendulum.

Text Books:

1. Reddy Vijaykumar K. and J. Suresh Kumar," Singer's Engineering Mechanics Statics and Dynamics", B. S. Publications 2011.
2. A. Nelson, "Engineering Mechanics", Tata McGraw Hill, New Delhi, 2010.

Suggested Reading:

1. Irving H. Shames, "Engineering Mechanics", 4th Edition, Prentice Hall, 2006.
2. F. P. Beer and E. R .Johnson, "Vector Mechanics for engineers, Vol. I - Statics, Vol. II - Dynamics", 9th edition, Tata McGraw Hill, 2011.
3. R. C. Hibbeler, "Engineering Mechanics: Principles of Statics and Dynamics", Pearson Press, 2006.

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18ME C01

ENGINEERING GRAPHICS AND DESIGN

Instruction	1T+4D Hours per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation:	30 Marks
Credits	3

Course Objectives:

1. to prepare to design a system, component, or process to meet desired needs within realistic constraints.
2. to prepare the student to communicate effectively.
3. to prepare the student to use the techniques, skills, and modern. engineering tools necessary for engineering practice.
4. to get exposure to a CAD package.

Course Outcomes:

1. Introduction to engineering design and its place in society.
2. Exposure to the visual aspects of engineering design.
3. To become familiar with engineering graphics standards.
4. Exposure to solid modelling.
5. Exposure to computer-aided geometric design.
6. Exposure to creating working drawings.
7. Exposure to engineering communication.

Detailed contents

Traditional Engineering Graphics:

Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Perspective; Reading a Drawing; Sectional Views;
Dimensioning & Tolerances; True Length, Angle; intersection, Shortest Distance.

Computer Graphics:

Engineering Graphics Software; -Spatial Transformations; Orthographic Projections; Model Viewing; Coordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modeling; Solid Modeling; Introduction to Building Information Modeling (BIM).

(Except the basic essential concepts, most of the teaching part can happen concurrently in the laboratory).

UNIT-1 Introduction to Engineering Drawing:

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute;

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UNIT-2 Orthographic Projections:

Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes (without traces) ; Projections of planes inclined Planes;

Introduction to CAD package:

Listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids.

UNIT-3 Projections of Regular Solids:

Projection of Prism, Cylinder, Pyramid and Cone : Simple position, axis inclined to one of the reference plane only. Customization & CAD Drawing: consisting of set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;

UNIT-4 Sections and Sectional Views of Right Angular Solids:

Sections of solids in simple position Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids.

Annotations, layering & other functions:

applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); rinting documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer-aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and twodimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multi view, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling;

UNIT-5 Isometric Projections:

Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Viceversa, Conventions;

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Demonstration of a simple team design project:
Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; geometric dimensioning and tolerancing;
Use of solid-modeling software for creating associative models at the component and assembly levels; (Examples of specific components to the branch of study may be included).

Text Books:

1. N.D.Bhatt, Elementary Engineering Drawing, Charotar Publishers,2012.
2. K.L.Narayana and P.K.Kannaiah, –Text Book of Engineering Drawing Scitech Publications, 2011.
3. Basanth Agrawal and C M Agrawal –Engineering Drawing 2e –, McGraw-Hill Education(India) Pvt.Ltd.

Suggested Reading:

1. Shaw M.B and Rana B.C., –Engineering drawing Pearson, 2ndedition, 2009.
2. K.Veenugopal, –Engineering Drawing and Graphics + Autocad New Age International Pvt.Ltd,2011.
3. Bhattacharya. B, –Engineering Graphics I. K. International Pvt.Ltd, 2009.

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18EE C01

BASIC ELECTRICAL ENGINEERING

Instruction:	3L+1T Hours per Week
Duration of Semester End Examination:	3 Hours
Semester End Examination:	70 Marks
Continuous Internal Evaluation:	30 Marks
Credits:	4

Course Objectives:

1. To understand the behavior of different circuit elements R,L & C, and the basic concepts of electrical circuit analysis.
2. To know the concepts of AC circuits, RMS value, Average value, Phasor analysis etc., 3. To understand the basic principle of operation of Transformer and DC machines.
4. To understand the basic principle of operation of DC machines and AC machines.
5. To know about different types of electrical wires and cables, domestic and industrial wiring.
6. To understand safety rules and methods of earthing.

Course Outcomes: At the end of the course, the student will be able to

1. Acquire the concepts of Kirchhoff's laws and network theorems and able to get the solution of simple dc circuits.
2. Obtain the steady state response of RLC circuits and also determine the different powers in AC circuits.
3. Acquire the concepts of principle of operation of Transformers and DC machines.
4. Acquire the concepts of principle of operation of DC machines and AC machines.
5. Acquire the knowledge of electrical wiring and cables and electrical safety precautions.
6. Recognize importance of earthing and methods of earthing and electrical installations.

UNIT-I: DC Circuits

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation, Superposition, Thevenin and Norton Theorems, Time-domain analysis of first order RL and RC circuits.

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UNIT-II: AC Circuits

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor, Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel). Three phase balanced circuits, voltage and current relations in star and delta connections.

UNIT-III: Transformers

Construction, Working principle, EMF Equation, Ideal and Practical transformer, Equivalent circuit of Transformer, OC and SC tests on a transformer, Efficiency and Regulation, Auto transformer

UNIT-IV: DC and AC Machines

DC Generators: Construction, Principle of operation, EMF equation, Classification, Characteristics of shunt, series and compound generators. DC Motors: Classification, Torque equation, Characteristics, Efficiency, Speed Control of Series and Shunt Motors. Three - Phase Induction Motors: Construction, Principle of operation, Torque equation, torque-slip characteristics, Power stages, speed control of induction motors.

UNIT-V: Electrical Installations

Electrical Wiring: Types of wires and cables, Electrical Safety precautions in handling electrical appliances, electric shock, first aid for electric shock, safety rules. Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Earthing, Elementary calculations for energy consumption.

Text books:

1. L. S. Bobrow, Fundamentals of Electrical Engineering, Oxford University Press, 2011.
2. E. Hughes, Electrical and Electronics Technology, Pearson, 2010.

Suggested Reading:

1. D. P. Kothari & I. J. Nagrath, –Basic Electrical Engineering .Tata McGraw Hill, 2010.
2. V. D. Toro, –Electrical Engineering Fundamentals Prentice Hall India, 1989.
3. D.C. Kulshreshtha, –Basic Electrical Engineering McGraw Hill,2009
4. P.V.Prasad, S.sivanagaraju, R.Prasad, "Basic Electrical and Electronics Engineering" Cengage Learning, 1st Edition, 2013.

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18EE C02

BASIC ELECTRICAL ENGINEERING LAB

Instruction	2 Hours per week
Duration of Semester End Examination	2 Hours
Semester End Examination	35 Marks
Continuous Internal Evaluation:	15 Marks
Credits	1

Course Objectives:

1. To acquire the knowledge of different types of electrical elements.
2. To verify the basic electrical circuit laws and theorems.
3. To determine the parameters and power factor of a coil.
4. To calculate the time and frequency responses of RLC circuits
5. To determine the characteristics of Transformers.
6. To determine the characteristics of dc and ac machines.

Course Outcomes: At the end of the course, the students are expected to

1. Get an exposure to common electrical components and their ratings.
2. Make electrical connections by wires of appropriate ratings.
3. Understand the circuit analysis techniques.
4. Determine the parameters of the given coil.
5. Understand the basic characteristics of transformer.
6. Understand the basic characteristics of dc and ac machines.

List of Laboratory Experiments/Demonstrations:

1. Demonstration of Measuring Instruments and Electrical Lab components
2. Verification of KCL and KVL.
3. Time response of RL and RC circuits.
4. Calculation of permittivity of a choke or coil by Wattmeter Method.
5. Verification of Thevenin's and Norton's theorems.
6. Turns ratio /voltage ratio verification of 1-Ph Transformers.
7. OC and SC tests on a given 1-Ph Transformer.
8. Observation of Excitation Phenomenon in Transformer.
9. Measurement of 3-Ph power in a balanced system (By 2- Wattmeter method).
10. Measurement of 3-Ph Energy by an Energy Meter (Demonstration of Principle).
11. Load test of DC Shunt motor.
12. Speed control of DC Shunt motor.
13. Load test of 3-Ph Induction motor.
14. Demonstration of LT Switchgear Equipment/Components.
15. Demonstration of cut - out section of Machines like DC Machine, Induction Machine, etc.

Note: at least **TEN** experiments should be conducted in the semester.

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18CY C02

CHEMISTRY LAB

(Common to all branches)

Instruction:	3 Hours per Week
Duration of Semester End Examination:	3 Hours
Semester End Examination:	50 Marks
Continuous Internal Evaluation:	25 Marks
Credits:	1.5

Course Objectives

1. To impart fundamental knowledge in handling the equipment / glassware and chemicals in chemistry laboratory
2. The student should be conversant with the principles of volumetric analysis and identification of organic functional groups.
3. To apply various instrumental methods to analyze the chemical compounds and to improve understanding of theoretical concepts.

Course Outcomes

The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering.

The students will learn to:

1. Estimate rate constants of reactions from concentration of reactants/ products as a function of time.
2. Measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water, etc
3. Synthesize a small drug molecule and Identify the organic compounds.
4. understand importance of analytical instrumentation for different chemical analysis.
5. Perform interdisciplinary research such that the findings benefit the common man.

Chemistry Lab

1. Estimation of temporary and permanent hardness of water using EDTA solution.
2. Estimation of amount of chloride in water.
3. Determination of rate constant for the reaction of hydrolysis of methyl acetate (first order).
4. Estimation of amount of HCl Conductometerically using NaOH solution.

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5. Estimation of (a) amount of CH_3 COOH Conductometerically using NaOH solution. (b) amount of HCl and CH_3 COOH present in the given mixture of acids Conductometerically using NaOH solution.
6. Estimation of amount of HCl Potentiometrically using NaOH solution.
7. Estimation of amount of Fe^{+2} Potentiometrically using $KMnO_4$ solution.
8. Distribution of acetic acid between n-butanol and water.
9. Synthesis of drug - Aspirin.
10. Organic Chemistry- Identification of Functional groups - neutral group (carbonyl groups-acetaldehyde and acetone); acidic group(benzoic acid) ; basic group (aniline).
11. Determination of surface tension of organic solvents (ethanol, ethyl acetate).
12. Determination of Viscosity.

TEXT BOOKS

1. J. Mendham and Thomas ,"Vogel' s text book of quantitative chemical analysis", Pearson education Pvt.Ltd., New Delhi , 6th ed. 2002.

SUGGESTED READINGS

1. Dr. Subdharani , "Laboratory Manual on Engineering Chemistry", Dhanpat Rai Publishing, 2012.
2. S.S. Dara , "A Textbook on experiment and calculation in engineering chemistry", S.Chand and Company, 9th revised edition, 2015.

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16MT C05

ENGINEERING MATHEMATICS-III

Instruction	3 Hours per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course objectives:

1. To study the expansion of functions in various intervals.
2. To form P.D.E and to find its solution.
3. To solve Wave, Heat & Laplace equations.
4. To learn Differentiation and Integration of complex valued functions.
5. To evaluate Complex Integration.
6. To evaluate Real definite integrals.

Course outcomes: On successful completion of this course the student will be able to

1. Expand functions in the given intervals.
2. Solve linear and non linear PDEs.
3. Solve one-dimension, two-dimension, Heat steady state equations and also one-dimension wave equation.
4. Solve problems on Analytic functions, Cauchy's theorem and Cauchy's integral formula.
5. Expand functions by using Taylor's and Laurent's series.
6. Solve Real and Complex integrals by using Cauchy Theorems.

UNIT – I

Fourier series: Definition of Periodic, Single valued, finite maxima and minima of functions. Euler's Formulae, Dirichlets Conditions for Fourier expansion, Functions having points of discontinuity, Change of interval, Expansion of odd and even functions, Half-range sine series and cosine series.

UNIT-II:

Partial differential equations: Formation of partial differential equations by eliminating the arbitrary constants or arbitrary functions, solutions of linear partial differential equation of first order by using Lagrange's Method, solution of Non-linear partial differential equations of first order by using standard types, Charpit's Method.

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UNIT - III

Applications of Partial differential equations: Solution of partial differential equations by using method of separation of variables, solution of vibration of a stretched string (1D-Wave equation), one dimensional heat equation, Two dimensional heat equation under steady state conditions.

UNIT - IV

Theory of Complex variables: Analytic functions, Cauchy Riemann equations (Cartesian and polar forms), construction of Analytic functions by using Milne-Thomson's method. Harmonic function. Complex line integrals, Cauchy's theorem, Cauchy's Integral formula and its derivatives and problems related to the above theorems.

UNIT - V

Expansion of functions, Singularities & Residues: Taylor's and Laurent's series Expansions (Only statements). Zeros, types of singularities, Residues and Cauchy's Residue theorem, Evaluation of real integrals by Cauchy's residue theorem. Evaluation of improper real integrals of the type: $\int_{-\infty}^{\infty} f(x)dx$ Where f(x) has no poles on real axis and $\int_0^{2\pi} f(\sin\theta, \cos\theta)d\theta$.

Text Books:

1. B.S. Grewal, Higher Engineering Mathematics, 43rd Edition, Khanna Publishers, 2015.
2. M.D. Raisinghania, Advanced Differential equations, 7th edition, S Chand publishers, 2013.
3. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Edition, McGraw Hill publishers, 2003.

Suggested Reading:

1. N P Bali and Manish Goyal, A Text Book of Engineering Mathematics, 9th Edition, Laxmi publishers, 2016.
2. Alan Jeffrey, Mathematics for Engineers and Scientists, 6th Edition, Chapman & Hall/CRC publishers, 2013.
3. A R Vasistha and R K Gupta, Integral transforms, Krishna prakashan publishers, 2004.
4. R.K.Jain & S.R.K.Iyenger, Advanced Engineering Mathematics, 3rd Edition, Narosa Publications, 2007.

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16ME C04

MATERIAL SCIENCE AND METALLURGY

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: Student will

1. Enable to understand structure property relations, analyze the failures of metals and their prevention.
2. To broad understanding of phase diagrams.
3. Acquire basic knowledge in various heat treatment operations, their purpose and applications.
4. Expose to various methods of extractive metallurgy techniques.
5. Understand various modes of failure and suggest mechanisms for preventions of failures.
6. Understand applications of conventional metals and alloys.

Course Outcomes: On successful completion of this course the student will be able to

1. Know the fundamental science and engineering principles relevant to material.
2. Suggest appropriate physical metallurgical methods (phase diagrams).
3. The type of heat treatment operation to be given to any metal in order to improve desired Mechanical properties.
4. Basic ability to plan an extraction process for given ore.
5. Suggest the appropriate methods for prevention of failures.
6. Analyze the applications of conventional metals and alloys.

UNIT–I

Imperfections in crystals, dislocation in crystals, types of dislocations, effect of slip and twinning on the plastic deformation, cold and hot working, strain hardening and Bauchinger effect, recovery, recrystallization, grain growth and its effect.
on mechanical properties of metals.

Fracture: Types of fracture in metals, modes of fracture, Griffith theory of brittle fracture, crack propagation, ductile fracture, fracture under combined stress.

UNIT–II

Fatigue: S–N curve, Structure of fatigue fracture specimen. Fatigue crack propagation, effect of metallurgical variables on fatigue of metal, low cycle fatigue, experimental determination of fatigue strength (RR–Moore test).

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Creep: Creep strength, creep curve, creep deformation mechanisms, creep test.

Diffusion: Fick's law of diffusion, application of diffusion theory in mechanical engineering.

UNIT–III

Structure of Alloys: study of eutectic, eutectoid, peritectic and peritectoid reactions, Iron–Iron Carbide equilibrium diagram, construction and interpretation.

Types of plain carbon steels, cast irons and their properties and characteristics.

UNIT–IV

Heat Treatment: Annealing, normalising, hardening, tempering, Construction and interpretation of T–T–T diagram, austempering and martempering, case hardening, carburizing, nitriding, carbo–nitriding, flame hardening, induction hardening.

UNIT–V

Introduction to Extractive Metallurgy: Method of production of pig iron by blast furnace, cast iron by cupola furnace, Method of production of steel by Bessemer convertor, L.D process and electric arc process.

Alloy Steels: Effects of alloying elements like nickel, chromium, manganese, silicon tungsten, and titanium, Study about stainless steels, HSS, brass, bronze; their composition and properties.

Text Books:

1. V. Raghavan, Materials Science and Engineering, Prentice Hall of India Ltd., 4th Edn. ,2005.
2. S.H. Avner, Introduction to Physical Metallurgy, Tata McGraw Hill Publishers, 2nd Edn., 2005.

Suggested Reading:

1. S.P. Nayak, Engineering Metallurgy and Material Science, Charoter Publishing House, 6th Edn., 2005.
2. E. Dieter, Mechanical Metallurgy, Metric Edition, Tata McGraw Hill, 3rd Edn, 2005.
3. K.L. Kakani, Material Science, New Age Publications (P) Ltd., 2008.

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16ME C05

MECHANICS OF MATERIALS

Instruction	3L+1T Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	4

Pre-Requisites: Engineering Mathematics, Engineering Mechanics.

Course Objectives:

1. Student is exposed to the concept of different types of loads, stresses, strains and analysis of members for axial loads.
2. Student will acquire knowledge in drawing bending and shear force diagrams of beams for various loads.
3. Student becomes familiar with methods of evaluation of deflection of beams of various configurations and stresses that arise due to simple bending.
4. Student is exposed to the concept of principal stresses and phenomenon of torsion.
5. Student will acquire knowledge in estimating stresses for thin and thick cylindrical shells.
6. Student will acquire knowledge in estimating crippling load in buckling for various columns and struts.

Course Outcomes:

Students who successfully complete this course will have demonstrated ability to:

1. Classify the materials, stresses, strains and understand engineering constants, poisons ratio along with relation between them. Also analyze axially loaded members.
2. Draw shear force, bending moment diagrams for different types of beams and calculate stresses and strains due to simple bending.
3. Determine slope and deflection for various configurations of beams using different methods and stress, strain and deflection due to torsion of circular members.
4. Analyze shear stress distribution in different sections of beams.
5. Understand compound stresses, calculation of principal stresses analytically and graphically using Mohr's circle.

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6. Estimate stresses in thin and thick cylinders. Also estimate critical load in buckling for various columns and struts.

UNIT–I

Stresses and Strains: Definitions, types of stresses and strains, elasticity and plasticity. Hooke's law, stress-strain diagrams for engineering materials, modulus of elasticity. Poisson's ratio, relationship between elastic constants, linear and volumetric strains, bars of uniform strength, temperature stresses, compound bars.

UNIT–II

Beams: Definition of bending moment and shear force; relationship between intensity of loading, shear force and bending moment; bending moment and shear force diagrams for cantilever, simply supported and overhanging beams; simple theory of bending, moment of resistance, modulus of section.

UNIT–III

Slopes and Deflections: Slope and deflection measurements of cantilever, simply supported beams with Macaulay's and double integration methods subjected to point loads and uniformly distributed loads.

Torsion: Derivation of torsion formula for circular sections, torsional stresses, angle of twist, power transmission, effect of combined bending and torsion.

UNIT–IV

Shear Stresses in beams: Distribution of shear stresses in rectangular, I-section and T-section for solid and hollow sections.

Compound stresses, principal stresses and strains. Mohr's circle of stress.

UNIT–V

Cylinders: Stresses in thin and thick cylinders with internal and external pressures. Hoop and longitudinal stresses in cylinders, stresses in compound cylinders.

Columns and struts: Euler's and Rankine's formulae for axial load applications. Secant and Perry formulae for eccentrically loaded columns.

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Text Books:

1. S.S.Rattan, "Strength of materials", Tata Mc-Graw Hill, 3rd Edition, 2016.
2. S. Ramamrutham, "Strength of Materials", Dhanpatrai and Sons, 1993.
3. G.H.Ryder, "Strength of materials", 3rd Edition in SI Units, Macmillan India Limited, Delhi 2002.

Suggested Reading:

1. S.S. Bhavakatti, Strength of Materials, Vikas Publication, 2003.
2. B.C. Punmia, Strength of Materials and Theory of Structures, Laxmi Pub., 1992.
3. G.H. Ryder, Strength of Materials, Third Edition in SI units, Macmillan India Limited, Delhi, 2002

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16ME C06

FLUID DYNAMICS

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: Student will understand

1. The fluid properties and different fluids.
2. The centre of pressure and stability conditions.
3. The importance of stream function and velocity potential function.
4. The equations related to Fluid dynamics.
5. Different types of fluid flows.
6. Major and minor losses of fluid flows.

Course Outcome: On successful completion of this course the student will be able to

1. Differentiate different types of fluids.
2. Calculate centre of buoyancy and metacentric height.
3. Differentiate rotational and irrotational flows.
4. Determine forces exerted on fluid body.
5. Differentiate laminar over turbulent flows.
6. Determine various losses incurred in fluid flows.

UNIT–I

Properties of fluids: Definition of fluid and concept of continuum. Difference between ideal and real fluids. Classification of fluids. Fluid properties: Pressure, Density, Specific weight, Specific volume, Dynamic and Kinematic viscosity, Compressibility and Bulk modulus, Surface tension and Capillarity.

Pressure measurement: Fluid pressure at a point, pascal's law, Hydrostatic law, Measurement of pressure by different manometers.

UNIT–II

Fluid Statics: Total pressure, centre of pressure, total pressure and centre of pressure on plane surfaces like horizontal plate, vertical plate, inclined plate and curved surfaces.

Buoyancy and Floatation: Buoyancy, buoyant force, centre of buoyancy, Meta centre, stability for submerged and floating bodies.

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UNIT-III

Fluid Kinematics: Classification of fluid flow: steady and unsteady, uniform and non-uniform, laminar and turbulent, rotational and irrotational,

one, two and three dimensional flows, General concepts of path line, stream line and stream tube. Definition and properties of stream function, velocity potential function and use of flow nets.

UNIT–IV

Fluid Dynamics: Energy of fluid body, potential energy and potential head, pressure energy and pressure head, kinetic energy and kinetic head, derivation of Euler's and Bernoulli's equations and their applications like venturi meter, orifice meter, pitot tube, impulse momentum equation and applications. Discharge equations for weirs and notches.

UNIT–V

Laminar and Turbulent flow in pipes: Distinction between laminar and turbulent flows, Reynold's number and its significance, upper and lower critical values of Reynold's number for flow in pipes, development of laminar and turbulent flow in circular pipes. Hagen–Poiseuille equation, frictional losses in pipes, Darcy equation, estimation of Darcy's friction factor, empirical formulae and Moody's chart.

Flow through pipes: Loss of energy in pipes, Major losses, Minor losses, Hydraulic gradient and total energy lines.

Text Books:

1. P.N.Modi and S.M.Seth, Hydraulic and Fluid Mechanics, Standard Book House, 2010.
2. R.K.Rajput, Fluid Mechanics and Hydraulic Machines, S. Chand and Company, 2010.

Suggested Reading:

1. K.L.Kumar, Engineering Fluid Mechanics, Eurasia Publishing House, 2005.
2. V.L.Streeter, Fluid Mechanics, Mc.Graw Hill Co. Ltd., 2005.
3. D.S.Kumar, Fluid Mechanics, S.K. Kataria and Sons, 2010.

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16ME C07

MACHINE DRAWING

Instruction	1L+2D Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	2

Pre-Requisites: The student is required to have an idea about Engineering Drawing

Course Objectives: Student will

1. Understand drawing and develop capacity to represent any object with the help of sketch.
2. Study the conventions and rules to be followed by engineers for making accurate drawings.
3. Understand the basic dimensioning practices that have to be followed in the preparation of Drawings.

Course Outcomes:

On successful completion of this course the students will be able to:

1. Draw conventional representation of different materials and mechanical components.
2. Read the working drawings in the machine shop.
3. Draw the orthographic projections and sectional views of machine parts.
4. Draw missing views as well as to analyze and interpret drawings of machine components.
5. Understand the shape and structure of different types of screws, keys, couplings, and rivets.
6. Draw assembly drawings of certain Machine Tools, Engine parts and Valves etc.

1. INTRODUCTION:

Format of drawing sheet, title block, conventions of drawing lines and dimensions, First and third angles projections, conversion of Pictorial view to orthographic views, convention for sectional views. Orthographic projections including sectional views of simple machine elements.

2. DRAWING OF FASTENERS, JOINTS AND COUPLINGS:

Practices of sketching work: Free hand sketches of typical machine elements for simple cases for riveted and screwed fastening, joints, couplings (To indicate proportions).

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3. ASSEMBLY DRAWING:

Preparation of assembly drawings from given details, Ability to supply additional views. The exercises will be drawings of typical machine parts like:

1. Bearings-Plummer block(Pedestal bearing),
2. Petrol Engine Connecting rod,
3. Eccentric,
4. Cross head,
5. Stuffing box,
6. Pipe vice,
7. Screw jack,
8. Lathe Tail-stock
9. Single Tool Post,
10. Revolving centre.

Note: The test is for the ability of the student to read and interpret drawings. The drawing should include part list in standard format.

Text Books:

1. N. Siddeshwar, Machine Drawing, Tata McGraw Hill Publishing Co., Ltd., 5th Edition, 2004.
2. N.D. Bhatt, V.M. Panchel, Machine Drawing, Cherotar Publishing house, Anand, New Delhi, 49th Edition, 2014.

Suggested Reading:

1. K.L. Narayan, P. Kanniah, K. Venkat Reddy, Machine Drawing, New Age International (P) Ltd., 2nd Edition, 2009.
2. K.C. John, Text book of Machine Drawing, PHI Learning, 2010.
3. Ajeet Singh, Machine Drawing, Galgotia Publications, 2010.

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16MB C01

ENGINEERING ECONOMICS AND ACCOUNTANCY

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: Students will

1. introduce managerial economics and demonstrate its importance in managerial decision making.
2. develop an understanding of demand and relevance of its forecasting in the business.
3. provide the basics of market structure and the concept of equilibrium in different market structures.
4. examine the economic analysis of production process, types of inputs and to explain different costs and their relationship with the output.
5. understand the importance of project evaluation in achieving a firm's objective.
6. explain the concept of Accountancy and provided knowledge on preparation and analysis of Final accounts.

Course Outcomes: After completion of the course, student will be able to:

1. apply fundamental knowledge of Managerial economics concepts and tools.
2. understand various aspects of demand analysis and forecasting.
3. understand price determination for different markets.
4. study production theory and analyze various costs and benefits involved in it so as to make best use of resources available.
5. analyze different opportunities and come out with best feasible capital investment decisions.
6. apply accountancy concepts and conventions, Final accounts and financial analysis.

UNIT-I:

Introduction to Managerial Economics: Introduction to Economics and its evolution - Managerial Economics - its scope, importance, Its usefulness to engineers - Basic concepts of Managerial economics.

UNIT-II:

Demand Analysis: Demand Analysis - Concept of demand, determinants, Law of demand, its assumptions, Elasticity of demand, price, income and

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cross elasticity, Demand Forecasting – Types of Market structures. (Simple numerical problems).

UNIT-III:

Production and Cost Analysis: Theory of Production - Firm and Industry - Production function - input-out relations - laws of returns - internal and external economies of scale. Cost Analysis: Cost concepts - fixed and variable costs - explicit and implicit costs - out of pocket costs and imputed costs - Opportunity cost - Cost output relationship - Break-even analysis. (Theory and problems).

UNIT-IV:

Accountancy: Book-keeping, principles and significance of double entry book keeping, Journal, Subsidiary books, Ledger accounts, Trial Balance concept and preparation of Final Accounts with simple adjustments.

UNIT-V:

Capital Budgeting: Introduction to capital budgeting, Methods: traditional and discounted cash flow methods. Introduction to Working capital management. (Numerical problems).

Text Books:

1. Mehta P.L., Managerial Economics – Analysis, Problems and Cases, Sultan Chand and Son's Educational publishers, 2013.
2. Maheswari S.N., Introduction to Accountancy, Vikas Publishing House, 2013.
3. Panday I.M., Financial Management, Vikas Publishing House, 11th edition, 2015.

Suggested Reading:

1. Varshney and KL Maheswari, Managerial Economics, Sultan Chand, 2014.
2. M.Kasi Reddy and S.Saraswathi, Managerial Economics and Financial Accounting, Prentice Hall of India Pvt Ltd, 2007.
3. A.R.Aryasri, Managerial Economics and Financial Analysis, McGraw-Hill, 2013.

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16ME C08

MATERIAL SCIENCE AND METALLURGY LAB

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	25 Marks
Credits	3

Course Objectives: Students will

1. Acquire basic knowledge by understanding iron-carbide diagram and its application in engineering.
2. Expose to Metallographic study and analysis of various metals.
3. Acquire knowledge in determining the hardness of metals before and after various Heattreatment operations.
4. Understand differences between different heat treatment methods.
5. Expose to T-T-T curve and its application in engineering metallurgy.
6. Understand the relation between micro structure and properties.

Course Outcomes: On successful completion of this course the students will be able to

1. Identify crystal structure of various metals.
2. Measure hardness and can correlate with microstructure.
3. Perform a suitable heat treatment operation based on desired properties.
4. Underlines the importance of grain size in evaluating the desired mechanical properties.
5. Understand the process of heating and cooling for various heat treatment methods.
6. Correlate the heat treatment methods and the mechanical properties obtained.

List of the Experiments

1. Study of: Metallurgical Microscope, Allotropes of Iron, Iron-Iron carbide diagram, Procedure for specimen preparation.
2. Observations for the following specimens - i) Low carbon steels, ii) Medium carbon steels, iii) Eutectoid steels, iv) High Carbon steels, v)Stainless steels, vi) Case carburized, vii)HSS, viii) White cast iron, ix) Gray cast iron, x) alleable iron, xi)Spheroidal iron, xii) Al–Si alloy and determination of grain size using Image Analyzer.
3. Preparations of the following specimens : i) $\alpha - \beta$ Brass, ii)Normalised steel iii)Medium carbon steel iv)Nodular cast iron v) Grey cast iron.

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4. Heat Treatment Processes
   i) Annealing
   ii) Normalizing
   iii) Hardening.

Text Books:

1. V. Raghavan, Materials Science and Engineering, Prentice Hall of India Ltd., 4th Edition. ,2005.
2. S.H. Avner, Introduction to Physical Metallurgy, Tata McGraw Hill Publishers, 2nd Edition., 2005.

Suggested Reading:

1. S.P. Nayak, Engineering Metallurgy and Material Science, Charoter Publishing House, 6th Edition., 2005.
2. E. Dieter, Mechanical Metallurgy, Metric Edition, Tata McGraw Hill, 3rd Edition, 2005.
3. K.L. Kakani, Material Science, New Age Publications (P) Ltd.,2008.

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16ME C09

MECHANICS OF MATERIALS LAB

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	25 Marks
Credits	3

Course Objectives:

1. To apply mechanics of materials theory on real specimens and learn the practical testing procedures and concepts.
2. Demonstrate an understanding of tension, and the relationship between stress, strain and application of Hooke's law.
3. Demonstrate an understanding of types of beams, deflections and measurement of material property through deflections.
4. Demonstrate an understanding of torsion and deformations resulting from torsion.
5. To demonstrate the understanding of hardness and its measurement using different scales like Brinnel and Rockwell.
6. To demonstrate an understanding of measurement of shear modulus and young's modulus for machine members like helical and leaf springs through loading respectively.

Course Outcomes: Students who successfully complete this course will have demonstrated ability to:

1. Draw stress-strain curve for an isotropic material and understand the salient features of it.
2. Demonstrate in determining the Young's modulus of various beam materials by conducting load-deflection test.
3. Evaluate rigidity modulus of a given shaft specimen by torsion test.
4. Able to find out Young's modulus and shear modulus for mechanical components like leaf spring and closely coiled helical spring through load-deflection test respectively.
5. Evaluate hardness of different materials using different scales and also estimate the impact resistance of a material by conducting impact tests.

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6. Find the compressive and crushing strengths of concrete cubes and bricks.

List of Experiments

1. Uni-axial tension test using UTM.
2. Brinnel's and Rockwell's hardness tests.
3. Deflection test on propped cantilever.
4. Deflection test on a helical spring to determine the rigidity modulus.
5. Torsion of shaft to determine the rigidity modulus of shaft material.
6. Defection test on a cantilever beam to determine the Young's modulus.
7. Deflection test on a simply supported beam to determine the Young's modulus.
8. Deflection test on continuous beam to determine the Young's modulus.
9. Load-deflection test on a leaf spring to find out the young's modulus of leaf material.
10. Crushing and compression test on bricks and concrete cubes.

Text Books:

1. S.S.Rattan, Strength of materials, Tata Mc-Graw Hill, 3rd Edition, 2016.
2. S. Ramamrutham, Strength of Materials, Dhanpatrai and Sons, 1993.
3. G.H.Ryder, Strength of Materials, 3rd Edition in SI Units, Macmillan India Limited, Delhi 2002.

Suggested Reading:

1. S.S. Bhavakatti, Strength of Materials, Vikas Publication, 2003.
2. B.C. Punmia, Strength of Materials and Theory of Structures, Laxmi Pub., 1992.
3. G.H. Ryder, Strength of Materials, Third Edition in SI units, Macmillan India Limited, Delhi, 2002.

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COMPUTER DRAFTING LAB

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	25 Marks
Credits	2

Course Objectives: Students will

1. Acquire knowledge in 2D drafting tools.
2. Acquire knowledge in graphic communication.
3. Expose to design methodologies.
4. Acquire knowledge in concept of layers.

Course Outcomes: On successful completion of this course the students will be able to

1. Demonstrates Graphics and design competencies.
2. Apply CAD techniques for 2D modeling.
3. Develops an ability to think 3D and interpret data from blue prints and sketches, layers concepts.
4. Apply and draw orthographic projections with the knowledge of correct graphics communication (drawings).
5. Draw 2D drawings and sectional views of part models.
6. Draw 2D drawings and sectional views of assembly models.

Application Software Tool: **Auto CAD / Solid Works**

1. **INTRODUCTION TO SOLIDWORKS DRG EDITOR/ AUTOCAD :**
   XY Coordinate system, Angular measurement, Setting of Units, Limits, Absolute, Relative and Polar Coordinates, zoom, Text, Multiline Text, Creating Title Block – Title, Drawing Number, Drawn, Checked, Approved, Angle of Projection, Scale, Basic Toolbars and commands - Format, View, Draw, Dimension, Modify Tool bars, Draw tool bar options - line, Circle, Rectangle, Ellipse, Spline and Arc , Modify tool bar options- Trim, Extend, Offset, Fillet, Chamfer, Mirror, Break, Array, Polar, Rectangular, Move, Copy, Stretch, Rotate ESNAP, SNAP, Grid, Ortho, Dimension Tool bar –aligned, angular, linear and annotations, leader line. Setting Dimension Style. View Tool bar - Orbit, Render, 3D Views (SW, SE, NE, NW Isometric Views).

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2. **EXERCISES FOR PRACTICE:**
Square headed spanner, circular, rectangular components, concentric squares, circle inscribed in a square and rectangle. Fork, Depth Stop, Pump Housing, Geneva Wheel. Importance of Layer - Layer and object properties; construction line, object line, hidden line, centre line, hatching, dimensioning, leader, Options like - Region, Extrude.

3. **EXERCISES FOR PRACTICE:**
2D drawings and sectional views - Shaft support, Sliding Block, Bearing Bracket, Shaft bracket, Anchor bracket, Piston of Petrol Engine, Petrol Engine Connecting Rod.

4. **EXERCISES FOR PRACTICE:**
2D drawings of Components of Screw Jack, Components of Plummer Block.

Text Books:

1. Machine Drawing, K L Narayana, Kannaiah & Venkat Reddy.
2. Solidworks Drawing and Training Manual.
3. Autocad Command Reference manual.

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KINEMATICS OF MACHINES

Instruction	3L+1T Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	4

Course Objectives: Student will acquire knowledge in

1. Analysis of mechanisms.
2. Drawing displacement diagrams for followers with various types of motions.
3. Cam profile drawing for various followers.
4. Estimation of transmission of power by belts and application of various gears and gear trains.

Course Outcomes: Student will demonstrate knowledge in

1. Understanding basic elements of machinery and their motion characteristics.
2. Designing a suitable mechanism depending on application.
3. Drawing displacement diagrams and cam profile diagram for followers executing different types of motions and various configurations of followers.
4. Drawing velocity and acceleration diagrams for different mechanisms.
5. Selecting gear and gear train depending on application.
6. Selection of suitable clutch, brake.

UNIT–I

Introduction: Definition of link, element, pair, kinematic chain, mechanism and machine, Grubler's criterion, single and double slider chains, inversions of quadratic chain, inversions of single and double slider crank chains. Mechanism with lower pairs and straight line motion mechanism, Pantograph and Geneva mechanisms. Ackerman and Davis steering gear mechanisms and Hooke's Joint. Peaucellier, Hart, Scott-Russel, Watt and Tchebicheff mechanisms.

UNIT–II

Analysis of mechanisms: Graphical methods to find velocities of mechanisms, instantaneous centre, body centre and space centre, Kennedy's theorem, graphical determination of acceleration of different mechanisms including Coriolis component of acceleration, analytical method to find the velocity and acceleration, analysis of four bar mechanism with turning pairs, Freudenstein's method for synthesis of four bar linkage.

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UNIT–III

Laws of Friction: Friction in screw threads, pivots, collars, Clutches - Single and Multi plate, Cone and centrifugal clutches. Friction circle and friction axis of a link.

Brakes and Dynamometers: Block or shoe, band and block, internal expanding shoe brake, Prony, rope brake, belt transmission, torsion dynamometers.

UNIT–IV

Cams: Types of cams and followers, displacement diagrams for followers, uniform motion, parabolic motion, simple harmonic motion, cycloidal motion, drawing cam profile with knife edge follower, translating roller follower and translating flat follower. Cams of specified contours, tangent cam with roller follower, circular arc (convex) cam with roller follower.

UNIT–V

Gears: Classification of gears, spur gears, nomenclature, law of gear tooth action, involute as gear tooth profile, interference of involute gears, minimum number of teeth to avoid interference, contact ratio, cycloidal tooth profile, comparison of involute and cycliodal tooth profile.

Helical Gears: Helical gear tooth relations, contact of helical gear teeth,

Gear trains: Gear trains–simple and compound, reverted and epicyclic gear trains. Differential of an Automobile.

Text Books:

1. Thomas Bevan, Theory of Machines, CBS Publishers, 2009.
2. S.S. Rattan, Theory of Machines, Tata McGraw Hill Publishers, 4th Edition, 2013.
3. J.E.Shigley, Theory of Machines, Tata Mc.Graw Hill Publishers, New Delhi, 3rd Edition, 2005.

Suggested Reading:

1. C.S. Sharma and Kamlesh Purohit, Theory of Mechanisms and Machines PHI Learning Pvt. Limited, 2006.
2. Amitabh Ghosh and A.K.Mallik, Theory of Machines, East West Publications, 3rd Edition, 2009.

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THERMODYNAMICS

Instruction	4 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	4

Course Objectives: Student will understand

1. Basic definitions of thermodynamics and significance of Zeroth law of thermodynamics.
2. The importance and application of first law of thermodynamics.
3. The various laws associated with second law of thermodynamics.
4. Properties of pure substances and use of Molier diagram.
5. Various air standard cycles, their importance and their comparison.
6. Calculation procedures of the air-fuel ratio.

Course Outcomes: On successful completion of this course the students will be able to

1. Estimate the temperature of different scales of thermometers.
2. Apply the first law of thermodynamics process to various thermodynamics processes.
3. Understand the meaning of perpetual motion of machine of second kind and its significance.
4. Read data from the chart of Mollier diagram and its applications.
5. Distinguish working principles of various IC engines like diesel engine, petrol engine.
6. Calculate theoretical air–fuel ratios required for combustion of fuels and also convert from gravimetric analysis to volumetric analysis and vice versa.

UNIT–I

Introduction: Thermodynamics, Macroscopic and Microscopic approaches, thermodynamic systems, properties, processes and cycles, thermodynamic equilibrium, quasi – static process, measurement of pressure, Zeroth law of thermodynamics and its significance, measurement of temperature, reference points, ideal gas equation.

UNIT–II

First Law of Thermodynamics: Concept of heat and work, first law of thermodynamics for closed system, energy- a property of the system, application of first law to various thermodynamic processes like isobaric, isochoric, isothermal, adiabatic and polytropic, definition of enthalpy,

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PMM1, first law applied to flow processes, application of SFEE to nozzle and diffuser, throttling device, turbine and compressor.

UNIT–III

Second Law of Thermodynamics: Limitations of first law of thermodynamics, Kelvin–Planck and Clausius statements of second law of thermodynamics, PMM2, equivalence of Kelvin-Planck and Clausius statement, reversible and irreversible processes, Carnot theorem, Clausius inequality, calculation of entropy change during various thermodynamic processes, principle of entropy increase, T–S diagrams, application of entropy principle for mixing of two fluids. Helmholtz and Gibb's functions.

UNIT–IV

Thermodynamic Properties of Fluids: Properties of pure substances, p–v diagram, p–T diagram, p–v–T surface, T–s diagram, h–s diagram, dryness fraction, use of steam tables, Maxwell relations.

UNIT–V

Air Standard Cycles: Air standard cycles - Otto, Diesel, Dual Combustion Cycles, working principle, derivation of expression for air standard efficiency, comparison of otto, diesel and dual cycles-for the same compression ratio, for the same maximum pressure and temperature.

Vapour Power Cycles: Vapour power cycles - Carnot cycle, Simple Rankine cycle.

Fuels and Combustion: Characteristics of an ideal fuel, classification of fuels, Stoichiometric air-fuel ratio, equivalence ratio, relation between volumetric and gravimetric analysis.

Text Books:

1. P.K. Nag, Engineering Thermodynamics, Tata McGraw Hill Publishers, 5th edition, 2013.
2. D.S. Kumar, Thermal science and Engineering, S.K.Kataria and Sons, 4th edition, 2013.
3. D.P.Mishra, Engineering Thermodynamics, Cengage Learning, 2012.
4. Y.A. Cengel and M.A. Boles, Thermodynamics: An Engineering Approach, Tata McGraw Hill Publishers, 7th edition, 2014.

Suggested Reading:

1. R.K. Rajput, Thermal Engineering, Laxmi Publications (P) Ltd, 8th edition, 2011.
2. Mahesh M Rathor, Thermal Engineering, Tata McGraw Hill Publishers, 2013.

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HYDRAULIC MACHINERY AND SYSTEMS

Instruction	4 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	4

Objectives: Students will

1. Learn laws related to Fluid Machinery.
2. Demonstrate his/her knowledge of principles and problems associated with reciprocating pumps.
3. Understand various principles related to rotary pumps.
4. Come to know the working principles of Hydraulic turbines.
5. Learn the performance characters and selection of turbines.
6. Understand the fundamental principles of hydraulic systems.

Outcomes: On successful completion of this course the students will be able to

1. Apply the various fluid laws to different hydraulic machines.
2. Understand the methodology of selection of reciprocating pumps.
3. Acquire the knowledge the functionality of rotary pumps.
4. Understand the selection procedure and estimate the power developed by various hydraulic turbines.
5. Compare the performance of hydraulic turbines and pumps based on characteristics curves.
6. Acquire knowledge the functionality of various hydraulic systems.

UNIT-I

Hydraulic Machines: Classification- Impulse-momentum equation- Lay-out of hydraulic power plant- working principle- Impact of jet on vanes- Force exerted by a jet striking (i) a fixed flat vertical vane held normal to the jet flow (ii) at the centre of a fixed symmetrical curved vane (iii) at one end of fixed symmetrical and unsymmetrical curved vanes (iv) flat vertical vane moving in the direction of jet (v) a series of flat vertical moving vanes (vi) at the centre of symmetrical moving curved vanes (vii) symmetrical curved vanes moving in the same direction as that of jet at inlet (viii) at one end of a series of un-symmetrical moving curved vanes.

UNIT-II

Reciprocating Pumps: Classification- working principle- single and double acting pumps- discharge, work done and power required to drive the pumps- slip, % slip and negative slip- Variation of pressure head in the suction and delivery pipes due to acceleration of piston- Variation of

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pressure head due to friction in the suction and delivery pipes- Indicator diagrams- Ideal and actual diagrams- Effect of piston acceleration and pipe friction on indicator diagram- Maximum speed at which the pump must run to avoid separation during suction and delivery strokes- Air vessels- Function of air vessels- Work saved by fitting air vessels to single and double acting pumps- Discharge of liquid into and out of air vessels- Performance characteristic curves.

UNIT-III

Centrifugal pumps: Classification- Working principle- Comparison over reciprocating pumps-Velocity triangles- Manometric head- work done per second- Head equivalent of work done- Manometric, mechanical and overall efficiencies- Pressure rise in the impeller- Minimum starting speed- Specific speed- Physical significance of specific speed- Model testing- Conditions of similarity of CF pumps- Priming- Performance characteristic curves.

UNIT-IV

Hydraulic Turbines: Classification- Impulse and reaction turbines- Construction and working of Pelton wheel, Francis turbine and Kaplan turbine- Velocity triangles- Work done (power developed)- Hydraulic, Mechanical and Overall efficiencies- Maximum efficiency- Comparison between Impulse and reaction turbines- Comparison between Francis and Kaplan turbines- Specific speed- Physical significance of specific speed- Unit testing -Unit quantities- Model testing of turbines- Conditions for similarity of turbines- Performance characteristic curves.

UNIT-V

Hydraulic Systems (appliances): Working of hydraulic press- accumulator- intensifier- Ram- jack- lift- direct acting hydraulic lift- Suspended hydraulic lift- crane- air lift pump- gear wheel pump.

Text Books:

1. Bansal, R.K., A Text Book of Fluid Mechanics and Hydraulic Machines, Laxmi Publication (P) Ltd., New Delhi, 2004.
2. Modi, P.N. and Seth. S.M., Hydraulics and Fluid Machines, Standard Book House, New Delhi, 2004.

Suggested Reading:

1. Ramamrutham S., Hydraulics, Fluid Mechanics and Fluid Machines, Dhanpat Rai and Sons, New Delhi, 2004.
2. Kumar K.L., Engineering Fluid Mechanics, Eurasia Publishing House (P) Ltd., New Delhi, 2004.
3. White, Frank. M., Fluid Mechanics, 5th Edition., McGraw Hill 2003.
4. Madan Mohan Das., Fluid Mechanics and Turbomachines, PHI Learning Private Limited, New Delhi, 2009.

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16ME C17

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MANUFACTURING PROCESSES

Instruction	4 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	4

Course Objectives: to enable the students to

1. Aelect the suitable manufacturing process for a given component.
2. Design pattern, gating system and rises for a simple casting.
3. Identify defect and suggest the remedy for the same.
4. Select suitable welding process for a given requirement.
5. Decide minimum capacity of the machine for a given forming operation.
6. Select suitable forming process for a simple component.

Course Outcomes: Students are able to

1. Select the suitable manufacturing process for a given component.
2. Design pattern, gating system and rises for a simple casting.
3. Identify defect and suggest the remedy for the same.
4. Select suitable welding process for a given requirement.
5. Decide minimum capacity of the machine for a given forming operation.
6. Select suitable forming process for a simple component.

UNIT- I

Pattern design and Methoding: Introduction to casting, classification of casting processes, pattern design: Types of patterns, pattern materials, pattern allowances; Gating system: purpose, elements, requirements, types of gates, choke, gating ratio, types of gating systems, gating system design; Risering: purpose, requirements, chvorinov's rule, optimum shape and dimensions of riser, riser design by Caine's method, Modulus method and NRL method.

UNIT- II

Moulding, Melting, and special casting processes : Moulding sand: ingredients, required properties of moulding sand; Core : purpose, core prints, Melting furnaces: cupola, induction and arc furnace; casting defects and remedies; Special casting processes: Pressure die casting, Centrifugal casting, shell moulding, investment casting, CO2 moulding.

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UNIT- III:

Arc and Resistance Welding Processes: Introduction, Classification of welding processes, Physics of arc, DCSP, DCRP, AC, shielded Metal Arc Welding, Submerged arc welding, Gas Tungsten arc welding, Plasma arc welding, Atomic Hydrogen welding, Resistance welding: spot, projection, seam, butt and percussion welding.

UNIT-IV:

Other Welding processes: Oxy-Acetylene welding, Thermit welding, laser beam welding, Electron beam welding. solid state welding: forge welding, friction welding, ultrasonic welding and explosive welding Soldering and brazing, weld defects and Weldability.

Fundamentals of metal Forming: True stress and true strain, strain hardening, volume constancy applied to disc and slab. Yield criteria. Hot working and Cold working.

UNIT-V:

Metal Forming processes: forging: open die ,closed die and isothermal forging processes, forging equipment, defects; Rolling: process, nomenclature, geometric relationships, rolling mills, defects; Extrusion: types, load calculation assuming ideal deformation, defects; Wire Drawing: Process, analysis considering ideal deformation, defects; shearing: shearing load, energy required, types of shearing processes; Cup Drawing : process, calculation of blank diameter for a given cup, drawing load; sheet bending: process, bend allowance.

Text Books

1. P.N.Rao, Manufacturing Technology, Vol.1, Tata McGraw Hill Publ., 3rd Edition, 2011.
2. Amitabh Ghosh and Mallick, Manufacturing Science, Assoc. East West Press Pvt. Ltd., 4th Edition, 2011.

Suggested Reading

1. Schey, Introduction To Manufacturing Processes, 2nd Edition, Mcgraw -hill Education
2. Roy A.Lindberg, Materials and Process of Manufacturing, Prentice Hall of India 5th Edition, 1992.
3. Serope Kalpakjian, Manufacturing Engineering and Technology, Addision, Wesley Publishing Company, 2006.
4. Mikell P.Grover, Fundamentals of Modern Manufacturing Materials, Processes And Systems, 3rd Edition, Willey A.

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16EE C14

ELECTRICAL MACHINES AND MICROCONTROLLER APPLICATIONS

(Common to BE - Mech and Prod)

Instruction	4 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	4

Course Objectives:

1. To understand the concepts of transformers.
2. To comprehend the need of DC and AC machines and their control aspects.
3. To know the features of 3-phase induction motors.
4. To understand the concepts of 8051 microcontrollers.
5. To understand the basics of interfacing with 8051 microcontrollers.

Course Outcomes: The student will be able to

1. Identify the compatibility of DC machines for a given application.
2. Identify the applications of 3-phase induction motor.
3. Know the calculation of Efficiency and regulation of transformer.
4. Program using 8051 microcontrollers.
5. Use 8051 microcontrollers for basic applications.

UNIT- I

D.C. Generators: Constructional details, Principle of operation, EMF equation, Classification of generators, Armature reaction, Characteristics of shunt, series and compound generators.

DC Motors: Working Principle, back EMF, Classification of motors, Torque developed in motors, Characteristics of shunt, series and compound motors, Three point starter, Speed control of DC motors.

UNIT- II

Transformers: Construction, Working principle, EMF equation, Ideal transformer, Practical transformer on no load and load conditions, Equivalent circuit of transformer, Efficiency and regulation of transformer, OC and SC tests.

UNIT-III

Three Phase Induction Motors: Production of rotating magnetic field, construction and principle of operation, Torque Calculation, speed-torque characteristics, Speed control of 3-phase induction motors.

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UNIT-IV

8051 Microcontrollers: Introduction to microprocessor, microcontroller classification, Internal architecture of 8051 and its pin configuration, Memory organization and expansion. **SFR's:** Counter and timers, serial data I/O, Interrupts.

8051 Instruction set: Addressing modes and Instruction set. Assembly Language Programming with 8051.

UNIT-V

8051 Interfacing: Expansion of I/O ports, A/D converter, D/A converter, Stepper motor interfacing with 8051, DC motor interfacing with 8051.

Text Books:

1. D.P. Kothari and Nagrath, Basic Electrical Engineering, Tata McGraw Hill Publications, 2nd edition, 2007.
2. V.K.Mehta, Principles of Electrical Engineering, S.Chand and Co, 1st edition, 2003.
3. Muhammad Ali Mazidi, Jainice Gilispie Mazidi and Rolin D. MCkinlay, The Microcontroller and Embedded Systems using Assembly and 'C', 2/e Pearson Education, 2007.
4. Ayala K.J., The 8051 Micro Controller Architecture, Programming and Application, Penram International, 2007.

Suggested Reading:

1. B. L.Theraja and A.K. Theraja, A Text book of Electrical Technology, S.Chand and Co., 24th revised Edition, 2007.
2. P. V. Prasad, S. Sivanagaraju, Electrical Engineering: Concepts and Applications, Cengage Learning, 1st Edition, 2012.

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16ME C18

HYDRAULIC MACHINERY AND SYSTEMS LAB

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	25 Marks
Credits	2

Course Objectives: Students will

1. Determine discharge of fluid flow.
2. Understand how to determine various types of flow using Reynolds apparatus.
3. Verify fluid laws like Bernoulli's equation.
4. Determine losses through pipes.
5. Demonstrate knowledge in evaluating performance characteristics of pumps.
6. Vvaluate the performance characteristics of turbines.

Course Outcomes: On completion of the course, the students will be able to

1. Measure the discharge in pipes.
2. Carry out discharge measurements in open channel.
3. Determine the energy loss in conduits.
4. Calculate forces and work done by a jet on fixed or moving, flat and curved blades.
5. Evaluate the performance characteristics of pumps.
6. Demonstrate the characteristics curves of turbines.

List of experiments:

1. Verification of Bernoulli's equation.
2. Determination of Darcy's friction factor and nature of water flow through pipes.
3. Determination of Cd for V- notch.
4. Determination of Cd for rectangular notch.
5. Determination of Cd for venturimeter.
6. Determination of Cd for Orifice meter.
7. Determination of impact force of jet on fixed flat and fixed curved vanes.
8. Performance and characteristic curves of reciprocating pump.
9. Performance and characteristic curves of centrifugal pump.
10. Performance and characteristic curves of self-priming pump.
11. Performance and characteristic curves of gear pump.
12. Performance and characteristic curves of Pelton wheel.

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13. Performance and characteristic curves of Francis Turbine under constant speed and variable speed conditions.
14. Performance and characteristic curves of Kaplan turbine under constant speed and variable speed conditions.

Note: Any 12 experiments need to be conducted.

Text Books:

1. Bansal R.K., A Text Book of Fluid Mechanics and Hydraulic Machines, Laxmi Publication (P). Ltd., New Delhi, 2004.
2. Modi P.N. and Seth S.M., Hydraulics and Fluid Machines, Standard Book House, New Delhi, 2004.

Suggested Reading:

1. Ramamrutham S., Hydraulics, Fluid Mechanics and Fluid Machines, Dhanpat Rai and Sons, New Delhi, 2004.
2. Kumar K.L., Engineering Fluid Mechanics, Eurasia Publishing House (P). Ltd., New Delhi, 2004.

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MANUFACTURING PROCESSES LAB

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	25 Marks
Credits	2

Course Objectives: to enable the students to

1. prepare the mould for a single piece and split patterns.
2. test the moulding sand and anlalyse the same.
3. test the bead geometry and correlate the results to the input parameters.
4. use TIG, MIG and Spot welding machines and experiment with them.
5. test the formability characteristics of a given sheet metal.
6. demonstrate the of understanding the parts of simple, compound, progressive and combination dies and use them for production of parts.

Course Out comes: Students are able to

1. prepare the mould for a single piece and split patterns.
2. test the moulding sand and anlalyse the same.
3. test the bead geometry and correlate the results to the input parameters.
4. use TIG, MIG and Spot welding machines and experiment with them.
5. test the formability characteristics of a given sheet metal.
6. demonstrate the understanding of the parts of simple, compound, progressive and combination dies and use them for production of parts.

Experiments:

Casting

1. Design and manufacturing of a simple pattern with various allowances.
2. Green sand moulding practice for a single piece pattern.
3. Green sand moulding practice for a split pattern with a horizontal core.
4. Moulding sand testing: GCS, GSS, DCS and DSS Permeability and shatter index.
5. Finding out the GFN, Moisture content and clay content for a given sand sample.
6. Melting and Pouring of Aluminum.
7. Dimensional inspection and visual inspection of the casting and analysis of dimensional variation and defects.

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Welding

8. Study of gas welding equipment and process. Identification of flames, making Butt joint with gas welding.
9. Study of Arc welding process, comparison of the bead geometry with DCSP, DCRP and A.C.
10. Study of resistance welding process and plot the variation of spot area with time and current variation.
11. Study of TIG welding process and plotting cooling curve in TIG welding process.
12. Study of SAW Welding process and finding out deposition efficiency of the process.
13. Study of MIG welding process and testing of weld bead formed by MIG welding.

Metal Forming

14. Evaluation of Formability of a given sheet material using Erichsen cupping test.
15. Study of Simple Die design for Blanking/Piercing operations in sheet metal forming and.
16. Manufacturing of circular blanks using a mechanical press (capacity 30 Tons) and measurement of forces and comparing with theoretical loads.
17. Study of Progressive die design and manufacturing of washer components using the same on a fly press (capacity 6 Tons) and estimation of forces.
18. Study of Compound die design and manufacturing of washer components using the same on double body fly press (capacity 8 Tons) and estimation of forces.
19. Study of Combination die design and manufacturing of cylindrical cups using the same on a Hydraulic power press (capacity 50 Tons) and estimation of drawing force.
20. Study of deep drawing die design and measuring forces with/ without blank holder for cylindrical/square cups using 10T load cell on a Hydraulic power Press and comparing them with the theoretical values.
21. Measurement of cutting force for Blanking operation using 10T load cell on Mechanical power Press for different materials and comparing theoretical and practical values.
22. Study of extrusion dies and demonstration of extruding lead material

Note: Minimum 12 Experiments need to be conducted by choosing any 4 from each section.

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CBIT(A) with effect from the academic year 2017-18

16EGCO3

SOFT SKILLS AND EMPLOYABILITY ENHANCEMENT LAB

Instruction	2 hours per week
Duration of Semester End Examination	2 Hours
Semester End Examination	35 Marks
CIE	15 Marks
Credits	1

Course Objectives: To help the students

1. Participate in group discussions and case studies with confidence and to make effective presentations. Also to learn the art of communication.
2. With- resume packaging, preparing and facing interviews.
3. Build an impressive personality through effective time management & goal setting, self confidence and assertiveness.
4. Understand what constitutes proper grooming and etiquette in a professional environment. Also to understand academic ethics and value systems.
5. To understand the elements of research and hone their soft skills through a live, mini project.

Course Outcomes: The students will be able to

1. Be effective communicators and participate in group discussions and case studies with confidence. Also be able to make presentations in a professional context.
2. Write resumes, prepare and face interviews confidently.
3. Be assertive and set short term and long term goals. Also learn to mange time effectively and deal with stress.
4. Make the transition smoothly from Campus to Corporate. Also use media with etiquette and know what academic ethics are.
5. To do a live, mini project by collecting and analyzing data and making oral and written presentation of the same.

Exercise 1

Group Discussion and Case studies: Dynamics of group discussion, intervention, summarizing, modulation of voice, body language, relevance, fluency and coherence.

Elements of effective presentation, Structure of presentation, Presentation tools, Body language, Creating an effective PPT.

Exercise 2

Interview Skills: Resume writing, structure and presentation, planning, defining the career objective, projecting ones strengths and skill-sets.

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Interview Skills: concept and process, pre-interview planning, opening strategies, answering strategies, mock interviews.

Exercise 3

Personality Development: Effective Time Management, setting realistic goals, self confidence and assertiveness, stress management, moral values.

Exercise 4

Corporate Culture: Grooming and etiquette, communication media etiquette, Academic ethics and integrity.

Exercise 5

Mini Project: General/Technical Research, developing a questionnaire, data collection, analysis, written report and project seminar.

Suggested Reading:

1. Dr. Shalini Verma, Body Language- Your Success Mantra, S Chand, 2006.
2. Ramesh, Gopalswamy, and Mahadevan Ramesh, The ACE of Soft Skills, New Delhi: Pearson, 2010.
3. Covey and Stephen R, The Habits of Highly Effective People, New York: Free Press, 1989.

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16ME C20

DYNAMICS OF MACHINES

Instruction	3 Hours + 1 Tutorial per week
Duration of End Examination	3 Hours
End Examination	70 Marks
Sessionals	30 Marks
Credits	4

Course Objectives:

1. To find static and dynamic forces on planar mechanisms.
2. To know the causes and effects of unbalanced forces in machine members.
3. To determine natural frequencies of undamped, damped and forced vibrating systems of one, two and multi degree freedom systems.

Course Outcomes:

1. Graduates are expected to demonstrate the ability of the analysis of forces in mechanism which provide them the required inputs to design the systems which withstand operating conditions..
2. Graduates are expected to understand the turning moment diagram, cyclic fluctuation in speed, fluctuation in energy and get the ability of designing flywheel.
3. Graduates are expected to understand gyroscopic and centrifugal actions of vehicles and will be able to reckon additional bearings reactions due to gyroscopic and centrifugal effects.
4. Graduates will have ability to control speed using governors.
5. Graduates will have ability to identify the unbalance in rotor and engines and will get the knowledge of balancing.
6. Graduates will understand the concepts of vibration thereby they are able to design the systems free from ill effects of vibration.

UNIT-I: Static and Dynamic Force Analysis:
Force analysis of Four bar and slider crank mechanisms: Study of dynamically equivalent system, Inertia forces on connecting rod.
Flywheels: Functions, Turning moment diagrams, flywheels analysis for I.C. Engines and Presses.

UNIT-II: Gyroscope: Gyroscopic couple, gyroscopic effects on vehicles.
Governors: Classification of governors, Watt, Porter, Hartnell and Hartung governors, Controlling Force, Stability, Isochronism, Sensitivity, Power and Effort of governors.

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UNIT-III: Balancing of Rotating masses:
Forces on bearings due to rotating shaft carrying several masses in several planes. Determination of balance masses from the forces on the bearings.
Balancing of Reciprocating masses: Shaking forces in single cylinder engine, Partial balancing of reciprocating engine. Balancing of two cylinder locomotive engine. Balancing of multi cylinder in-line engines. Balancing of radial engines by direct and reverse cranks method.

UNIT-IV: Vibrations:
Vibrations of Single degree freedom system, (axial, transverse and torsional). Equivalent system of combination of springs, stepped shaft, whirling speed of shafts.

Damped vibrations:
Types of damping, Vibrations with viscous damping.

Forced vibrations:
Vibrations with harmonically applied force with viscous damping. Dynamic magnifier, Resonance, Vibration isolation and Transmissibility.

UNIT-V: Two degree freedom systems: Natural frequencies and modes of vibration
Approximate Methods: Dunkerley and Rayleigh's methods.
Multi rotor system: Holzers method.

Text Books:

1. S.S. Rattan, *Theory of Machines*, Tata-Mc Graw Hill, 1995.
2. John.J.Vicker, Gordon R. Pennock, Joseph E. Shigley, *Theory of Machines & Mechanisms*, Oxford University Press, 2003.
3. Theory of Vibration with Application, J.J. Thompson, Dec-2002.

Suggested Reading:

1. A. Ghosh and Mallick, *Theory of mechanisms and machines*, Affiliated to E-W Press, 1988.
2. Ashok G Ambedkar, Mechanism and Machine Theory, PHI, 2013.
3. Robert L. Norton, *Design of Machinery*, Tata Mc Graw Hill, 2005.
4. J.S. Rao and Gupta, 'Theory and Practice of Mechanical Vibrations, PHI, 1984.
5. Benson H. Tangue, Principles of Vibration, 2nd Edn., Oxford University Press, 2007.

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16ME C21

APPLIED THERMODYNAMICS AND HEAT TRANSFER

Instruction	3 Hours + 1 Tutorial per week
Duration of End Examination	3 Hours
End Examination	70 Marks
Sessionals	30 Marks
Credits	4

Course Objectives:

1. To demonstrate basic knowledge by understanding the basic working principles of reciprocating air compressor and its applications in engineering.
2. Students will come to know the working principle and various performance parameters of diesel and petrol engines.
3. Student will understand the configurational features of IC engine like ignition system, injection system, lubricating system and cooling systems.
4. To demonstrate basic knowledge by understanding different modes of heat transfer.
5. Students will understand the basic principles of radiation.
6. Student will understand the working principles of parallel and counter-flow heat exchangers.

Course Outcomes: Students will be able to

1. Estimate power required for reciprocating air compressor, used for many engineering applications.
2. Evaluate the performance of diesel and petrol engines and various heat losses from engines.
3. Understand the importance of combustion phenomenon and various functional systems of IC engines.
4. Apply appropriate equations depending on mode of heat transfer.
5. Distinguish the various modes of heat transfer.
6. Design heat exchangers with the basic knowledge acquired in heat exchangers.

UNIT-I: Reciprocating Air Compressors:
Single stage and multi stage compressors with and without clearance volume, work done, various Efficiencies of multi stage compression.

UNIT-II: Internal Combustion Engines:
Classification, Working principles of 2 stroke, 4 stroke SI and CI engines. Performance of IC Engines. Heat balance sheet.

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UNIT-III: Combustion Phenomena:
Normal and abnormal combustion phenomenon in SI and CI engines. Cooling, lubrication systems, Battery and magneto ignition systems of IC engines. Working principle of Simple Carburetor and Fuel Injector.

UNIT-IV: Modes of Heat Transfer:
General 3-D conduction equation in Cartesian and cylindrical coordinates, one dimensional steady state conduction through slabs, hollow cylinders without heat generation. Steady state heat transfer through composite slabs and cylinders, critical radius of insulation for cylinders.

UNIT-V: Convection:
Dimensional analysis and its use in free and forced convection, Buckingham "π" theorem, Physical significance of different dimensionless numbers.
Simple problems on free and forced convection.

Radiation:
Definition of absorptivity, reflectivity and transmissivity, Concept of black-body and emissivity. Kirchoff's law, Planck's black body spectral distribution, Wien's and Steffan Boltzmann law. Concept of surface, space resistances and radiation shields.

Heat Exchangers:
Classification, LMTD and NTU Concepts.

Text Books

1. Mahesh M. Rathore, Thermal Engineering, TMH, New Delhi, 2010.
2. V. Ganeshan, Internal Combustion Engines, Tata Mcgraw Hill Publishing, New Delhi,2015.
3. J.P. Holman, Heat Transfer, McGraw Hill Publication, New Delhi, 2004.

Suggested Reading

1. Rajput, R. K., Thermal Engineering, Laxmi Publishers, New Delhi, 2014
2. D.S. Kumar; Heat Transfer S k Kataria Publishers, 2015.

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16ME C22

DESIGN OF MACHINE ELEMENTS
(USAGE OF DATA BOOK IS COMPULSORY)

Instruction	3 Hours + 1 Tutorial per week
Duration of End Examination	3 Hours
End Examination	70 Marks
Sessional	30 Marks
Credits	4

Course Objectives:

1. To understand the basics of mechanics of materials and design of machine elements for static and fatigue strength, rigidity and wear criterions, use of codes and standards.
2. To know the principles of ergonomic design.
3. To learn the principles to design shafts, keys, belt drives, joints and couplings.
4. To Develop and solve mechanical component design problems based upon given data and requirements.

Course Outcomes: Students will able to

1. Select material based on type of load and manufacturing considerations.
2. Design the components subjected to static loads.
3. Design the components subjected to fluctuating loads.
4. Become familiar with mechanical elements like shafts, keys, couplings and pulleys.
5. Become familiar with permanent types of joints and their design concepts.
6. Become familiar with detachable joints and power screws.

UNIT-I: Introduction:

Materials used in machine design and their specifications to Indian standards. Codes and standards used in design. Reliability, Principles of good Ergonomic Design, Manufacturing considerations. Preferred numbers. Value analysis.

Analysis of Stress and Strain: Definition of stress and strain, Types of loading, direct normal stress, bending stress, Torsional stress, crushing and bearing stresses, biaxial stress and triaxial stress. Theories of elastic failure, Stress concentration factor, factor of safety, Design of components for static loads.

UNIT-II: Design for Fatigue and Impact loads:

Importance of fatigue in design, Fluctuating stresses, fatigue strength and endurance limit. Factors affecting fatigue strength. S-N Diagram, Soderberg and Modified Goodman's diagrams for fatigue design. Cumulative fatigue, Miner's rule, Design of components for fatigue. Design of components for impact loading.

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UNIT-III : Design of keys and Shafts:
Solid, hollow, stepped shafts and splined shafts under torsion and bending loads.
Design of couplings:
Muff and Split muff Couplings, Flange, Flexible and Marine type of couplings.
Design of belt drive systems: selection of belts and design of pulleys.

UNIT-IV: Design of riveted joints:
Types of joints, efficiency of the joints, structural joints, and joints subjected to direct and eccentric loads.
Design of welded joints - types of joints, joints subjected to direct and eccentric loading.

UNIT-V: Design of Cotter and Knuckle Joints:
Design of bolts and nuts, locking devices, bolt of uniform strength, design of gasket joints.
Design of power screws and screw jack.

Text Books:

1. V.B. Bhandari, Machine Design, Tata Mc Graw Hill Publication, 2010.
2. J.E. Shigley, C.R. Mischne, Mechanical Engineering Design, Tata Mc Graw Hill Publications, 2011.
3. Siraj Ahmed, Mechanical Engineering Design, PHI, 2014.

Suggested Reading

1. L. Robert Norton, Machine Design: An Integrated Approach, 2/e Pearson Education, 2013
2. P. Kannaiah, Machine Design, Science-Tech Publications, 2010
3. M.F. Spotts, Design of Machine Elements, Prentice Hall of India, 2013.

Machine Design Data Books:

1. Design Data Hand book for Mechanical Engineers, K. Mahadevan, K. Balaveera Reddy, CBS Publisher 3rd Edition, 2016.
2. Design Data book by PSG College – 2012.
3. Machine Design Data Book, by V.B. Bhandari McGraw hill education, 2015.

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16ME E01

REFRIGERATION AND AIR CONDITIONING (Professional Elective-I)

Instruction	3 Hours per week
Duration of End Examination	3 Hours
End Examination	70 Marks
Sessionals	30 Marks
Credits	3

Course Objectives: Students will

1. Acquire the basic knowledge about the importance of refrigeration, its applications in aircraft refrigeration.
2. Demonstrate basic knowledge of vapor compression refrigeration system, cascade and compound refrigeration.
3. Understand various types of absorption refrigeration systems like ammonia, Electrolux and lithium bromide refrigeration systems.
4. Acquire the basic knowledge on various psychrometric processes.
5. Understand the importance of comfort air conditioning.
6. Acquire knowledge in estimating air conditioning loads.

Course Outcomes: Students will be able to

1. Differentiate refrigeration from air conditioning.
2. Understand merits and demerits of vapor compression refrigeration system over air refrigeration system.
3. Know the importance of absorption refrigeration system over vapor refrigeration system.
4. Apply a suitable psychrometric process depending on requirement or application.
5. Know the condition necessary for comfort condition.
6. Estimate the load required for AC system depending on application.

UNIT-I: Introduction to Refrigeration:
Application of Refrigeration, Definition of COP, Tonne of Refrigeration, Designation, Carnot cycle, Eco-friendly Refrigerants, Properties of Refrigerants.

Air Refrigeration Systems:
Analysis of Bell-Coleman Cycle, Application to aircraft refrigeration, Simple cooling system, Bootstrap simple evaporating system, Regenerative cooling system and Reduced ambient cooling system.

UNIT-II: Vapour Compression System:
Working principle and analysis of Simple vapor compression Refrigeration cycle. Effect of operating conditions like evaporating pressure, condenser pressure, Liquid sub-cooling and Vapor super heating, Performance of the system. Low temperature

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refrigeration system (with single load system), Compound compression with water inter cooler and Flash intercooler, Cascade refrigeration system-Analysis and advantages.

UNIT-III: Vapour Absorption Refrigeration System:
Simple absorption systems, COP, Practical ammonia absorption refrigeration system, Lithium bromide absorption system, Electrolux refrigerator, Common refrigerants and absorbents properties, Comparison with vapor compression refrigeration system
Steam Jet Refrigeration: Principle of working, Analysis of the system, Advantages, limitations and applications.

UNIT-IV: Psychrometry:
Psychrometric properties, Psychrometric chart, construction, Representation of various Psychrometric processes on the chart.
Introduction to Air Conditioning:
Requirements of comfort air conditioning, Thermodynamics of human body, ASHRE comfort chart, Effective temperature.

UNIT-V: Cooling Load Calculations in Air Conditioning:
Concept of bypass factor, Sensible heat factor, Apparatus Dew Point, Various Heat Loads.
Design of air conditioning systems: Simple Problems on Summer, Winter and Year Round Air conditioning systems Energy conservation in air conditioned building.
Air Conditioning Systems:
Components of air conditioner equipments, Humidifier, Dehumidifier, Filter.

Text Books

1. C.P. Arora, Refrigeration and Air conditioning, Tata McGraw Hill, New Delhi, 2004.
2. W.S. Stocker, Refrigeration and Air conditioning, McGraw Hill, New Delhi, 2004.
3. R.K. Rajput, Refrigeration and Air Conditioning Laxmi Publications, New Delhi, 2007.

Suggested Reading

1. V.K. Jain, Refrigeration and Air Conditioning, S Chand & Company, New Delhi, 2004.
2. Manohar Prasad, Refrigeration and Air Conditioning, New Age International, Allahabad, 2007.
3. Edward G Pita, Air conditioning Principles and Sytems: An Energy Approach,4th edn, PHI, 2012.

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16ME E02

MECHANICAL VIBRATIONS (Professional Elective-I)

Instruction	3 Hours per week
Duration of End Examination	3 Hours
End Examination	70 Marks
Sessionals	30 Marks
Credits	3

Course Objectives:

1. To gain the knowledge of mathematical modeling of a physical system and applying the principles of Newton's Second Law and conservation of energy to derive the equations of motion.
2. To study the response of a vibrating system with periodic excitation and understand the principle of vibration isolation.
3. To develop the equations of motion for a continuous system in elongation, bending and torsion to find the natural frequencies and mode shapes.

Course Outcomes: Students aquire the

1. Ability to construct a Free Body Diagram, formulates the equations of motion, analytically solves the equations of motion for arbitrary linear single-degree-of-freedom systems in undamped, damped cases.
2. Ability to analyze the basic principles of vibration isolation and absorption and ability to apply them to the design of mechanical systems such as automotive suspensions.
3. Ability to formulate the equations of motion analytically solves the equations of motion for arbitrary linear two -degree-of-freedom systems in undamped, damped, free and forced cases.
4. Ability to analyze normal mode vibration, coordinate coupling and orthogonal property of modeshape.
5. Ability to differentiate discrete and continuous systems, formulate equation of motion and solve for string, bar and beams in continuous systems.
6. Ability to understand vibration measuring instruments, display and recording to elements, frequency analysis.

UNIT-I: Free Vibration Analysis-Single Degree of Freedom Systems Undamped and Damped Translation and Torsional Systems:

Different methods for equation of motion- Energy method, Rayleigh method, principal of virtual work, principal of conservation energy, Rayleigh's method. Viscously damped free vibration, logarithmic decrement, coulomb damping,

UNIT-II: Harmonically Excited Vibration:

Forced harmonic vibration, Rotating unbalance, whirling of rotating shafts, support motion, vibration isolation, energy dissipated by damping. Equivalent viscous damping, structural damping.

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UNIT-III: Damped and Undamped Vibrations of two Degree of Freedom System:

Free and forced vibration analysis of two degree of freedom system-different methods for the formulation of equation equations of motion, natural frequencies, Normal mode vibration, Coordinate coupling and principal coordinates, semi definite systems, influence coefficients-flexibility, stiffness. Eigen values and Eigen vectors, orthogonal properties of Eigen vectors, repeated roots, modal matrix.

UNIT-IV: Vibrations of Continuous Systems:

Vibrations of strings, bars and beams, formulation of equation of motion, characteristic equation, identification of node and mode shape.

UNIT-V: Vibration Measurements and Applications:

Vibration pickup, Vibrometer, accelerometer. Transducers, piezoelectric transducers, Electrodynamic transducers. Vibration exciters, mechanical and electro dynamic shakers. Frequency measuring instruments.

Text Books:

1. Theory of Vibration with Application, J.J. Thomson, Dec-2002
2. S.S. Rao ,Mechanical vibration, 4th edn, Pearson, 2009
3. G.S. Grover & Nigam ,Mechanical Vibrations,Nem Chand & Bros, 6th edn,1998.

Suggested Reading:

1. V.P. Singh , Mechanical vibration, Dhanpath Rai &Co.,3rd edn,2006.
2. Graham Kelley,S., Mechanical vibration – Schaums Outline Series, TMH, 2011.
3. F.S. Tse, Morse & Hinkle, Mechanical Vibration, Allyn and Bacon, 1978.

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16PE E02

PRODUCT DESIGN AND PROCESSES PLANNING
(Professional Elective-I)

Instruction	3 Hours per week
Duration of End Examination	3 Hours
End Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives:

1. The Product Design and Process Functions.
2. The essence of innovation in product development.
3. The Human Machine Interactions (ergonomics).
4. The various Intellectual Property Rights.
5. The interaction between Design, Manufacturing, Quality and Marketing.
6. The awareness about overall view of Process Planning.

Course Outcomes:

1. Have overall view of Product Design and Process Planning.
2. Apply creativity techniques in Product Development.
3. Applying ergonomically enabled concepts in developing a new product.
4. Have awareness and apply Intellectual Property Rights.
5. Integrate various stages of developing a new product.
6. Develop and execute an effective Process Plan.

UNIT-I: Product Design and Process Design:
Functions, Essential factors of product design, Selection of right product, Systematic procedure of product innovation, function of design, value of appearance, colors and laws of appearance.

UNIT-II: Product Selection and Evaluation:
Need for creativity and innovation. Techniques of innovation like brain storming and Delphi techniques, collection of ideas. Selection criteria - screening ideas for new products using evaluation techniques. Principles of ergonomics, Anthropometry, Design with Human Machine Interaction (HMI).

UNIT-III: New Product Planning and Development:
Interaction between the functions of design, manufacture, and marketing, design and material selection, Steps for introducing new products after evaluation, Product life cycle, Research and new product development.

UNIT-IV: Intellectual Property Rights (IPR):
Patents, definitions, Types of Patent, Patent search, Patent laws, International code for patents, Trademark, Trade Secret, Copy Rights and Industrial Design.

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UNIT-V: Process Selection and Planning:

Process selection, process planning, process sheets, Selection of manufacturing process, estimation of machining time in various cutting operations, Estimation of costs for manufacture, value engineering in product design, Group technology, concepts of concurrent engineering.

Text Books:

1. Niebel BW & Draper AB, Production Design & Process Engg, McGraw Hill, Kogakusha, 1974.
2. K. G Swift & J. D. Booker, Process Selection: From Design to Manufacture, Butterworth-Heinemann Ltd; 2nd Revised edition, 2003.
3. Bhaskaran Gopalakrishnan, Product Design and Process Planning in CE (Design & Manufacturing, Chapman and Hall publishers, 1994.

Suggested Reading:

1. Harry Nystrom, Creativity and Innovation, John Wiley & Sons, 1979.
2. Brain Twiss, Managing Technological Innovation, Pittrnan Publications, 1992.
3. Harry, B.Waton, New Product Planning, Prentice Hall Inc., 1992
4. Chitale, A. K. & Gupta RC., Product Design & Manufacturing, PHI, 1997.

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16PE E01

PRINCIPLES OF INDUSTRIAL ENGINEERING (Professional Elective-1)

Instruction	3 Hours per week
Duration of End Examination	3 Hours
End Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives: Student will learn the

1. Basic principles of industrial engineering along with work study techniques.
2. Concepts of plant location and layouts.
3. Significance of production planning & control.
4. Necessity of inventory control techniques.
5. Essence of quality engineering.
6. Productivity improvement tools and techniques.

Course Outcomes: At the end of the course, the students are able to

1. Conceptualize the essence of industrial engineering techniques.
2. Select and design plant location and layouts.
3. Plan, execute and control production related issues.
4. Analyze and choose right inventory control techniques.
5. Plot control charts and apply quality control tools.
6. Apply productivity improvement techniques.

UNIT – I: Concepts of Industrial Engineering:
Productivity-concepts, Principles and Techniques, Production Vs Productivity, Productivity Improvement Methods. Work Study: Method Study and Work Measurement steps involved in method study and work measurement, Recording Techniques-Flow Process Charts, multiple activity chart, two handed process chart, SIMO Chart. Various techniques of work measurement-Time Study, Work Sampling, PMTS etc, Standard time computation.

UNIT – II: Plant Location and Layout:
Factors for Plant Locations, Types of production - Mass, batch, job. Types of plant layout - product, process and fixed position layouts, cellular layouts.

UNIT – III: Production Planning and Control:
Elements of PPC-Planning, Routing, Scheduling, Dispatching. Production planning by line of Controls, Materials Requirement Planning (MRP), Manufacturing Resource Planning (MRP II).

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UNIT – IV: Inventory Control:
ABC analysis, FSN analysis, VED Analysis, P System, Q System. Economic order quantity, Lead time, Buffer Stock, ASRS, Stores management.

UNIT – V: Quality Engineering:
Control Charts-X, R, P, C charts. OC Curve, Acceptance Sampling, Kaizen, JIT, ISO-9000, Quality Concepts by Deming, Juran, Philip Crosby. Taguchi ' loss function.

Text Books:

1. SK Hajra Choudhury, Nirjhar Roy, AK Hajra Choudhury 'Industrial Engineering & Management' Media Promoters & Pub. Pvt. Ltd.,
2. Banga and Sharma 'Industrial Engineering and Management' Khanna Publishers, 2008.
3. O.P. Khanna, Industrial Engineering and Management, Dhanpat Rai Pub.,
4. M.S. Mahajan Industrial Organization & Management, Nirali Prakashan Pub.

Suggested Readings:

1. K.K.Ahuja, Industrial Management, Khanna Publishers, 5th Ed. 1993.
2. Production Systems - Planning Analysis And Control Riggs., Wiley Publishers, 1992.
3. Elwood S Buff Rakesh K Sarin Modern Production Operations Management, John Wiley & Sons (Asia) Pte Ltd. 1983.

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16ME E03

FUELS, COMBUSTION AND ENVIRONMENT (Professional Elective-II)

Instruction	3 Hours per week
Duration of End Examination	3 Hours
End Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives: Student will understand

1. Different types of solid fuels with their properties.
2. Natural and Manufactured gaseous fuels with different tests on the gaseous fuels.
3. The principles of refining liquid fuels, properties & their tests.
4. The thermodynamics of combustion and stoichiometric relations.
5. Features of different types of burners.
6. The importance of control of air pollutants and its effect on human being and environment.

Course Outcomes: A student will be able to

1. Know different types of solid fuels along with the properties.
2. Understand different manufacturing methods of gaseous fuels.
3. Understand the refining methods of various liquid fuels.
4. Estimates the theoretical air fuel ratio for various fuels.
5. Select the different types of burners according to the application.
6. Know various techniques to control pollutants and emission standards.

UNIT-I: Solid and Gaseous Fuels:
Solid fuels—origin of coal, analysis of coal, tests on coal, coal petrology, classification of coal other solid fuels. Gaseous fuels—natural gas, methane from coal mines, coal gas, blast furnace gas, liquified petroleum gas(LPG), properties and testing of fuel gases. Alcohols and biogas.

UNIT-II: Liquid Fuels:
Origin of petroleum, chemistry of petroleum, refining of petroleum, other conversion process, properties and tests for petroleum products, various petroleum products

UNIT-III: Combustion of Fuels:
Combustion Stoichiometry— flue gas analysis, dew point of flue gases. Thermodynamics of Combustion—enthalpy of combustion, enthalpy of formation, Adiabatic flame temperature.

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UNIT-IV: Combustion Appliances:
Classification, Coal burning equipment—over feed stokers, chain - grate stokers, under feed stokers, pulverized coal burners, cyclone furnaces. Oil burners—vaporized burners, rotary-cup oil burners, mechanical atomizing burners, high pressure and low pressure atomizing burners Gas burners—non-aerated burners, aerated burners, surface combustion burners.

UNIT-V: Environmental Considerations:
Air Pollution-types, combustion generated air pollution and its control, Effects on Environment, Human Health. Emission Standards.

Text Books:

1. Samir Sarkar, Fuels & Combustion Orient Longman, 1996
2. Sharma and Chander Mohan, Fuels and Combustion by Tata McGraw Hill, 1984.
3. Combustion Fundamentals by Roger A Strehlow, Tata McGraw Hill, 1984.

Suggested Reading:

1. Shaha AK, Combustion Engineering and Fuel Technology by Oxford and IBH. 1974.
2. R. Turns, An introduction to combustion-Stephen McGraw Hill International Edition, 2012.
3. S.P. Sharma and Chander Mohan, Fuels and Combustion, Tata McGrawhill, 2004.

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16PE 03

NON-DESTRUCTIVE TESTING AND EVALUATION
(Professional Elective - II)

Instruction	3 Hours per week
Duration of End Examination	3 Hours
End examination	70 Marks
Sessionals	30 Marks
Credits	3

Course Objectives: Student has to understand the

1. Need, basic concepts and technologies of Non Destructive Testing (NDT).
2. Security precautions from Radiography, protection from radiation and measurement of radiation received by personnel.
3. Technology of acoustic emission (AE), the associated instrumentation and applications.
4. Technologies like neutron radiography; laser induced ultrasonics, surface analysis and thermography.
5. Merits and demerits of the different NDT Technologies.
6. Latest research and developments in NDT.

Course Outcomes: At the end of the course, the students will be able to demonstrate

1. The knowledge of different NDT techniques.
2. Clear understanding of liquid penetrant inspection and magnetic particle inspection.
3. View and interpret radiographs, utilize the various principles of radiography for different components of different shapes.
4. The knowledge of acoustic emission for NDT and the instrumentation used for NDT.
5. The ability to analyze and prepare a technical report.
6. The knowledge of latest research, developments and trends in NDT.

UNIT-I: Liquid Penetrate Inspection:
Principles of penetrate inspection, characteristics of a penetrate, water washable system, post emulsification system, solvent removable system, surface preparation and cleaning, penetrate application, development, advantages limitations, and applications.

Magnetic Particle Instruction: Principle, magnetization methods, continuous and residual methods, sensitivities, demagnetization, magnetic particles, applications advantages and limitations.

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UNIT-II: Eddy Current Testing:
Principle, lift-off factor, and edge effect, skin effect, inspection frequency, coil arrangements, inspection probes, types of circuit, reference pieces, phase analysis, display methods and applications.

UNIT-III: Ultrasonic Testing:
Generation of ultra sound, characteristics of an ultrasonic beam, sound waves at interfaces, sound attenuation, display systems, probe construction, type of display, inspection techniques, identification of defects, Immersion testing , sensitivity and calibration. Reference standards. Surface condition, Applications.

UNIT-IV: Radiography:
Principle and uses of radiography, limitation principle, radiation sources, production of X-Rays, x-ray spectra, attenuation of radiation, radiographic equivalence, shadow formation enlargement and distortion, radio graphic film and paper, Xeroradiography, fluoroscopy, exposure factors, radiographic screens, identification markers and image quality indicators, inspection of simple shapes, inspection of complex shapes, viewing and interpretation of radiographs, radiation hazard, protection against radiation, measurement of radiation received by personnel.

UNIT-V: Acoustic Emission:
Physical Principles, Sources of emission, instrumentation and applications, Other NDT Techniques: Neuron radiography, Laser induced ultrasonic, surface analysis, and thermography.

Text Books:

1. Barry Hull & Vernon John, Non Destructive Testing, 1988.
2. H J Frissell (Editorial Coordinator), Non-Destructive Evaluation and quality control, ASM handbook-International Publication USA, 1989.
3. Dove and Adams, Experimental Stress analysis and Motion Measurement, Prentice Hall of India, Delhi, 1964.

Suggested Reading:

1. Non-Destructive Examination and Quality Control, ASM International, Vol.17, 9th edition, 1989.
2. J. Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition, 2011.
3. B. Raj, T. Jayakumar and M. Thavasimuthu, Practical Non Destructive Testing, Alpha Science International Limited, 3rd edition, 2002.
4. T.Rangachari, J. Prasad and B.N.S. Murthy, Treatise on non-destructive testing and evaluation, Navbharath Enterprises, Vol. 3, 1983.

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16PE E04

PLASTICS, CERAMICS AND COMPOSITE MATERIALS
(Professional Elective-II)

Instruction	3 Hours per week
Duration of End Examination	3 Hours
End examination	70 Marks
Sessionals	30 Marks
Credits	3

Course Objectives: To make the students to

1. Understand various types of plastics, their properties and uses.
2. Understand various methods of manufacturing plastic components.
3. Understand types of ceramics, refractoriness, their uses.
4. Familiarize with white wares ceramic coatings and glass.
5. Understand the manufacturing processes of ceramics.
6. Understand composites and their uses.

Course Outcomes: Students should able to

1. Describe about types of plastics, their properties and uses.
2. Suggest the suitable method of manufacturing a plastic component.
3. Describe about types of ceramics, refractoriness, their uses.
4. Express the details about white wares ceramic coatings and glass.
5. Suggest the suitable method of manufacturing processes of ceramics.
6. Describe about types composites and their uses.

UNIT I: Introduction to polymers:
Plastics and elastomeres, polymerization, degree of polymerization thermoplastics and thermosetting plastics, properties and applications of various thermo and thermosetting plastics, mechanical properties of plastics and their influencing parameters.

UNIT II: Manufacturing Methods of Plastics:
Injection moulding, Extrusion, calendering, thermoforming, Blow moulding, compaction moulding, transfer moulding

UNIT III: Introduction to Ceramics, Classification of Ceramic Materials , Conventional and Advanced; Refractories:
Classification of Refractories, Modern trends and developments, Basic raw materials, Elementary idea of manufacturing process technology, Flow diagram of steps necessary for manufacture, basic properties and areas of application.

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UNIT IV: White wares:

Classification and type of White wares, Elementary idea of manufacturing process technology including body preparation, basic properties and application area;.

Ceramic Coatings : Types of glazes and enamels, Elementary ideas on compositions, Process of enameling & glazing and their properties. Glass: Definition of glass, Basic concepts of glass structure, glass manufacturing processes, Different types of glasses. Application of glasses.

UNIT V: Fundamentals of composites:

Need for composites – enhancement of properties – classification of composites – Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Reinforcement–particle reinforced composites, Fibre reinforced composites. Applications of various types of composites. Fiber production techniques for glass, carbon and ceramic fibers. Manufacturing methods of composites.

Text Books:

1. Mikell P. Groover, "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems" Wiley publications, 6th edition'2015.
2. Kalpak Jain "Manufacturing Engineering and Technology" Pearson publications, 7th edition 2013.
3. P.N. Rao, Manufacturing Technology, Vol.-1, McGraw Hills Publication, 4th Edn., 2016.

Suggested Reading:

1. R.K.Rajput 'a text book of Manufacturing Technology", laxmi Pub., Vol-I, 2007.
2. P.C. Sharma, 'A Text book of Production Technology', S. Chand & Co., Pvt.Ltd., 8th Edn 2014.

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16MT EO4
PROBABILITY AND NUMERICAL METHODS (Professional Elective-II)

Instruction	3 Hours per week
Duration	3 Hours
End Exam	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives:

1. To compute the statistical averages& different properties.
2. To study the probability distributions for stochastic data.
3. To understand for finding solution of non-linear equations.
4. To study the process of calculating the value of the numerical derivative of a functions & numerical integration of a given data.
5. To identify the solution for initial value problem numerical differential equations.

Course Outcomes: On the successful completion of this course, the student shall be able to

1. Analyse the statistical averages and different properties for probability function.
2. Fit the probability distribution for the random data.
3. Solve the non-linear equations for finding the roots.
4. Solving the Differentiation & Integration for numerical data.
5. Solving the ordinary differential equations using single & multi-step methods.

UNIT I: Random Variables: Mathematical Expectation, Variance, Co-Variance, and its properties, Probability function, Moments, mgf, cgf and its properties.

UNIT II:
Probability Distributions: Discrete distribution: Binomial, Poison distributions, finding Mean and Variance through mgf. Continuous distribution: Normal distribution, Exponential & Uniform distributions.

UNIT III:
Solution For Non-Linear Equations: Algebraic & transcendental equations, Bisection method, Regular False Method and Newton Raphson method, interpolation, Newton's forward and backward formulas.

UNIT IV: Numerical Differentiation & Integration: Numerical differentiation using numerical forward & backward interpolation formula, Numerical integration: Simpson's 3/8th rule, Weddle's rule.

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UNIT V: Numerical Solution Of Oridinary Differential Equations: Picard's method, Euler's method, R.K method (fourth order) and Milne Thompson's method (predictor & corrector)

Text Books:

1. S.C Gupta and V.K.Kapoor, Fundamentals of Mathematical statistics, S.Chand& Co.2006.
2. M.K.Jain, S.R.K Iyengar and R.K.Jain: Numerical methods for Scientific and Engineering Computation. New Age International publications, 2008.

Suggested Reading:

1. Miller and Freund, Probability and Statistics for Engineers, Pearson, 2005.
2. S.S.Shastry, Introductory Methods of Numerical Analysis, PHI Learning Pvt. Ltd., 2012.

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16ME C23

DYNAMICS AND VIBRATIONS LAB

Instruction	3 Hours per week
Duration of End Examination	3 Hours
End Examination	50 Marks
Sessionals	25 Marks
Credits	2

Course Objectives:

1. To demonstrate basic principle and exposure to evaluate CAM Follower Motion and Gyroscopic effects.
2. Students will understand the importance of static and dynamic balancing.
3. Students will acquire the knowledge in evaluating the stability of dynamic systems.

Course Outcomes: Students will be able to

1. Evaluate the effect of gyroscopic couple.
2. Evaluate the effect of CAM Follower Motions in machines.
3. Estimate the performance of governors.
4. Evaluate the static and dynamic balancing of rotating masses.
5. Estimate the natural frequency of different un-damped vibrating systems.
6. Estimate the natural frequency of different damped vibrating systems.

List of experiments:

(1) To study the motion of follower with the given profile of the cam. (To plot the n-q (Follower displacement Vs Angle of rotation) curves for different cam follower pairs.
(2) To study the gyroscopic effect on a rotating disc.
(3) Determination of the frequency of torsional vibration.
(4) Static and Dynamic balancing in a Rotating mass system.
(5) Study the effect of varying mass on the centre of sleeve in porter governor.
(6) Study the effect of varying the initial spring compression in Hartnell governor.
(7) Undamped torsional vibrations of double rotor system.
(8) To study the longitudinal vibrations of helical coiled spring.
(9) To study the undamped forced vibration of spring mass system.
(10) To study the force damped vibration of spring mass system.
(11) Determination of critical speed of the given shaft with the given end conditions (Whirling of Shafts).
(12) Frequency response of spring mass system with damping.

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Text Books:

1. S. Rattan, Theory of Machines, Tata-Mc Graw Hill, 1995.
2. John.J.Vicker, Gordon R. Pennock, Joseph E. Shigley, Theory of Machines & Mechanisms, Oxford University Press, 2003.

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16ME C24

APPLIED THERMODYNAMICS AND HEAT TRANSFER LAB

Instruction	3 Hours per week
Duration of End Examination	3 Hours
End Examination	50 Marks
Sessional	25 Marks
Credits	2

Course Objectives:

1. To demonstrate basic knowledge and exposure to determine valve and port diagram and also to evaluate the performance of the petrol engine and diesel engine.
2. Student will determine the importance of heat balance sheet of IC engine.
3. Students will acquire knowledge in evaluating the performance of multi-stage reciprocating compressor.
4. To demonstrate knowledge in evaluating thermal conductivity and heat transfer coefficient under natural convection phenomena and forced convection phenomena.
5. Students will understand the basic concepts of radiation heat transfer
6. Student will understand the effectiveness of parallel and counter flow heat exchangers.

Course Outcomes: Students will be able to

1. Evaluate the performance of petrol and diesel engines.
2. Estimate the heat losses in heat balance sheet of IC engine.
3. Evaluate the performance of multi stage reciprocating air compressor and its importance over single stage air compressor.
4. Estimate the effect of insulation on conduction heat transfer and also estimate the value of convection heat transfer coefficients under different scenario.
5. Determine Steffan and Boltzman constant and emissivity in radiation heat transfer.
6. Estimate the properties of radiating body and effectiveness of heat exchangers.

Applied Thermodynamics

1. Determination of Valve timing diagram and Port diagram of IC engine.
2. Determination of Performance characteristics of a multi-cylinder petrol engine.
3. To conduct Morse test on multi cylinder petrol engine.
4. To conduct performance test on a variable compression ratio petrol engine.
5. To conduct performance test on single cylinder diesel engine.

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6. To conduct heat balance test on single cylinder diesel engine.
7. To determine volumetric efficiency, isothermal efficiency of multi -stage reciprocating air compressor.

Heat Transfer

1. Determination of Thermal conductivity of insulating powder.
2. Determination of thermal conductivity of composite wall.
3. Determination of convective heat transfer coefficient under Natural and Forced convection phenomena using pin-fin apparatus.
4. Determination of Emissivity of a given plate.
5. Determination of the value of Stefan-Boltzman constant.
6. Determination of Heat transfer coefficient in parallel and counter flow heat exchanger.

Text Books:

1. R. K. Rajput, Thermal Engineering, Laxmi Publishers, New Delhi, 2014.
2. Mahesh M. Rathore, Thermal Engineering, TMH, New Delhi, 2010.

Note: Minimum 12 Experiments taking 6 from each section

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16EE C22

ELECTRICAL MACHINES AND MICROCONTROLLER APPLICATIONS LAB

(Common to BE3/4, Mech. & Prod, V- SEM)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	25 Marks
Credits	2

Course Objectives:

1. To understand the testing of 1-phase transformers.
2. To comprehend various characteristics of DC machines.
3. To understand the characteristics of different AC machines.
4. To learn operations on 8051 microcontroller.
5. To understand basics of interfacing devices with 8051 microcontroller.

Course Outcomes: The student will be able to

1. Test the 1-phase transformer.
2. Know the right instrument and its usage for the given circuit.
3. Identify the suitable machine for required application.
4. Process the data using 805i microcontroller.
5. Interface the given device with 8051 microcontroller.

List of Experiments:

Cycle -I

1. Magnetization characteristics of a separately excited DC generator.
2. Load characteristics of a shunt generator.
3. Performance characteristics of a shunt motor.
4. Performance characteristics of a compound motor.
5. Speed control of DC shunt motor.
6. O.C. and S.C. tests on single phase transformer.
7. Load test on a three phase induction motor. .
8. Speed control methods of induction motor.
9. To determine the load characteristics of a DC series motor.

Note:

At least **SIX** experiments should be conducted in the semester from cycle - I.

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Cycle -II

1. 8051 Microcontroller Experiments.
2. Data Transfer - Block move, Exchange, sorting, Finding largest element in an array.
3. Arithmetic Instructions :Multi byte operations.
4. Boolean & Logical Instructions (Bit manipulations)
5. Use of JUMP and CALL instructions.
6. Control of stepper Motor using 8051.
7. A/D converter interface with 8051 Microcontroller.
8. D/A converter Interface with 8051 Microcontroller.

Note:

At least **FOUR** experiments should be conducted in the semester from cycle - II.

Text Books:

1. V.K. Mehta, Principles of Electrical Engineering & Electronics, S.Chnad Limited, 1998.
2. Muhammad Ali Mazidi, Tanice Gillispie Mazid, Rolin D. Mckinlay, The 8051 Microcontroller & Embedded Systems, Pearson Education, 2016.

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16ME C25

INDUSTRIAL VISIT

A minimum of two industrial visits will be arranged by department and students have to attend the visits and prepare a data report of their visits to the industries and submit to the department. Students are required to present a seminar based on their report which is evaluated by Head of the Department and two senior faculty to award the grade and these grades are categorized as follows.

Excellent / Very Good / Good / Satisfactory / Unsatisfactory.

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16ME C26

CAD and CAM

Instruction	3 Hours per week
Duration of End Examination	3 Hours
End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. Understand the basic and advanced concepts of computer aided design. Learn the application of CAD in geometric modeling.
2. Students will develop an understanding of the theory and construct the elements of curved surface representation.
3. Explain solid modeling representation schemes and the Euler operators. Understand and be able to perform two-dimensional and three-dimensional geometric transformations on objects.
4. Have an overview of advantages and disadvantages of modeling and analysis packages.

Course Outcomes: After completion of course, the student will be able to

1. Apply design concepts in design , analysis and modeling of entities and curves.
2. Apply surface and solid modeling techniques for the generating various parts and implement transformations on various geometric models for manipulation.
3. Visualize the models through the graphics standards and implement NC,CNC systems and programming.
4. Implement and practice the DNC and AC controls , analyze the manipulator motions, configurations including end effectors, actuators, drives and sensors and programming.
5. Learn and Implement GT and Coding methods and CAPP.
6. Understand and implement FMS,CIMS,RPT ,QC- methods & controls and Turnkey CAD/CAM systems.

UNIT-I: Design Process:
Design criteria, Alternative solutions, Alternative design, Computer aided design and review.

Drafting techniques: Basic geometric elements and their creation.

Geometric modeling: Wire frame entities and their definition, interpolation and approximation curves. Concept of Parametric and non-parametric representation of circle and helix curves,
properties of splines. Synthetic curves: parametric representation of cubic spline, Bezier and B-spline curves, continuity, properties and characteristics. Introduction to NURBS.

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UNIT-II: Surface Modeling:
Analytic surfaces: Definition of planar, Ruled , surface of revolution, tabulated cylinder.
Synthetic Surfaces: Cubic and Bezier surfaces.
Solid modeling: C – rep and B – rep approaches.
Design Applications: Mass property calculations, mechanical tolerancing, finite element analysis.
2 D Transformations: Translation, scaling and rotation about arbitrary point, shear and reflection, homogenous representation, concatenation.

UNIT-III: CAD Database and Data Exchange:
CAD database and structure, IGES, STEP and STL format.

Numerical Control of Machine Tools:
Features and elements of NC, Types of NC systems: PTP, Straight Cut and Contouring Introduction to CNC, Typical configurations, Definition of axes, Definition of interpolation, post-processor, preparatory and miscellaneous functions, canned cycles, tool length and cutter radius compensation. Manual and computer aided part programming (APT) for simple components. Programming with MACROS.

UNIT-IV: DNC:
Typical configurations, CNC vs DNC, Adaptive control systems, Machining centers. Introduction to FANUC, SINUMERIC controllers.
Industrial robots: Robot anatomy, configurations, controls, drivers, programming methods and applications.

UNIT-V: GT:
Part families, layout, part classification and coding system- OPITZ, MICLASS.
CAPP: Variant and generative process planning.
FMS and CIM: F.M.S equipment, FMS layouts, benefits of FMS. Elements of CIM.

Computer Aided Inspection and QC: Automated inspection- Off-line, On-line, contact (Co-ordinate measuring machine), Non-contact inspection (Machine Vision, Scanning LASER Beam, Photogrammetry).
CAD/CAM integration, Turnkey CAD/CAM systems, Introduction to rapid prototyping technique.

Text Books:

1. Ibrahim Zeid, CAD/ CAM Theory and Practice, McGraw Hill Inc, New York, 2011.
2. Grover MP and Zimmers EW CAD/CAM Prentice Hall of India, 1989.
3. Rao PN CAD/CAM : Principles and Applications 2nd edition, Tata McGraw Hill, New Delhi, 2004.

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Suggested Reading:

1. Arvid R Eide, Roland D Jenison, Lane H Mashaw, Larry L Northup, Introduction to Engineering Design McGraw Hill 1998.
2. Yoramkoren, Computer Control of Manufacturing Systems McGraw Hill Int, New York, 1994.
3. C. Elanchezhian, T . Sunder Selwyn , G . Shanmuga Sunder, Computer Aided manufacturing , Laxmi Publications (P) Ltd, 2nd edition, New Delhi 2007.

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16ME C27

METAL CUTTING AND MACHINE TOOL ENGINEERING

Instruction	3 Hours per week
Duration of End Examination	3 Hours
End Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives: Student will learn the

1. Basic understanding of cutting tools, geometry in machining processes.
2. Make students familiar with cutting forces in turning drilling, milling operations.
3. Understand various machine tools, like lathe, drilling, milling shaper, planner,
4. Knowledge of Thread manufacturing and gear manufacturing.
5. Understand un-conventional machining processes like, EDM, ECM.
6. Understand LBM, EBM, ECG and do problems on MRR, Surface finish.

Course Outcomes: Students are able to

1. Grind single point cutting tool with various angles.
2. Perform taper turning and knurling on lathe.
3. Perform drilling and thread cutting operations.
4. Manufacture a gear using milling machine.
5. Do operation on shaper.
6. Exposed to various unconventional processes.

UNIT-I: **Cutting Tool Materials**:
High carbon steel, HSS, Stellite, Carbides, Diamonds, Tool materials properties.
Tool Geometry: Nomenclature of single point cutting tool by ASA& ORS systems, Geometry of drills, milling cutters.

Chip Formation: Types of chips, BUE, Chip breakers.

Machining: Orthogonal and oblique cutting, Merchants analysis, Shear angle, Solutions of merchant and Lee & shafer.

UNIT-II: Thermal Aspects of Metal Cutting:
Sources of heat and heat distribution. Various methods of measurement of temperature, cutting fluids and applications.

Tool Wear and Tool Life: Criteria for tool wear, flank and crater wear theories, criteria for tool life in roughing and finishing, Measurement of tool wear, Taylor's tool life equation, factors effecting tool life, Machiniability.
Economics of machining: Tool life for maximum production, minimum cost.

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UNIT-III:Lathes:

Types constructional features, size of lathe, various operations that can be performed on lathes types of lathes, capstan and turret lathes, bar work and chuck work and tool holding devices. Taper turning methods. Thread cutting and accessories of lathe.

Drilling Machines: Types and constructional features and applications, Radial drilling machine, drilling operations.

Milling Machines: Classifications and types various operations on milling machines, Up and down milling. Types of milling cutters and bars. Dividing head, plain, compound and differential indexing.

UNIT-IV: Boring Machines:

Horizontal, Vertical and Jig boring machines and constructional features. Differences between Shaper, Planner and slotter, Quick return mechanisms.

Grinding Machines: Types, Classification Abrasives and bonds used for grinding wheel, Selection of grinding wheel, cylindrical grinding and center less grinding.

Screws and Thread Production: Thread rolling, thread chasing , thread milling and thread grinding. Gear shaping, gear hobbing, gear shaving and gear grinding

UNIT-V: Jigs and Fixtures:

Design principles for location and clamping. Quick clamping devices. Types of jigs and fixtures.

Unconventional machining: Principles of working and applications USM, AJM,EDM, ECM, LBM and EBM (Mechanisms and theory MRR and Process parameters in each case)

Text Books:

1. B.L. JuneJa and Shekon, Fundamentals of Metal Cutting & Machines Tools, Wiley Eastern Ltd. 1987.
2. P.N. Rao, Manufacturing Technology – Metal Culling & Machine Tools, Vol. 2, Tata McGraw Hill Education Pvt. Ltd, 2010.
3. M.C. Shaw, Metal Cutting Principles, Clarendon Press, Oxford 1984.

Suggested Reading:

1. Hajra Choudary S.K, Elements of Workshop Technology, Vol. II, Media Pub., New Delhi, 2010.
2. P.C.Pandey& Shan HS Modern Machining process Tata McGraw-Hill Education 1980.
3. A. Bhattacharya Metal Cutting Theory and Practice New Central Book Agency (p) Ltd Calcutta, 1996.

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16ME C28

THERMAL TURBO MACHINES

Instruction	3 Hours per week
Duration of End Examination	3 Hours
End examination	70 Marks
Sessionals	30 Marks
Credits	3

Course Objectives:

1. Student will demonstrate basic knowledge by understanding concepts of various gas dynamics equations, necessary for CFD.
2. Student will acquire basic knowledge in designing of nozzles and diffusers used in rockets and aircrafts.
3. Student will come to know the design of ducts, combustion chambers and various types of shocks.
4. Student will come to know the working principles of various rotary compressors like centrifugal compressor and rotary compressor.
5. Student will understand the applications of various steam turbines and velocity triangles in order to calculate power developed by them.
6. Student will demonstrate the basic knowledge in gas turbines and various methods to improve efficiency of gas turbine cycles. Outcomes:

Course Outcomes: At the end of the course, students will be able to

1. Design various configurations of steam nozzles by the principles of gas dynamics which are essential or pre-requisite to computational fluid dynamics.
2. Understand Fanno curves along with shock waves.
3. Understand the importance of Rayleigh curves in gas dynamics.
4. Calculate power required by various types of rotary compressors with the principles of gas dynamics.
5. Specify steam turbine as per the application and also calculate power developed by them.
6. Calculate thermal efficiency of gas turbines with the principles of gas dynamics and suggest suitable methods to improve work output and efficiency of the plant.

UNIT-I:Introduction to Compressible Flows:
Speed of propagation of pressure waves, Mach number, Acoustic velocity and Mach cone, limits of compressibility, pressure field due to a moving source of disturbance, one dimensional compressible flow. Isentropic flow with variable area, Mach number variation, Area ratio as function of Mach number, flow through nozzles and diffusers Flow with Shock Waves-Development of Normal Shock waves, governing equations,

UNIT-II: Flow in Constant Area Ducts with Friction-Fanno Flow:
Variation of flow properties, variation of Mach number with duct length, isothermal flow with friction. Prandtl –Meyer relation, Rankine-Hugoniot equations, Stagnation pressure ratio across shock.

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UNIT-III:Rotodynamic Compressors:
Introduction and general classification, Comparison of Reciprocating and Rotary compressors, Positive displacement Rotary compressors, Flow through rotary compressors. Static and total head quantities. Thermodynamic cycles and work done, calculation of various efficiencies. Velocity diagrams and prewhirl. Euler equation for energy transfer between fluid and rotor, Analysis of Centrifugal compressors and analysis of axial flow compressors, Chocking, Surging and Stalling.

UNIT-IV: Steam Turbines:
Introduction to steam nozzles, design for throat area. Classification of steam turbines, Impulse turbine ,compounding of steam turbines, Pressure velocity variations across different compounding turbines, blade efficiency and work done by impulse turbine ,degree of reaction of reaction turbine, blade efficiency and work done by reaction turbine, stage efficiency and nozzle efficiency and simple problems on impulse and reaction turbines.

UNIT V: Gas Turbines:
Applications and Classification of Gas Turbines- constant pressure and constant volume gas turbines, Joule cycle-configuration diagram and temp-entropy diagram, Thermal efficiency of Joules cycle, maximum pressure ratio in terms of temperature ratio, optimum pressure ratio for maximum work output with and without considering machine efficiencies, Improvement of gas turbine plant performance- Inter-cooling, Reheating and Regeneration. Simple problems on Joule cycle.

Air Craft Propulsion: Air craft engine types, air craft propulsion theory, Turbo jet engines, Ramjet engines, Pulse jet engines..

Rocket Propulsion: Types of Propellants, Types of Rocket engines, Rocket propulsion theory-Rocket applications.

Text books:

1. S M Yahya , Fundamentals of Compressible Flow, New Age International Publishers, 2014.
2. Mahesh M. Rathore, Thermal Engineering, TMH, New Delhi, 2010
3. M L Mathur & F S Mehta, Thermal Engineering, Jain Brothers, New Delhi, 201.

Suggested Reading:

1. Dennis G Shepherd , Aerospace Propulsion, Elsevier Publishing Company, New York, 1995.
2. V. Ganeshan Gas Turbines, Tata Mc Graw Hills, New Delhi, 2010.
3. R Yadav, Steam and Gas Turbines, Central Publishing House Ltd, Allahabad, 2003.

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16ME C29

MACHINE DESIGN

Instruction	3 Hours + 1 Tutorial per week
Duration of End Examination	3 Hours
End examination	70 Marks
Sessionals	30 Marks
Credits	4

Course Objectives:

1. To learn design criteria of machine components, selection of materials and manufacturing process.
2. To learn application of principles to design helical coiled and leaf springs, gears, curved beams, sliding contact and rolling element bearings and IC engine components.
3. To provide the design concepts of helical and leaf springs.
4. To provide the students the knowledge of design of IC engine parts.

Course Outcomes:

1. Graduates demonstrate the ability to design helical, leaf springs for static and fluctuating loads.
2. Graduates have the ability to design gears for power transmission considering beam strength, dynamic factors and wear life.
3. Graduates demonstrate the ability in designing sliding contact bearings, considering power lost in friction, heat dissipation.
4. Graduates have the ability of selection of rolling contact bearings based on load-life relationship.
5. Graduates demonstrate the ability of designing IC engine parts such as piston, connecting rod and crank shaft considering gaseous impulse and thermal aspects.
6. Graduate demonstrate the ability of designing curved beams like C-clamp, crane hooks etc.

UNIT-I: Mechanical Springs:
Introduction, types of springs, Materials used for springs.

Helical Springs: Whal's factor, calculation of stresses, deflection and energy stored in spring. Design for static and fluctuating loads.

Leaf Springs: Stresses and deflection, nipping of Leaf springs. Design for static loads.

UNIT-II: Gears:
Introduction to gear drives, types of gears, materials used for gears. Standards and specification of gears. Design of Spur, Helical, Bevel and Worm gears: Lewis beam strength equation. Dynamic loads on gear tooth. Wear load and design for wear strength.

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UNIT-III: Bearings:
Introduction, classification of bearings, materials used for bearings, properties and types of lubricants.

Design of Sliding Contact Bearings:
Hydrostatic and Hydrodynamic bearings.

Selection of Rolling Contact Bearings: Types of rolling elements and their constructional details. Static and dynamic load carrying capacity. Load-life relationship, selection of bearing, for cyclic loads and speeds.

UNIT-IV: I.C. Engine Parts:
Introduction, Materials used, Design of piston, connecting rod and crank shaft.

UNIT-V: Design of Curved Beams:
Introduction, stresses in curved beams, expression for radius of curvature of neutral axis for rectangular, circular and trapezoidal sections. Design of C-clamp and crane Hook. Design of chain drives: Power rating of roller chains. Strength of roller chains.

Text Books:

1. Bhandari V.B. Machine Design, Tata Mc Graw Hill Publications, 2010.
2. J.E. Shigley , C.R. Misckhe, Mechanical Engineering Design, Tata Mc Graw Hill Publication, 2010.
3. P. Kannaiah, Machine Design, Science-Tech Publications, 2010.

Suggested Reading:

1. M.F. Spotts, Design of Machine Elements, Prentice Hall, 2013.
2. Robert L. Norton, Machine Design: An Integrated Approach, 2/e Pearson Education, 2013.
3. Siraj Ahmed, 'Mechanical Engineering Design, PHI, 2014.

Machine Design Data Books:

1. Design Data book by PSG College –2012.
2. Mahadevn .K, Balaveera Reddy. K, 'Design Data Hand Book, 4th Edn., CBS Publishers & Distributors, 2013.
3. Machine Design Data Book, by V.B. Bhandari McGraw hill education, 2015.

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16ME E04

ADVANCED IC ENGINES (Professional Elective – III)

Instruction	3 Hour per week
Duration of End Examination	3 Hours
End examination	70 Marks
Sessionals	30 Marks
Credits	3

Course Objective (s): Student will understand the

1. Fundamental working principles of diesel/petrol engines.
2. Importance of combustion phenomena in I.C. Engines.
3. Importance of control of pollutants and their remedies.
4. Working principles of analyzers for measurements of pollutants.
5. Concept of alternative fuel technology to improve the performance of the engine.
6. Concepts of recent trends with change of engine configuration.

Course Outcome (s): Student will be able to

1. Evaluate the performance of the diesel/petrol engine.
2. Distinguish abnormal combustion from normal combustion in CI and SI engine.
3. Ascertain the need for formation of various pollutants from IC engines.
4. Determine various pollutants from IC engine with different analyzers .
5. Stress the need for alternative fuels and their technological, environmental and social impacts.
6. Evaluate the performance of IC engine with recent trends with modern concepts like Lean burn, stratification, HCCI and GD.

UNIT-I : Fundamentals of IC Engines:
Classification, Working principles of 2 stroke, 4 stroke SI and CI engines. Performance of IC Engines. Heat balance sheet.

UNIT-II: Combustion Phenomena:
Normal and abnormal combustion phenomenon in SI and CI engines. Cooling, lubrication systems, Battery and magneto ignition systems of IC engines. Working principle of Simple Carburetor and Fuel Injector Combustion Chambers for SI & CI Engine.

UNIT-III: Pollutant Formation And Control:
Engine Variables Affecting Pollutants and their remedies Working Principles of Smoke Analyser, CO/UBHC Analyser and NO_x Analyser–Introduction to emission norms.

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UNIT-IV: Alternative Fuels

Alcohols, Vegetable oils, Bio Diesel Hydrogen, Natural Gas, Liquefied Petroleum Gas and Bio Gas Properties, Suitability, Merits and Demerits as fuels.

UNIT-V: Advances in IC Engines

Lean Burn Engines – Stratified charge Engines – homogeneous charge compression ignition (HCCI) Engines and GDI concepts.

Text books:

1. Ganeshan, V., Internal Combustion engines, Tata Mc Graw Hills Publishing Co.Ltd, New Delhi 2015.
2. Gill, P.W. and Smith (Jr,J.H, fundamentals of Internal combustion Engines, Oxford & IBH publishing Co.New Delhi, 1967.
3. Heywood, J.B, Internal Combustion engine fundamentals, McGrave Hills, Book Co, New York, 1988.

Suggested Readings:

1. C.F. Taylor and E.S.Taylor, The Internal Combustion Engine in Theory and Practice, M.I.T.Press, 1968.
2. M.L. Mathur and R.P. Sharma, Internal Combustion Engine, Dhanpat Rai & Sons, Delhi, 5th Edition, 1990.
3. V. Ganeshan, Internal Combustion engines, Tata Mc Graw Hills Publishing Co. Ltd., New Delhi 1984.

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16ME E05

COMPUTATIONAL FLUID DYNAMICS (Professional Elective – III)

Instruction	3 Hours per week
Duration of End Examination	3 Hours
End examination	70 Marks
Sessionals	30 Marks
Credits	3

Course Objectives:

1. Understanding of governing equations of fluid flow.
2. Student understand finite difference and finite volume methods to solve fluid flow equations.
3. Issues that arise in the solution of such equations.
4. Various methods to overcome those issues and modern trends in CFD.
5. Get exposure to grid generation.
6. Various boundary conditions and their implementation.

Course Outcomes: At the end of the course, the students are able to

1. Classify basic equations of fluid flow.
2. Choose appropriate boundary conditions.
3. Choose proper numerical technique to solve equations.
4. Critically analyze different mathematical models and computational methods for flow simulations.
5. Interpret computational results.
6. Acquire the required knowledge to take advanced courses in CFD.

UNIT-I: Basic Equations:

Continuity, momentum and energy equations, navier-stokes equations, Heat transfer conduction equations for steady and unsteady flows, steady convection-diffusion equation.

UNIT-II: Models:

Reynolds and Favre averaged N-S equations, Mixing length model, k-epsilon turbulence model.

Classifications of Partial Differential Equations:

Elliptic, parabolic and hyperbolic equations, Initial and boundary value problems.

UNIT-III: Finite Difference Method:

Forward, backward and central difference.

Parabolic partial differential equations: Euler, implicit and crank Nicholson methods, ADI models, Errors, consistency, stability analysis, Vonnumen analysis, Convergence criteria.

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UNIT-IV: Elliptic Partial Differential Equations:
Jacobi, Gauss seidel methods, Viscous incompressible flow, Stream-function-vorticity method.

Introduction to grid generation: Types of grids O, H, C.

UNIT – V: Finite Volume Method:
Finite volume formulation for diffusion equation, convection diffusion equation, Solution algorithm for pressure velocity coupling in steady flows, staggered grid, SIMPLE algorithm.

Text Books:

1. P.S. Ghoshdastidat, Computational Fluid Dynamics & Heat Transfer, Cengage Pub., 1998.
2. J.D. Anderson, Jr., Computational Fluid Dynamics: The Basic with Applications McGraw Hill, Inc., 2012.
3. H. Versteeg and W. Malalasekra, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Pearson,2nd edn. 2011.

Suggested Reading:

1. F. John Wendt (Editor), Computational Fluid Dynamics - An Introduction, Springer – Verlag, Berlin, 1992.
2. Charles Hirsch, Numerical Computation of Internal and External Flows, Vols. I and II. John Wiley & Sons, New York, 1988.
3. Anil W.Date, Introduction to Computational Fluid Dynamics, Cambridge, 2005.

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16ME E06

AUTOMOBILE ENGINEERING (Professional Elective – III)

Instruction	3 Hours per week
Duration of End Examination	3 Hours
End examination	70 Marks
Sessionals	20 Marks
Credits	3

Course Objectives: The student will learn

1. The anatomy of the automobile in general.
2. The location and importance of each part.
3. The functioning of the engine and its accessories, gear box, clutch, brakes, steering, axles and wheels.
4. Suspension, frame, springs and other connections.
5. ignition, controls, electrical systems and ventilation.
6. Emissions, pollution regulations, EURO and BHARATH stages.

Course Outcomes: At the end of the course, the student will be able to

1. Identify the different parts of the automobile.
2. Explain the working of various parts like engine, transmission, clutch, brakes.
3. Describe how the steering and the suspension systems operate.
4. Understand the environmental implications of automobile emissions.
5. Develop a strong base for understanding future developments in the automobile industry.

UNIT-I: Types of automobiles:
Normal, Hybrid and Hydrogen Fuel vehicles. Engine location and its components, chassis layout; crank shaft proportion, firing order, piston and piston rings, cylinder liners, valves and operation mechanism, inlet and exhaust manifolds, carburetion and fuel injection system, Mechanical Fuel Injection system.

UNIT-II: Lubricating Systems:
Wet sump, dry sump and petroil systems - Cooling systems: Water pumps, radiators, thermostat control anti freezing compounds - Types of Ignition Systems, Modern Ignition systems, Types of Batteries and charging systems, starting motors, lighting and electrical accessories, automobile air-conditioning.

UNIT-III: Steering Systems:
Linkage arrangements and its components modified Ackerman linkage, wheel alignment, caster and camber. Rack and pinion assembly, recent trends, Wheel and tyres: Tyre construction, specification. Tyre wear and causes, wheel balancing, wheel alignment, Types of Suspension systems, Independent suspension, coil and leaf springs, torsion bar, shock absorbers.

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UNIT-IV: Power Train:
Clutches gear and gearbox manual, semi-automatic and automatic gearboxes. Torque converter, propeller shaft, universal coupling differential, four-wheel drive system Brakes Systems: Description and operation of hydraulic brake, leading and trailing shoe layout, disc brakes, master cylinder and hand brake linkage, Recent Trends.

UNIT-V: Maintenance:
Pollution control, trouble shooting and servicing procedure overhauling, engine tune up, tools and equipment for repair and overhaul testing equipment, pollution control technologies used for petrol and diesel engines. Types and study of catalytic converters, Euro norms 2 & 3 and Bharat Norms – Recent Trends.

Text Books:

1. Crouse & Anglin, Automotive Mechanics, TataMcGraw Hill. Publishing Co. Ltd., New Delhi, Tenth Edition – 2004.
2. Kirpal singh., Automobile Engineering Vol. I & II Standard Publishers, Delhi, 2002.
3. Joseph Heitner, Automotive Mechanics, Affiliated East West Pvt. Ltd. Second Edition, 2006.

Suggested Reading:

1. C.P Nakra, Basic Automobile Engineering, Dhanpat Rai Publishing Co. (P) Ltd., New Delhi, 2003.
2. G.B.S. Narang, Automobile Engineering, Khanna Publishers, New Delhi, 2014.
3. R.K. Rajput, A Textbook of Automobile Engineering, Laxmi Publications, New Delhi, 2012.

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16PE E05

DIGITAL MANUFACTURING (Professional Elective-III)

Instruction	3 Hours per week
Duration of End Examination	3 Hours
End examination	70 Marks
Sessionals	30 Marks
Credits	3

Course Objectives: Student has to understand the

1. Concepts and architecture of digital manufacturing.
2. Different additive manufacturing processes.

Course Outcomes: By the end of the course, the students will be able to:

1. Understand the concept, architecture and process of digital manufacturing.
2. Relate different additive manufacturing processes as a part of digital manufacturing.
3. Understand the concept of virtual prototyping and importance of reverse engineering in digital manufacturing.
4. Understand Intelligent multi information sensing concept and its application in digital manufacturing.
5. Understand the various digital processing technologies in product lifecycle, digital equipment.
6. Understand future scope, precision, environmental protection of digital manufacturing.

UNIT-I: Overview of Digital Manufacturing Processes:
Concepts and research and development status of digital manufacturing, definition, features and development of digital manufacturing, Conventional and digital manufacturing.
Theory system of digital manufacturing science: Operation mode and architecture of digital manufacturing system , Operation reference mode of digital manufacturing system – architecture of digital manufacturing system.

UNIT-II: Additive Manufacturing Processes Advanced Materials:
Additive manufacturing processes, Engineering polymers, metals, ceramics: Stereolithography, Selective Laser Sintering, Fused Deposition Modeling, Layered object manufacturing Electronic Materials , Bio-printing, Food Printing Advanced materials of Additive Manufacturing for Electronic Materials, Bio-printing, Food Printing, Preprocessing and Post processing in AM.

UNIT-III: Virtual Prototyping:
Introduction to Virtual Prototyping, Basic theory of Virtual Prototyping, Application of Virtual Prototyping in Manufacturing, Virtual Prototyping and Virtual

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Manufacturing Reverse Engineering-Introduction, Basic Theory of Reverse Engineering, Application of Reverse Engineering in Digital Manufacturing.

UNIT-IV: Intelligent Multi Information Sensing:
Concept, The Application of Sensor in the Processing & tool monitoring, Data mining applied to Digital Manufacturing Autonomy of Manufacturing System, Self-Learning of Manufacturing System Intelligent Manufacturing System.

UNIT –V: Key Technology of Digital Manufacturing:
Various Digital Technologies in Product Lifecycle, Digital Equipment and Digital Processing Technology, The Technology of Digital Maintenance and Diagnosis Future Development of Digital Manufacturing Science-precision of Digital Manufacturing, Environmental protection of Digital manufacturing.

Text Books:

1. Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited, 2012
2. Additive Manufacturing Technologies (2010; Springer) by Brent Stucker, David Rosen, and Ian Gibson ISBN 978-1-4419-1120-9, 2010.
3. Chee Kai Chua, Kah Fai Leong , 3D printing and additive manufacturing: principles and application: fourth edition of rapid prototyping, 2010.

Suggested reading:

1 Lihui Wang and Andrew Yeh Ching Nee, Collaborative Design and Planning for Digital Manufacturing, Springer-Verlag London Limited, 2009.
2 PK. Venuvinod, Ma, W; Rapid prototyping – Laser based and other technologies, Kluwer, 2004.

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16ME E07

HEAT AND MASS TRANSFER (Professional Elective-IV)

Instruction	3 Hours per week
Duration of End Examination	3 Hours
End Examination	70 Marks
Sessionals	30 Marks
Credits	3

Course Objectives:

1. To demonstrate basic knowledge by understanding conduction heat Transfer.
2. Students will acquire the basic knowledge in understanding the principles of convection heat transfer.
3. Student will come to know basic principles of radiation heat transfer.
4. Student will come to know the difference of condensation phenomena and boiling phenomena.
5. Student will understand the working principle of heat exchanger and their effectiveness.
6. Student will come to know mass transfer phenomena in gases and liquids.

Course Outcomes: Students will be able to

1. Apply various laws pertaining to conduction heat transfer.
2. Establish relation between various dimensionless numbers in convection heat transfer.
3. Acquire the basic knowledge in understanding the principles of radiation
4. Evaluate convective heat transfer coefficient for condensation heat transfer
5. Design heat exchangers.
6. Estimate mass diffusion phenomena for industrial processes.

UNIT-I: Conduction in Heat Transfer:

General 3-D Conduction Equation in Cartesian and Cylindrical Coordinates, one dimensional steady state conduction through slabs, hollow cylinders without heat generation. Steady state heat transfer through composite slabs and cylinders, critical radius of insulation for cylinders.

UNIT-II: Convection in Heat Transfer:

Dimensional analysis and its use in free and forced convection, Buckingham " theorem, Physical significance of different dimensionless numbers. Simple problems on free and forced convection.

UNIT-III: Radiation in Heat Transfer:

Definition of absorptivity, reflectivity and transmissivity, Concept of black-body and emissivity. Kirchoff's law, Planck's black body spectral distribution, Wien's and Steffan Boltzmann law. Concept of surface, space resistances and radiation shields.

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UNIT-IV: Condensation in Heat Transfer:
Convective heat transfer coefficient for laminar condensation, boiling, critical heat flux, Heat Exchangers: Classification, LMTD and NTU Concepts, Simple problems on LMTD and NTU method.

UNIT-V: Mass Transfer:
Applications, Fick's law, three dimensional equation for mass transfer, diffusion coefficient, evaporation process in atmosphere, significance of dimensionless numbers in mass transfer.

Text Books:

1. J.P. Holman, Heat Transfer, McGraw Hill Publication, New Delhi, 2010.
2. Ozisik, Heat Transfer. TMH, 1998.
3. R.K. Rajput, Heat and Mass Transfer, Laxmi Publications, 2010.

Suggested Reading:

1. D.S. Kumar; Heat and Mass Transfer, S K Kataria Publishers, 2015.
2. R.C. Sachdeva, Fundamentals of Engineering Heat and Mass Transfer, New Age International Publications, 2014.
3. Yunus A Cenegal, Heat Transfer: A Practical Approach, Tata McGrahill, 2nd Edn. 1998.

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16ME E08

OBJECT ORIENTED PROGRAMMING WITH C++
(Professional Elective-IV)

Instruction	3 Hours per week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessionals	30 Marks
Credits	3

Course Objectives:

1. To teach difference between OOP and structured programming.
2. To teach how to use different features of C++.
3. To write programs for simple applications.
4. To understand capability of OOP.
5. To use operator overloading.
6. To create templates and usage of exception handling.

Course Outcomes: Be able to understand

1. The difference between object oriented programming and Structured programming and data types in C++.
2. To program using C++ features such as classes and objects.
3. The write C++ programs for simple applications in mechanical engineering.
4. The overload operators.
5. The use inheritance and polymorphism.
6. Capability to use effectively templates and exception handling.

UNIT-I: Principles of Object Oriented Programming:
Procedure Vs Object Oriented, Paradigm, Basic concepts, benefits, Applications and Object Oriented Languages.

Introduction:
Program structure, Creating, Compiling and Linking of C++ program.

Token, Expression and Control Structures:
Tokens, Keywords, Identifiers and Constants, Data Types, Operators, Precedence, Type Compatibility, Control Structures, New Features of C++.

Functions:
Function Prototype and Parameter Passing, Inline Functions, Default, Constant Arguments, Recursion, Function Overloading.

UNIT-II: Classes and Objects:
Defining classes and Member functions, creating objects, objects and arrays, objects and functions, const with classes, friends to a class, nesting static members of a class.

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Constructors and Destructors:
Type of Constructors, Dynamic Initialization of Objects, Destructors.

UNIT –III: C++ Operator Overloading and Type Conversions:
Fundamentals, restrictions, overloading unary / binary operators, overloading ++ and —, overloading special operators, overloading by member functions and friend functions, type conversions.

UNIT-IV: C++ Inheritance:
Defining derived classes, Types of Inheritance, Virtual Base class Abstract Class, function overriding and containership.

Pointers and Polymorphism:
Pointers and Generic pointer, Pointer to Objects and Derived Classes, this pointer, Virtual Functions, Virtual Destructors.

UNIT-V: C++ Templates:
Introduction, function templates and class templates.

C++ Exception Handling:
Conventional error handling mechanism, C++ error handling mechanism, Try, throw, catch, exception handling in classes.

Text Books:

1. Rohit Khurana Object oriented programming with C++, Vikas publications. 2nd edition, 2009.
2. Ashok Kamtani Object Oriented Programming with ANSI and Turbo C++, Pearson Education, 2014.
3. Somshekara & others, Object Oriented Programming with C++, Eastern Economy Edition, 2nd edition, 2012.

Suggested Reading:

1. E. Balagurusamy Object Oriented Programming with C++, McGraw-Hill Education (India), 6th Edition 2013.
2. Bjarne Stroustrup The C++ Programming Language, Pearson Education 5th Edition, 2013.
3. Robert Lafore Object-Oriented Programming in C++ Fourth Edition Sams Publishing, 2002.
4. John Hubbard, Atul Khate, Schaum's Series, Programming with C++ 3rd Edition, 1996.

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16PE E06

MODERN MACHINING AND FORMING PROCESSES
(Professional Elective-IV)

Instruction	3 Hours per week
Duration of End Examination	3 Hours
End examination	70 Marks
Sessionals	30 Marks
Credits	3

Course Objectives: Student will learn

1. The importance of non-conventional machining processes.
2. Various non-conventional machining processes and their process parameters.
3. The relative merits, limitations and applications of various non-conventional machining processes.
4. The knowledge regarding working media and its functions of non-conventional machining processes.
5. The concepts of non-conventional forming processes such as rubber pad forming, hydro forming, stretch forming, etc.
6. The concepts of HERF and to provide the description of HERF process.

Course Outcomes: At the end of the course, the students are able to

1. Select the non-conventional machining process for a particular application.
2. Demonstrate the capability of comparison of various non-conventional machining methods.
3. Describe the various non-conventional machining processes.
4. Exhibit the proficiency of selecting working media for various non-conventional machining processes.
5. Exhibit the basic understanding of non-conventional forming processes.
6. Compare various non-conventional forming processes based on their merits, limitations and applicability.

UNIT-I: Mechanical Energy Processes:

Ultrasonic Machining (USM): Introduction, Process description, abrasive slurry, Abrasive materials and their characteristics, Functions of liquid medium in slurry, Types of transducers, effect of process parameters, applications and limitations.

Abrasive Jet Machining (AJM):

Principle of operation, process details, process variables and their effect on MRR and accuracy, advantages, disadvantages and applications.

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Water Jet Machining (WJM):
Schematic diagram, equipment used, advantages and applications.

Abrasive Water Jet Machining (AWJM):
Process, advantages, limitations and applications

UNIT-II: Thermal Processes:
Electro Discharge Machining (EDM):
Process description with schematic diagram, process parameters, functions and characteristics of dielectric medium, dielectric fluids, flushing, mechanism of metal removal, types of power supply circuits, mathematical analysis of metal removal rate (MRR), equations for surface finish, characteristics of spark eroded surfaces, advantages, disadvantages and applications.

Wire EDM:
Process description and applications.

LASER Beam Machining (LBM):
Principle of LASER beam production, materials used, process parameters, advantages, limitations and applications.

Plasma Arc Machining (PAM):
Introduction, equipment used, process description and parameters, types of plasma arc: transferred arc and non transferred arc and process applications.

Electron Beam Machining (EBM): Schematic of the process, process parameters, principle of production of electron beam, equipment used, advantages, disadvantages and applications.

UNIT-III: Chemical and Other Machining Processes:
Electro-chemical machining (ECM): Schematic of process parameters, function and characteristics of electrolyte, MRR for pure metal and alloys, electrode feed rate (EFR), advantages, limitations and applications.

Chemical Machining: Chemical blanking and chemical milling, advantages, limitations and applications.

ION Etching: Process description, merits, limitations and applications.

UNIT-IV: High Energy Rate Forming Processes (HERF):
Introduction, applications, advantages, **Explosive Forming:**
Principles, explosive materials, Equipment, types of explosive forming, standoff operation and contact operation.

Electro-Hydraulic Forming (EHF): Schematic of process, description and its applications, **Electro-Magnetic Forming (EMF):** Process description, merits, limitations and applications.

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UNIT-V: Other Forming Processes:

Rubber Pad Forming: Principle of the process, process details and its types, Guerin, wheelon, Mar forming and Hydro forming processes and applications

Stretch Forming: Introduction, types of stretch forming, stretch draw forming, rotary stretch forming or stretch wrapping, compression forming, radial draw forming.

Tube spinning: Introduction, methods of tube spinning, backward spinning, forward spinning.

Text Books:

1. P.C. Pandey and H.S. Shah, Modern Machining Process Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1980.
2. J Paulo Davim, Modern Machining Technology, A Practical Guide, 1st Edition, Woodhead Publishing in Mechanical Engineering, 1980.
3. Hassan Abdel-Gawad El-Hofy, Advanced Machining Processes, Nontraditional and Hybrid Machining Processes, McGraw Hill Publishing Co. Ltd., 1984.

Suggested Reading:

1. Davies and Austin, Developments in High Speed Metal Forming, The Machinery Publishing Co. Ltd., 1985.
2. Production Technology, HMT, 1984.
3. A. Bhattacharya, New Technology, The Institution of Engineers (India), 1984.

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16PE E07

SURFACE ENGINEERING (Professional Elective-IV)

Instruction	3 Hours per week
Duration of End Examination	3 Hours
End examination	70 Marks
Sessionals	30 Marks
Credits	3

Course Objectives:

1. To impart knowledge on surface engineering and surface modification methods that will come in handy to solve the industrial problems.
2. This will also serve as a precursor for future research in the same field.
3. Student will understand the basic principles of corrosion and know the methods to reduce the corrosion on mechanical components.
4. Student will understand the role of wear and wear measurement techniques on Engineering components.

Course Outcomes: Students will be able to

1. Demonstrate basic understanding of friction, and be familiar with adhesion theories and the effect of adhesion on friction.
2. Demonstrate basic understanding of wear processes, and able to describe wear mechanisms on engineering components.
3. Demonstrate basic understanding of corrosion and know the methods to reduce the corrosion on engineering components.
4. Design a tribological system for optimal performance, and Justify, critical analysis on surface engineering techniques and surface design for relevant applications.
5. Apply surface engineering principles and methods to modify and improve the properties of surfaces for structural and functional applications.
6. Identify suitable surface processing method from various methods to create surface engineering solutions for specific materials, specific environments and specific applications in modern engineering practice.

UNIT I: Friction:

Topography of Surfaces – Surface features – Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction – Rolling Friction – Friction properties of metallic and non metallic materials – Friction in extreme conditions – Thermal considerations in sliding contact.

UNIT II: Wear:

Introduction – Abrasive wear, Erosive, Cavitation, Adhesion, Fatigue wear and Fretting Wear- Laws of wear – Theoretical wear models – Wear of metals and non metals - International standards in friction and wear measurements.

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UNIT III: Corrosion

Introduction – Principle of corrosion – Classification of corrosion – Types of corrosion – Factors influencing corrosion – Testing of corrosion – In-service monitoring, Simulated service, Laboratory testing – Evaluation of corrosion – Prevention of Corrosion – Material selection, Alteration of environment, Design, Cathodic and Anodic Protection, Corrosion inhibitors.

UNIT IV: Surface Treatments

Introduction: Surface properties, Superficial layer – Changing surface metallurgy – Wear resistant coatings and Surface treatments – Techniques – PVD – CVD – Physical CVD – Ion implantation – Surface welding – Thermal spraying – Laser surface hardening and alloying, Applications of coatings and surface treatments in wear and friction control – Characteristics of Wear resistant coatings – New trends in coating technology – DLC – CNC – Thick coatings – Nano-engineered coatings – Other coatings, Corrosion resistant coatings.

UNIT V: Engineering Materials

Introduction:

Advanced alloys – Super alloys, Titanium alloys, Magnesium alloys, Aluminium alloys, and Nickel based alloys – Ceramics – Polymers – Biomaterials – Applications – Bio Tribology, Nano Tribology.

Text Books:

1. G.W.Stachowiak & A.W. Batchelor, Engineering Tribology, Butterworth-Heinemann, UK, 2005.
2. E. Rabinowicz, Friction and Wear of materials, John Willey & Sons, UK, 1995.
3. J. Halling, (Editor) – Principles of Tribology, Macmillian – 1984.

Suggested Readings:

1. J.A. Williams Engineering Tribology, Oxford Univ. Press, 1994.
2. S.K.Basu, S.N. Sengupta & B.B. Ahuja, Fundamentals of Tribology, Prentice - Hall of India Pvt. Ltd., New Delhi, 2005.
3. G. Fontana Corrosion Engineering, McGraw Hill, 1985.

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16ME C30

CAD and CAM LAB

Instruction	3 Hours per week
Duration of End Examination	3 Hours
End Examination	50 Marks
CIE	24 Marks
Credits	3

Course Objectives:

1. 3D Part modeling – protrusion, cut, sweep, draft, loft, blend, rib, Editing – Move, Pattern, Mirror, Round, Chamfer.
2. Assembly (Coupling, Screw jack) – creating assembly from parts – assembly constraints.
3. Conversion of 3D solid model to 2D drawing - different views, sections, isometric view and dimensioning , mass property calculations.
4. To learn and develop the skill in creating a component by utilizing the Automated Machines.

Course Outcomes:

1. Draw complex geometries of parts in sketcher mode.
2. Generate freeform shapes in part mode to visualize parts.
3. Create complex engineering assemblies using appropriate assembly constraints.
4. Develop various machine components and generate their orthographic view modeling software.
5. Have a fundamental knowledge of Computer Numerical Control machines.
6. Write part programs using G and M codes for lathe and milling operations.

Detailed Syllabus:

1. Introduction to Solid Works Package, Working with sketch mode and features of Solid Works and applying on various part models.
2. Part modeling of cotter, Knuckle Joints and Couplings.
3. Generating, editing and modifying drawings in SolidWorks.

4-8 Assembly modeling of the following.
(a) Stuffing Box (b) Screw Jack (c) CrossHead (d) Eccentric

9. Specifying tolerances for part and assembly Drawings.
10. Contouring on CNC Milling Machine.
11. Facing on CNC Milling Machine.
12. Rectangular Pocketing on CNC Milling Machine.
13. Circular pocketing on CNC Milling Machine.
14. Step Turning, Taper Turning and Multiple Turning On CNC Lathe Machine
15. Use of CAM software for various Machining Operations.

Text Books:

1. Ibrahim Zeid, CAD/ CAM Theory and Practice, McGraw Hill Inc , New York, 2011.
2. PN Rao CAD/CAM : Principles and applications 2nd edition, Tata McGraw Hill, New Delhi, 2004.

Note: Any 12 experiments need to be conducted.

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16ME C31

METAL CUTTING AND MACHINE TOOL ENGINEERING LAB

Instruction	3 Hours per week
Duration of End Examination	3 Hours
End Examination	50 Marks
CIE	25 Marks
Credits	2

Course Objectives: Students will learn

1. To grind single point cutting tool using HSS as cutting tool
2. To do various operations like plain turning, step turning, knurling
3. Have work shop practice on lathe drilling and milling machines
4. The gear cutting and to cut gear on milling machine
5. Measure cutting forces during machining on Lathe machine, milling
6. Unconventional machining operations like EDM & ECM

Course Outcomes: Student is able to

1. Grind single point cutting tool with various angles
2. Perform taper turning and knurling on lathe
3. Perform drilling and thread cutting operations
4. Manufacture a gear using milling machine
5. Do operation on shaper
6. Exposed to various unconventional processes

Experiments:

1. Introduction to Machine Tools, like Lathe, Drilling, Milling and Shaper.
2. Plain and step turning operations on Lathe.
3. Step turning and Knurling on Lathe machine.
4. Taper turning on Lathe.
5. Drilling and Boring on Lathe.
6. Thread Cutting on Lathe.
7. Grinding of Single Point Cutting Tool.
8. Gear Cutting using (a) Plain Indexing. (b) Compound Indexing using universal dividing head.
9. Measurement of Cutting forces machine. during machining on Lathe machine, milling.
10. Finding Shear angle experimentally in turning operation.
11. Grinding flat surfaces using surface grinding machine and measurement of surface finish.
12. Process parameters of Electro Discharge Machining (EDM).

Text Books:

1. B.L. JuneJa and Shekon, Fundamentals of Metal Cutting & Machines Tools, Wiley Eastern Ltd. 1987.
2. P.N. Rao, Manufacturing Technology – Metal Culling & Machine Tools, Vol. 2, Tata McGraw Hill Education Pvt. Ltd, 2010.

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16ME C32

THERMAL ENGINEERING LAB

Instruction	3 Hours per week
Duration of End Examination	3 Hours
End Examination	50 Marks
CIE	25 Marks
Credits	2

Course Objectives:

1. To demonstrate knowledge in evaluating thermal conductivity of metal rod.
2. Student will understand how to evaluate critical heat flux.
3. Student will come to know the mechanism or formation of shock waves in convergent and divergent nozzle.
4. Student will come to know the working principle of axial flow fan and centrifugal blower.
5. Student will understand to evaluate the COP of Refrigeration tutor and AC tutor.
6. Student will come to know to evaluate drag and lift coefficients for contoured bodies.

Course Outcomes: Student will be able to

1. Estimate thermal conductivity of a metal.
2. Estimate the convective heat transfer coefficients for phase change heat transfer.
3. Know pressure distribution across the length of convergent and divergent nozzle.
4. Evaluate the overall efficiency of rotary compressors.
5. Determine COP of Refrigeration and air conditioned tutors.
6. Evaluate drag and lift coefficients for different profiles of automobiles.

Experiments:

1. Determination of Thermal conductivity of metal rod.
2. Determination of critical heat flux for copper wire in water.
3. Determination of convective heat transfer coefficient for condensation and boiling equipment.
4. Determination of pressure distribution for convergent and divergent nozzle
5. Determination of overall efficiency of axial flow fan
6. Determination of overall efficiency of centrifugal blower
7. Determination of COP of refrigerating tutor
8. Determination of COP of air conditioned tutor
9. Determination of humidification and dehumidification processes with AC tutor.

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10. Determination of pressure distribution for a cylinder
11. Determination of pressure distribution for an aerofoil
12. Determination of lift and drag coefficient for different contours.

Text Books:

1. Mahesh M. Rathore, Thermal Engineering, TMH, New Delhi, 2010.
2. R.K. Rajput, Heat Transfer, Laxmi Publication, 2014.

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ME 411

Thermal Turbo Machines

Instruction	4 Theory + 1 Tutorial Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives:

1. Student will demonstrate basic knowledge by understanding concepts of various gas dynamics equations, necessary for CFD
2. Student will acquire basic knowledge in designing of nozzles and diffusers used in rockets and aircrafts
3. Student will come to know the design of ducts, combustion chambers and various types of shocks
4. Student will come to know the working principles of various rotary compressors like centrifugal compressor and rotary compressor
5. Student will understand the applications of various steam turbines and velocity triangles in order to calculate power developed by them
6. Student will demonstrate the basic knowledge in gas turbines and various methods to improve efficiency of gas turbine cycles.

Outcomes: At the end of the course, students will be able to

1. Design various configurations of steam nozzles by the principles of gas dynamics which are essential or pre-requisite to computational fluid dynamics
2. Understand Fanno curves along with shock waves
3. Understand the importance of Rayleigh curves in gas dynamics
4. Calculate power required by various types of rotary compressors with the principles of gas dynamics
5. Specify steam turbine as per the application and also calculate power developed by them
6. Calculate thermal efficiency of gas turbines with the principles of gas dynamics and suggest suitable methods to improve work output and efficiency of the plant.

UNIT-I

Introduction to compressible flows: Speed of propagation of pressure waves, Mach number, Acoustic velocity and Mach cone, limits of compressibility, pressure field due to a moving source of disturbance, one dimensional compressible flow. Isentropic flow with variable area, Mach number variation, Area ratio as function of Mach number, flow through nozzles and diffusers. Flow in constant area ducts with friction-Fanno flow, variation of flow properties, variation of Mach number with duct length, isothermal flow with friction

UNIT-II

Flow in constant area duct with Heat Transfer, -The Rayleigh liner, Rayleigh flow relations, variation of flow properties, Maximum heat transfer. Flow with Shock Waves-Development of Normal Shock waves, governing equations, Prandtl -Meyer relation, Rankine-Hugoniot equations, Stagnation pressure ratio across shock.

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UNIT-III

Blade nomenclature of an aerofoil, Rotodynamic compressors: Introduction and general classification, Comparison of Reciprocating and Rotary compressors, Positive displacement Rotary compressors, Flow through rotary compressors. Static and total head quantities, Thermodynamic cycles and work done, calculation of various efficiencies. Velocity diagrams and prewhirl. Euler equation for energy transfer between fluid and rotor, Analysis of Centrifugal compressors and analysis of axial flow compressors, Chocking, Surging and Stalling.

UNIT-IV

Steam Turbines: Classification, flow over blades, pressure velocity variations, Compounding of steam turbines- pressure compounding, velocity compounding and pressure-velocity compounding, Impulse turbine with several blade rings, Nozzle efficiency, Blade efficiency and Gross stage efficiency of Impulse turbine, Velocity diagrams for Impulse turbine-De Laval Turbine, blade efficiency of Impulse turbine, Optimum blade speed ratio, Maximum work done and blade efficiency of Impulse turbine, Degree of reaction of Reaction turbine, Parson Reaction turbine, Velocity diagram for Parson Reaction turbine, blade efficiency of Parson Reaction turbine, Maximum work done and blade efficiency of Parson Reaction turbine, Height of blades of Reaction turbine, Balancing of End thrust

UNIT-V

Gas Turbines: Applications and Classification of Gas Turbines- constant pressure and constant volume gas turbines, Joule cycle-configuration diagram and temp-entropy diagram, Thermal efficiency of Joules cycle, Maximum pressure ratio in terms of temperature ratio, optimum pressure ratio for maximum work output with and without considering machine efficiencies, Improvement of gas turbine plant performance- Inter-cooling, Reheating and Regeneration. Simple Problems on Joule cycle.

Air Craft Propulsion: Air craft engine types, air craft propulsion theory, Turbo jet engines, Ramjet engines, Pulse jet engines, Rocket Propulsion: Types of Propellants, Types of Rocket engines, Rocket propulsion theory-Rocket applications

Text Books:

1. Yahya S M, *Fundamentals of Compressible Flow,* New Age International Publishers, Third Edition, 2007.
2. Mathur ML, & Mehta F S, *Thermal Engineering,* Jain Brothers, New Delhi, 2003
3. Dennis G Shepherd, *Aerospace Propulsion,* Elsevier Publishing Company, New York, 1995.

Suggested Reading:

1. Cohen H Rogers G F C, Saravana Mutto H I H, *Gas Turbine Theory,* Longman 5th Edition, New York, 2004.
2. Ganeshan V, *Gas Turbines,* Tata Me Graw Hills, New Delhi, 2003
3. Yadav, R *Steam and Gas Turbines,* Central Publishing House Ltd, Alllahabad, 2003

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ME 412

Metrology and Instrumentation

Instruction	4	Periods per week
Duration of End Examination	3	Hours
End examination	75	Marks
Sessionals	25	Marks
Credits	3	

Objectives:

1. Student will understand the need for measurement and fundamental concepts of measurement.
2. Student will get familiarize with limits, Fits& tolerances and the instruments used to measure these limits.
3. Student will able to have knowledge of various precision linear and angular measuring instruments.
4. Student will learn the importance of Geometric form and how to measure form errors.
5. Equip the student to have knowledge in the concepts of classification of instrument errors and their characteristics.
6. Student will enable to understand the working principles of various instruments used for the measurement of strain, forces, pressure, and temperature.

Outcomes: At the end of the course, students are able to

1. Learn and understand the need for measurement and fundamental concepts of measurement.
2. Demonstrate sound knowledge in gauges design and gauge selection for inspection.
3. Acquire the knowledge about fundamentals of linear and angular measurements and various instruments used for measuring the different parameters.
4. Demonstrate an ability to select and use the appropriate measuring instruments to measure surface roughness and other geometric form errors.
5. Recognize the concepts of errors, classification and instrument characteristics.
6. Apply the skills in measuring various quantities like strain, force, pressure & temperature.

UNIT-I

Limits, Fits and Tolerances: Types of fits, Selective assembly and interchangeability, Taylor's Principle for plain limit gauges, Use of Plug, Ring and Snap gauges, Introduction to Linear and Angular measurements, Slip gauges and End bars, Gauge material and manufacturing methods, Different types of Micrometers, Height gauges, Tomlinson gauges, Sine bar.

UNIT-II

Comparators: Dial indicator, Sigma Mechanical comparator, Back pressure type Pneumatic comparator. Optical projector and its Principle and Applications, Tool maker's Microscope and its Principle and applications, measurement of straightness and flatness, Auto collimator, Roundness measurement with bench centers and talyround, Coordinate Measuring Machine.

UNIT-III

Surface Roughness Measurements: Profilometer, Taylor Hobson Talysurf, Application of screw Thread metrology - 2 wire and 3 wire methods, Best wire size, Spur Gear nomenclature, Gear tooth thickness measurement by gear tooth vernier, Parkinson gear tester.
Introduction to Interferometry and its applications, The N.P.L. flatness Interferometer.

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UNIT-IV

Elements of instrumentation system: Static and Dynamic characteristics of instruments, Types of errors, Strain measurement, Wire and foil type resistance strain gauges, Rosette Gauges, Bonding procedure, Strain Gauge Factor, Application of strain gauges, Strain gauge load cells, measurement of axial load and torsion by strain gauges, Piezo electric load cell.

UNIT-V

Introduction to Transducers: Displacement and acceleration measurement, L.V.D.T, Pressure measurement by Bourdon pressure gauge, Bulk modulus pressure gauge and Pirani gauge, Temperature measurement by thermo couples, Laws of thermo electricity, Types of materials used in thermocouples, Series and parallel circuits.

Text Books:

1. R.K. Jain, *Engineering Metrology*, Khanna Publications, 1996.
2. Doeblin, *Measurement Systems Application and Design*, TMH, 5th Edn., 2004.
3. Anand Bewoore & Vinay Kulkarni, *Metrology & Management*, McGrawhill Education India, 2014.
4. I B.C. Nakra & K.K. Chaudhary , *Instrumentation Measurement and Analysis* , 3rd Edn., McGrawhill, 2014

Suggested Reading:

1. IC Gupta., *Engineering Metrology*, Dhanpat Rai Pub. New Delhi, 1984.
2. Rega Rajendra, *Principles of Engineering Metrology*, Jaico Publishing House, Mumbai, 2008.

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ME 413 **Finite Element Analysis**

Instruction	4	Theory + 1 Tutorial Periods per week
Duration of End Examination	3	Hours
End examination	75	Marks
Sessionals	25	Marks
Credits	3	

Objectives:

1. Equip the students with the Finite Element Analysis fundamentals and formulations
2. Enable the students to formulate the axial, truss, beam and 2d problems
3. Enable the students to formulate the heat conduction and dynamics problems
4. Able to understand use of numerical integration and Gaussian quadrature
5. Enable the students to understand the convergence requirements and to formulate torsional and 3D problems
6. Enable the students to perform engineering simulations using Finite Element Analysis software (ANSYS)

Outcomes: At the end of the course a student will be able to

1. Apply FE method for solving field problems using Virtual work and Potential energy formulations
2. Analyze linear problems like axial, trusses and beam; 2D structural problems using CST element and analyze the axi-symmetric problems with triangular elements
3. Write shape functions for 4 node quadrilateral, isoparametric elements and apply numerical integration and Gaussian quadrature to solve the problems
4. Solve linear 1D and 2D heat conduction and convection heat transfer problems, analysis of torsion of circular shaft
5. Evaluate the Eigen values and Eigenvectors for stepped bar and beam, formulate 3D elements, check for convergence requirements
6. Apply FE for 1D transient heat conduction, use of FEA software ANSYS for engineering solutions

UNIT-I

Fundamental concepts: Introduction to Finite Element Method, Stresses and Equilibrium, Boundary conditions, Strain-Displacement and Stress-Strain relationship.

One dimensional problems: Finite element modeling coordinates and shapes functions, Virtual work and Potential Energy approach, Assembly of Global stiffness matrix and load vector, Finite element equations, Treatment of boundary conditions, Analysis of Axial element and Quadratic element.

UNIT-II

Analysis of Trusses and Frames: Element stiffness matrix for a truss member, Analysis of plane truss with two degrees of freedom at each node. Analysis of Beams: Element stiffness matrix for two nodes (two degrees of freedom per node). Analysis of frames with two translations and rotational degrees of freedom per node. Torsion: Analysis of circular shaft subjected to torsion.

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UNIT-III

2D Triangular Elements: Plane stress, Plane strain and Axisymmetry, Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions. Finite element modeling of axi-symmetric solids subjected to axi- symmetric loading with triangular elements.

UNIT-IV

Quadrilateral Elements and Numerical Integration: Two dimensional Four nodded iso-parametric Elements, Numerical Integration and Gaussian Quadrature

Dynamic Analysis: Formulation of finite element model, element mass matrices, Evaluation of Eigen values and Eigen vectors for a stepped bar and a beam

UNIT-V

Heat Transfer Analysis: Steady State Heat Transfer Analysis: One dimensional analysis of a fin and two dimensional analysis of thin plate. Time dependent field problems: Application to one dimensional heat flow in a rod.

3D Elements and FEA Software: Introduction to finite element formulation of three dimensional problems in stress analysis, Convergence requirements, Finite Element Analysis Software: Modeling, Analysis and Post Processing.

Text Books:

1. Ramamurthy, G. *Applied Finite Element Analysis,* I.K. International Publishing House Pvt. Ltd., New Delhi, 2009
2. Tirupathi R, Chandraputla and Ashok D Belagundu, *Introduction to Finite Elements in Engineering.* Practice Hall of India, 1997.
3. Daryl L. Logan, *A First Course in the Finite Element Method*, Cengage Learning, 2011.

Suggested Reading:

1. Rao S S, *The Finite Element Method in Engineering*, Pergamon Press, 1989.
2. Segerlind L J, *Applied Finite Element Analysis*, Wiley Eastern, 1984.
3. Reddy JN, *An Introduction to Finite Element Method,* McGraw-Hill, 1984.
4. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt., *Concepts and Applications of Finite Element Analysis*, 4th Edition. Wiley

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C.T. M.E. 4/4 M.E.CH

With Effect from the Academic Year 2016 - 2017

ME 414

Operations Research

(for Mech, Prod and I.T)

Instruction	4	Periods per week
Duration of End Examination	3	Hours
End examination	75	Marks
Sessionals	25	Marks
Credits	3	

Objectives:

1. Students will understand the significance of Operations Research concept and techniques
2. Students will come to know the formulation of LPP models
3. Students will understand the Algorithms of Graphical and Simplex Methods
4. Students will understand the Transportation and Assignment techniques
5. Students will come to know the procedure of Project Management along with CPM and PERT techniques
6. Students will understand the concepts of sequencing and queuing theory

Outcomes: At the end of the course, the students were able to

1. Recognize the importance and value of Operations Research and mathematical formulation in solving practical problems in industry;
2. Formulate a managerial decision problem into a mathematical model;
3. Apply Operations Research models to real time industry problems;
4. Build and solve Transportation Models and Assignment Models.
5. Apply project management techniques like CPM and PERT to plan and execute project successfully
6. Apply sequencing and queuing theory concepts in industry applications

UNIT-I

Introduction: Definition and Scope of Operations Research.

Linear Programming: Introduction, Formulation of linear programming problems, graphical method of solving LP problem, simplex method, Degeneracy in Simplex, Duality in Simplex.

UNIT-II

Transportation Models: Finding an initial feasible solution - North West Corner Method, Least Cost Method, Vogel's Approximation Method, Finding the optimal solution, Special cases in Transportation problems - Unbalanced Transportation problem, Degeneracy in Transportation, Profit Maximization in Transportation.

UNIT-III

Assignment Techniques: Introduction, Hungarian technique of Assignment techniques, unbalanced problems, problems with restrictions, Maximization in Assignment problems, Travelling salesman problems

UNIT-IV

Project Management: Definition, Procedure and Objectives of Project Management, Differences between PERT and CPM, Rules for drawing Network diagram, Scheduling the activities, Fulkerson's rule, Earliest and Latest times, Determination of ES and EF times in forward path, LS & LF times in backward path, Determination of critical path, duration of the project, Free float, Independent float and Total float, Crashing of network.

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UNIT-V

Sequencing Models: Introduction, General assumptions, processing 'n' jobs through two machines, processing 'n' jobs through three machines.

Queuing Theory: Introduction, Kendal's Notation, single channel - poisson arrivals - exponential service times

Text Books:

1. Hamdy, A. Taha, *Operations Research-An Introduction*, Sixth Edition, Prentice Hall of India Pvt. Ltd., 1997.
2. S.D. Sharma, *Operations Research*, Kedarnath, Ramnath & Co., Meerut,2009
3. V.K. Kapoor, *Operations Research*, S. Chand Publishers, New Delhi, 2004

Suggested Reading:

1. Harvey M. Wagner, *Principles of Operations Research*, Second Edition, Prentice Hall of India Ltd., 1980.
2. R. Paneer Selvam, *Operations Research*, Second Edition, PHI Learning Pvt. Ltd., New Delhi, 2008.
3. Nita H. Shah, Ravi M. Gor, Hardik Soni, *Operations Research*, PHI Learning Private Limited, 2013

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With Effect from the Academic Year 2016 - 2017

ME 461

Renewable Energy Sources (Elective – II)

Instruction	4	Periods per week
Duration of End Examination	3	Hours
End examination	75	Marks
Sessionals	25	Marks
Credits	3	

Objectives: Student will learn the

1. Need and importance of non-conventional energy resources
2. Extent of solar energy which can be utilized as energy resource
3. Concept of wind energy and its merits and demerits
4. Operating principles of ocean and geothermal energy
5. Advantages and disadvantages of bio-energy over conventional energy
6. Merits and demerits of tidal energy, wave energy and OTEC

Outcomes: At the end of the course, the students are able to

1. Understand the depletion and of environmental impact conventional sources of energy and will suggest suitable and alternative renewable energies in place of fossil energies
2. Know the absorption, conversion and utilization of solar energy
3. Understand the problems associated with utilizing the wind energy
4. Describe the physics of geothermal resources and describe how biomass is currently used as a source of energy
5. Explain the physical principles of wave energy, the generation of tides and how to harness their power
6. Understand the environmental impact of OTEC plants

Unit-I

Statistics on conventional energy sources and supply in developing countries, Definition-Concepts of RES, Limitations of RES, Classification of NCES-Solar, Wind, Geothermal, Biomass, Ocean Energy Sources, comparison of these energy sources.

Unit-II

Solar Energy- Solar Radiation – Energy available from Sun, Solar Thermal Collectors – Flat Plate and Concentrating Collectors –Solar Applications, Solar engines-Stirling, Brayton engines, fundamentals of photo Voltaic Conversion – p-n junction – PV solar cells and its materials-solar satellite system

Unit-III

Wind energy- merits and demerits-Wind power plant-site selection-classification of wind power plants-Windmill rotors- Horizontal axis and vertical axis rotors-.working principle-New developments.

Unit-IV

Geothermal energy- Layers in earth-Definition and classification of resources.

Biomass energy-Biomass- Source, Composition, Conversion technologies – Direct combustion-Pyrolysis–Gasification, Biomass gasifier –float and fixed dome types

Unit V

Wave, Tidal and OTEC energy- Difference between tidal and wave power generation-single basin and double basin tidal plants-progressive wave.

OTEC power plants- Open and closed OTEC Cycles- Environmental impacts of OTEC.

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Text Books:

1. S. Hasan Saeed and D.K. Sharma, *Non Conventional Energy Resources*, S.K. Kataria & Sons, New Delhi, 2014
2. Dr. R.K. Singal, *Non Conventional Energy Resources*, S.K. Kataria & Sons, New Delhi, 2005
3. G.D. Rai, *Non Conventional Energy Sources*, Khanna Publishers, New Delhi, 2011

Suggested Reading:

1. Mittal K M, *Non-Conventional Energy Systems*,Wheeler Publishing Co. Ltd, New Delhi, 2003.
2. Ramesh R & Kumar K U, *Renewable Energy Technologies*, Narosa Publishing House, New Delhi, 2004
3. Shali Habibulla, *Non-Conventional Energy Sources*, State Institute of Vocational Education, Hyderabad, 2005
4. Ashok V Desai, *Non-Conventional Energy*, Wiley Eastern Ltd, New Delhi, 2003
5. R.K. Hegde, *Power Plant Engineering*, Pearson Education India, 2015

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With Effect from the Academic Year 2016 - 2017

ME 462

Computational Fluid Dynamics (Elective – II)

Instruction	4	Periods per week
Duration of End Examination	3	Hours
End examination	75	Marks
Sessionals	25	Marks
Credits	3	

Objectives:

1. Understanding of governing equations of fluid flow.
2. Student understand finite difference and finite volume methods to solve fluid flow equations.
3. Issues that arise in the solution of such equations.
4. Various methods to overcome those issues and modern trends in CFD.
5. Get exposure to grid generation.
6. Various boundary conditions and their implementation.

Outcomes: At the end of the course, the students were able to

1. Classify basic equations of fluid flow
2. Choose appropriate boundary conditions
3. Choose proper numerical technique to solve equations.
4. Critically analyze different mathematical models and computational methods for flow simulations
5. Interpret computational results.
6. Acquire the required knowledge to take advanced courses in CFD.

UNIT-I

Basic Equations: Continuity, momentum and energy equations, navier-stokes equations, Heat transfer conduction equations for steady and unsteady flows, steady convection-diffusion equation.

UNIT-II

Models: Reynolds and Favre averaged N-S equations, Mixing length model, k-epsilon turbulence model

Classifications of partial differential equations: Elliptic, parabolic and hyperbolic equations, Initial and boundary value problems

UNIT-III

Finite Difference Method: Forward, backward and central difference

Parabolic partial differential equations: Euler, implicit and crank Nicholson methods, ADI models, Errors, consistency, stability analysis, Vonnumen analysis, Convergence criteria.

UNIT-IV

Elliptic partial differential equations - Jacobi, Gauss seidel methods, Viscous incompressible flow, Stream-function-vorticity method

Introduction to grid generation- types of grids O, H, C

UNIT – V

Finite Volume Method: Finite volume formulation for diffusion equation, convection diffusion equation, Solution algorithm for pressure velocity coupling in steady flows, staggered grid, SIMPLE algorithm.

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CBIT MED 44 MECH

Text Books:

1. J.D. Anderson, Jr., *Computational Fluid Dynamics: The Basic with Applications* McGraw Hill, Inc., 2012
2. H. Versteeg and W. Malalasekra, *An Introduction to Computational Fluid Dynamics*: The Finite Volume Method, Pearson,2nd edn. 2011

Suggested Reading:

1. John F. Wendt (Editor), *Computational Fluid Dynamics - An Introduction*, Springer – Verlag, Berlin, 1992
2. Charles Hirsch, *Numerical Computation of Internal and External Flows*, Vols. I and II. John Wiley & Sons, New York, 1988.
3. K. Muralidhar and T. Sundarajan.. *Computational Fluid Flow and Heat Transfer*, Narosa Publishing House. 2008
4. C.J.Date , *Introduction to CFD*, Dorling Kindersley Pvt Ltd, 2007

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With Effect from the Academic Year 2016 - 2017

ME 463

Automobile Engineering (Elective – II)

Instruction	4	Periods per week
Duration of End Examination	3	Hours
End examination	75	Marks
Sessionals	25	Marks
Credits	3	

Objectives: The student will learn

1. The anatomy of the automobile in general
2. The location and importance of each part
3. The functioning of the engine and its accessories, gear box, clutch, brakes, steering, axles and wheels
4. Suspension, frame, springs and other connections
5. ignition, controls, electrical systems and ventilation
6. Emissions, pollution regulations, EURO and BHARATH stages

Outcomes: At the end of the course, the student will be able to

1. Identify the different parts of the automobile
2. Explain the working of various parts like engine, transmission, clutch, brakes
3. Describe how the steering and the suspension systems operate.
4. Understand the environmental implications of automobile emissions
5. Develop a strong base for understanding future developments in the automobile industry

Unit I

Types of automobiles: Normal, Hybrid and Hydrogen Fuel vehicles. Engine location and its components, chassis layout; crank shaft proportion, firing order, piston and piston rings, cylinder liners, valves and operation mechanism, inlet and exhaust manifolds, carburetion and fuel injection system, Mechanical Fuel Injection system & Electronic Fuel Injection System.

Unit II

Lubricating Systems: Wet sump, dry sump and petroil systems - Cooling systems: Water pumps, radiators, thermostat control anti freezing compounds - Types of Ignition Systems, Modern Ignition systems, Types of Batteries and charging systems, starting motors, lighting and electrical accessories, automobile air-conditioning.

Unit III

Steering systems: Linkage arrangements and its components modified Ackerman linkage, wheel alignment, caster and camber. Rack and pinion assembly, recent trends, Wheel and tyres: Tyre construction, specification. Tyre wear and causes, wheel balancing, Types q/' Suspension system, Independent suspension, coil and leaf springs, torsion bar, shock absorbers.

Unit IV

Power Train: Clutches, gear and gearbox manual, semi-automatic and automatic gearboxes. Torque converter, propeller shaft, universal coupling differential, four-wheel drive system
Brakes Systems: Description and operation of hydraulic brake, leading and trailing shoe layout, disc brakes, master cylinder and hand brake linkage, Recent Trends.

Unit V

Maintenance: Pollution control, trouble shooting and servicing procedure overhauling, engine tune up, tools and equipment for repair and overhaul testing equipment, pollution control technologies used for petrol and diesel engines. Types and study of catalytic converters, Euro norms 2 & 3 and Bharat Norms – Recent Trends.

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Text Books:

1. *Crouse & Anglin, Automotive Mechanics*, TataMcGraw Hill. Publishing Co. Ltd., New Delhi, Tenth Edition – 2004
2. Kirpal singh., *Automobile Engineering Vol. I & II* Standard Publishers, Delhi.

Suggested Reading:

1. Joseph Heitner, *Automotive Mechanics*, Affiliated East West Pvt. Ltd.
2. C.P Nakra, *Basic Automobile Engineering*, Dhanpat Rai Publishing Co(P) Ltd., New Delhi, 2003.
3. G.B.S. Narang, *Automobile Engineering*, Khanna Publishers, New Delhi, 2014
4. R.K. Rajput, *A Textbook of Automobile Engineering*, Laxmi Publications, New Delhi, 2012

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With Effect from the Academic Year 2016 - 2017

ME 464

Entrepreneurship (Elective – II)
(for Mech, Prod, Civil, EEE, ECE, I.T, Chemical, BioTech and CSE)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student will understand

1. The essence of Entrepreneurship
2. The environment of industry and related opportunities and challenges
3. Concept a procedure of idea generation
4. Elements of business plan and its procedure
5. Project management and its techniques
6. Behavioral issues and Time management

Outcomes: After completing this course, students will be able to:

1. Apply the entrepreneurial process
2. Analyze the feasibility of a new business plan and preparation of Business plan
3. Evaluate entrepreneurial tendency and attitude
4. Brainstorm ideas for new and innovative products or services
5. Use project management techniques like PERT and CPM
6. Analyze behavioural aspects and use time management matrix

UNIT-I

Indian Industrial Environment: Competence, Opportunities and Challenges, Entrepreneurship and Economic growth, Small Scale Industry in India, Objectives, Linkage among small, medium and heavy industries, Types of enterprises, Corporate Social Responsibility.

UNIT-II

Identification and characteristics of entrepreneurs: First generation entrepreneurs, environmental influence and women entrepreneurs, Conception and evaluation of ideas and their sources, Selection of Technology, Collaborative interaction for Technology development.

UNIT-III

Business plan: Introduction, Elements of Business Plan and its salient features, Technical Analysis, Profitability and Financial Analysis, Marketing Analysis, Feasibility studies, Executive Summary.

UNIT-IV

Project Management: During construction phase, project organization, project planning and control using CPM, PERT techniques, Human aspects of project management, Assessment of tax burden

UNIT-V

Behavioral aspects of entrepreneurs: Personality, determinants, attributes and models, Leadership concepts and models, Values and attitudes, Motivation aspects, Change behavior

Time Management: Approaches of time management, their strengths and weaknesses. Time management matrix and the urgency addiction

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BTNEDA4 MECH

Text Books:

1. Vasant Desai, *Dynamics of Entrepreneurial Development and Management*, Himalaya Publishing House, 1997.
2. Prasanna Chandra, *Project-Planning, Analysis, Selection, Implementation and Review*, Tata Mcgraw-Hill Publishing Company Ltd. 1995.
3. S.S. Khanka, *Entrepreneurial Development*, S. Chand & Co. Pvt. Ltd., New Delhi

Suggested Reading:

1. Robert D. Hisrich, Michael P. Peters, *Entrepreneurship*, Tata Me Graw Hill Publishing Company Ltd., 5lh Ed., 2005
2. Stephen R. Covey and A. Roger Merrill, *First Things First*, Simon and Schuster Publication, 1994.
3. Sudha G.S., *Organizational Behavior*, National Publishing House, 1996.

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With Effect from the Academic Year 2016 - 2017

PE 461

Robotics (Elective – II)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Students will understand

1. The configuration, work envelop and motion controls and applications
2. Familiarities with the kinematics of robots.
3. Robot end effectors and their design.
4. Familiarities with the dynamics of robots.
5. Robot Programming methods & Languages of robot.
6. Various Sensors and drives and their applications in robots

Outcomes: At the end of the course, the students will be

1. Equipped with robot anatomy, work volume and robot applications
2. Familiarized with the kinematic motions of robot
3. Having good knowledge about robot end effectors and their design concepts
4. Familiarized with the robot dynamics
5. Equipped with the Programming methods & drives used in robots
6. Equipped with the principles of various Sensors and their applications in robots.

Unit I

Robots: History and evolution of robots, Laws of Robotics, basic configuration, degree of freedom, work envelope, motion control methods, Application in industry, material handling, loading & unloading, processing, welding & painting applications, assembly and inspection, Robot specification requirements

Unit II

Rotation matrix: Homogenous transformation matrix, Denavit-Hartenberg convention, Euler angles, RPY reprensation, Direct and inverse kinematics for industrial robots for position and orientation, Redundancy

Unit III

Manipulator Jacobian: Joint, End effector velocity, direct and inverse velocity nalysis, Trajectory Planning, interpolation, cubic polynomial, linear segments with with parabolic blending, static force and moment transformation, solvability, stiffness, singularities

Unit IV

Robot dynamics: Lagrangian formulation, link inertia tensor and manipulator inertia tensor, Newton-Euler formulation for RR & RP manipulators, Control: Individual joint, computed torque

Unit V

End effectors: position and velocity measurement, Sensors: Proximity and range, tactile, force and torque, Drives for Robots: Electrical, Hydraulic and Pneumatic, Robot vision: Introduction to technique, image acquisition and processing, introduction to robot programming languages

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Text Books:

1. Spong and Vidyasagar, *Robot Dynamics and Control*, John Wile and Sons, 1990
2. R.K. Mittal, I.J. Nagrath, *Robotics and control*, Tata Mcgraw-Hill Publishing Company Ltd. 2003
3. Groover, *Industrial Robotics*, Mcgraw-Hill Publishing Company Ltd. 2003

Suggested Reading:

1. Asada and Siotine, *Robot analysis and Intelligence*, Wiley Interscience, 1986
2. K.S. Fu Gon ZalezRC., lEEc.S.G., *Robotics, Control Sensing Vision and Intelligence*, McGraw Hill, Int. Ed., 1987
3. Richard S. Paul, *Robot Manipulators: Mathematics, Programming, and Control*, MIT Press (MA)

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CE 461

Disaster Mitigation and Management (Elective – II)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives: Students will understand

1. The basic knowledge of hazards, disasters, risks and vulnerabilities including natural, climatic and human induced factors and associated impacts.
2. The nature, mechanism causes, consequences and mitigation measures of the various natural disasters including hydro metrological and geological based disasters.
3. Risks, vulnerabilities and human errors associated with human induced disasters including chemical, biological and nuclear warfare agents.
4. The knowledge of various chronological phases in the disaster management cycle.
5. The disaster management framework and legislations in the context of national and global conventions.
6. The applications of geospatial technologies like remote sensing and geographical information systems in disaster management.

Course Outcomes:

1. Ability to analyse and critically examine existing programs in disaster management regarding vulnerability, risk and capacity at local level
2. Ability to choose the appropriate activities and tools and set up priorities to build a coherent and adapted disaster management plan.
3. Ability to understand various mechanisms and consequences of natural and human induced disasters for the participatory role of engineers in disaster management.
4. Develop an awareness of the chronological phases of disaster preparedness, response and relief operations for formulating effective disaster management plans
5. Ability to understand various participatory approaches/strategies and their application in disaster management
6. Ability to understand the concepts of remote sensing and geographical information systems for their effective application in disaster management.

UNIT-I:

Introduction to Natural, human induced and human made disasters – Meaning, nature, types and effects; International decade of natural disaster reduction (IDNDR); International strategy of natural disaster reduction (ISDR)

UNIT-II:

Natural Disasters– Hydro meteorological disasters: Causes, impacts, Early warning systems, structural and non-structural measures for floods, drought and cyclones; Tropical cyclones: Overview, cyclogenesis, drought monitoring and management.; Geographical based disasters: Earthquakes and Tsunami- Overview, causes, impacts, zoning, structural and non-structural mitigation measures; Tsunami generation; Landslides and avalanches: Overview, causes, impacts, zoning and mitigation measures. Case studies related to various hydro meteorological and geographical based disasters.

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UNIT III:

Human induced hazards: Risks and control measures in a chemical industry, Causes, impacts and mitigation measures for chemical accidents, chemical disaster management, current status and perspectives; Case studies related to various chemical industrial hazards eg: Bhopal gas tragedy; Management of chemical terrorism disasters and biological disasters; Radiological Emergencies and case studies; Case studies related to major power break downs, fire accidents and traffic accidents .

UNIT IV:

Use of remote sensing and GIS in disaster mitigation and management; Scope of application of ICST (Information, communication and space technologies in disaster management, Critical applications& Infrastructure; Potential application of Remote sensing and GIS in disaster management and in various disastrous conditions like earthquakes, drought, Floods, landslides etc.

UNIT V:

Concept of Disaster Management: Introduction to disaster management, Relationship between Risk, vulnerability and a disaster, Disaster management cycle, Principles of disaster mitigation; Hazard identification and vulnerability analysis; Early warning systems and forecasting; Infrastructure and development in disaster management; Disaster management in India: National disaster management framework at central, state, district and local levels. Community based disaster management.

Text Books :

1. Rajib, S and Krishna Murthy, R.R, *Disaster Management Global Challenges and Local Solutions,* Universities Press Hyderabad, 2012
2. *Notes / Reading material published by National Disaster Management Institute*, Ministry of Home Affairs, Govt. of India.

Suggested Reading:

1. Navele, P & Raja, C.K., *Earth and Atmospheric Disasters Management, Natural and Manmade*. B.S. Publications, Hyderabad, 2009
2. Fearn-Banks, K, *Crises computations approach: A case book approach*. Route ledge Publishers, Special Indian Education, New York & London, 2011
3. Battacharya, T., *Disaster Science and Management*. Tata McGraw Hill Company, New Delhi., 2012

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ME 415

Thermal Engineering Lab

Instruction	3	Periods per week
Duration of End Examination	3	Hours
End examination	50	Marks
Sessionals	25	Marks
Credits	2	

Objectives:

1. Student will acquire basic knowledge in determining thermal conductivity of an insulating powder in composite slab or cylinder.
2. Student will demonstrate basic knowledge in evaluating the heat transfer coefficients under natural convection and forced convection phenomena
3. Student will determine the necessary constants pertaining to radiation
4. Student will acquire basic knowledge in understanding the working principles of axial flow fan and its overall efficiency.
5. Student will come to know in estimating overall efficiency of a centrifugal compressors
6. Student will demonstrate basic knowledge the importance of pressure distribution over cylinder and an aerofoil section on turbo machines

Outcomes: At the end of the course, the students were able to

1. Estimate thermal conductivity of insulating powder in composite slab or cylinder
2. Measure the heat transfer coefficients under natural and forced convection phenomena
3. Know the properties associated with radiation heat transfer
4. Determine overall efficiency of axial flow fan
5. Determine overall efficiency of centrifugal fan
6. Determine pressure distribution over cylinder and an aerofoil section and the effect of lift and drag forces on them.

Experiments:

1. Determination of COP of Air Conditioning System
2. Determination of percentage relative humidity and study of Humidification and Dehumidification process in Air Conditioning Systems
3. Determination of COP of Refrigeration Systems using Capillary tube/thermostatic expansion valve
4. Determination of Overall efficiency of Centrifugal Blower
5. Determination of Overall efficiency of Axial Flow Fan
6. Pressure distribution on symmetrical and non-symmetrical specimen in Wind tunnel
7. Measurement of Lift and Drag force of the models in wind tunnel test section
8. Determination of Thermal conductivity of metal bar
9. Determination of efficiency of pin-fin subjected to natural and forced convection
10. Determination of effectiveness of heat parallel flow and counter flow heat exchanger
11. Determination of Emissivity of given test plate
12. Determination of Stefan-Boltzmann constant

Note: Student should complete a minimum of 10 experiments.

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Suggested Reading:

1. Yahya S M, *Fundamentals of Compressible Flow,* New Age International Publishers, Third Edition, 2007.
2. Mathur ML, & Mehta F S, *Thermal Engineering,* Jain Brothers, New Delhi, 2003

With Effect from the Academic Year 2016 - 2017

ME 416

Metrology and Instrumentation Lab

Instruction	3 Periods per week
Duration of End Examination	3 Hours
End examination	50 Marks
Sessionals	25 Marks
Credits	2

Objectives:

1. Student will choose the proper measuring instrument for the precise measurement of Length, Height and diameter
2. Student will able to select the proper measuring instrument for the angular measurement.
3. Student will indentify gear & screw thread parameters using optical projector and tool makers microscope.
4. Student will get familiarize with limits & fits, gauge selection and design.
5. Student will enable to understand the working principles in the measurement of Flatness, Roundness and Surface roughness.
6. Student will equip with various aspects regarding displacement.

Outcomes: At the end of the course, the students were able to

1. Identify methods and devices for measurement of length, height and diameter.
2. Acquire the knowledge about angular measurement and various measuring instruments.
3. Recognize & measure the gear and screw thread parameters using profile projector and tool maker microscope.
4. Demonstrate the sound knowledge in gauges selection and design.
5. Acquire adequate knowledge in the measurement of flatness, roundness and surface roughness.
6. Demonstrate the measurement of displacement.

Experiments:

1. Measurement with inside, outside and depth micrometers.
2. Measurement with height gauges, height masters, etc.
3. Measurement of Linear and Angular dimensions with Tool Maker's Microscope – Diameter of a thin wire and single point cutting tool angle.
4. Measurement with Dial Indicator and its calibration.
5. Measurement of angles with Sine bar and Bevel protractor.
6. Measurement of roundness errors with bench centers.
7. Measurement of flatness errors (surface plate) with precision level.
8. Measurement with optical projector.
9. Checking machined components with plug gauges and adjustable snap gauges.
10. Surface roughness measurement by Taylor Hobson -Talysurf.
11. Measurement of Gear tooth thickness.
12. Displacement measurement with LVDT.

Note: Student should complete a minimum of 10 experiments.

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Suggested Reading:

1. IC Gupta, *Engineering Metrology*, Dhanpat Rai Pub., New Delhi, 1984.
2. B.C. Nakra & K.K. Chaudhary , *Instrumentation Measurement and Analysis*, , 3rd Edn. McGrawhill, 2014

ME 417

Computer Aided Engineering Lab

Instruction	3 Periods per week
Duration of End Examination	3 Hours
End examination	50 Marks
Sessionals	25 Marks
Credits	2

Objectives: Students will understand

1. The fundamental knowledge on using analytical tools like ANSYS for Simulation.
2. Various fields, where these tools can be used to improve the output of a product.
3. How these tools are used in Industries by solving some real time problems.
4. Models of trusses, plate structure, beams using ANSYS general purpose software
5. The solve heat transfer problems using ANSYS
6. Evaluating and interpret FEA results for design

Outcomes: At the end of the course a student should be able to:

1. Use FEA software to analyze complex structural systems.
2. Perform modal analysis of parts
3. Perform steady-state and transient heat transfer analysis
4. Produce graphical displays, including animations, of the results.
5. Perform buckling analysis
6. Acquire knowledge on utilizing ANSYS.

Experiments:

1. Analysis of plane truss & special truss with various cross sections and materials
2. 2D & 3D beam analysis with different sections, different materials for different loads
3. Static analysis of plate with a hole.
4. Plane stress, plane strain and axisymmetric loading on the in plane members.
5. Static analysis of connecting rod with tetrahedron and brick elements.
6. Static analysis of flat and curved shell due to internal pressure.
7. Buckling analysis of plates, shells and beams to estimate BF and modes.
8. Modal analysis of beams, plates and shells for natural frequencies and mode shapes.
9. Harmonic analysis of a shaft and transient analysis of plate.
10. Steady state heat transfer analysis of chimney and transient analysis of castings.
11. Non linear analysis of cantilever beam.
12. Coupled field analysis

Note: 1. Student should complete a minimum of 10 experiments.

2. Any of FEA software ANSYS/ABAQUS/NASTRAN/NISA/CAEFEM/ADINA may be used

Suggested Reading:

1 Tadeusz, A. Stolarski, Y. Nakasone, S. Yoshimoto, *Engineering Analysis with ANSYS Software*, 1st Edition, Elsevier Butterworth-Heinemann publications, 2007

2. ANSYS Inc. *User Manuals for Release 15.0*

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ME 418

Project Seminar

Instruction	3 Periods per week
Sessionals	25 Marks
Credits	1

The objective of the project seminar is to actively involve the student in the initial work required to undertake the final year project. Dealing with a real time problem should be the focus of the under graduate project.

It may comprise of

- Problem definition and specifications.
- A broad understanding of the available techniques to solve a problem of interest.
- Presentation (Oral & written) of the project.

The department should appoint a project coordinator who will coordinate the following.

- Grouping of students as project batch(a maximum of 3 in group)
- Allotment of projects and project guides
- Project monitoring at regular intervals.

Each project group/batch is required to

1. Submit a one page synopsis of the seminar to be delivered for display on notice board.
2. Give a 30-40 minutes presentation followed by 10 minutes discussion.
3. Submit a technical write up on the talk delivered.

Three (3) teachers will be associated with the evaluation of the project seminar for the award of the sessional marks which should be on the basis of performance on all the three items stated above.

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With Effect from the Academic Year 2016 - 2017

ME 419

Industrial Administration and Financial Management (for ECE and EEE)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Students able to learn

1. The roll importance and functions of Management in Industrial Organization
2. Various types of business organizations and organization structures.
3. Importance of plant location and plant layout
4. Importance of industrial engineering like method study and work measurement.
5. The importance of project management techniques
6. The total cost of a product based on elements of cost

Outcomes: At the end of the course, the students will be able to

1. Understand the role and importance of management and its principles.
2. Understand the need and importance of various types of layouts used in manufacturing industries
3. Apply the techniques of method study and work measurement in industry to enhance productivity
4. Apply the techniques of project management in industry
5. Understand the importance of quality control and plot the control charts
6. Calculate the total cost of the product based on its elements.

UNIT-I

Industrial Organization: Definition of an organization, types of various business organizations, organization structures and their relative merits and demerits, functions of management.

Plant location and layouts: Factors affecting the location of plant and layout, types of layouts and their merits and demerits.

UNIT-II

Work study: Definitions, objectives of method study and time study, steps in conducting method study, symbols and charts used in method study, principles of motion economy, calculation of standard time by time study and work sampling, performance rating factor, types of ratings, jobs evaluation and performance appraisal, wages, incentives, bonus, wage payment plans

UNIT-III

Inspection and quality control: Types and objectives of inspection, S.Q.C., its principles. Quality control chart and sampling plans, quality circles, introduction to ISO.

Production planning and control: Types of manufacture, types of production, principles of PPC and its function, production control charts.

UNIT-IV

Optimization: Introduction to linear programming and graphical solutions, assignment problems.

Project Management: Introduction to CPM and PERT, determination of critical path.

Material Management: Classification of materials, materials planning, duties of purchase manager, determination of economic ordering quantities, types of materials purchase.

UNIT-V

Cost accounting: Elements of cost, various costs, types of overheads, break even analysis and its applications, depreciation, methods of calculating depreciation fund, nature of financial management, time value of money, techniques of capital budgeting and methods, cost of capital, financial leverage.

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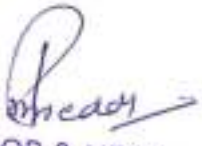
Text Books:

1. Pandey I.M. , *Elements of Financial Management*, Vikas Publ. House, New Delhi, 1994
2. James C Van Horne, John M Wachowicz, Jr., *Fundamentals of Financial Management*, 13th edition, Prentice Hall Financial Times
3. Khanna O.P., *Industrial Engineering and Management*, Dhanapat Rai & Sons

Suggested Reading:

1. S.N. Chary, *Production and Operations Management*, Tata McGraw Hill, 3rd Edition, 2006.
2. Paneer Selvam, *Production and Operations Management*, Pearson Education, 2007.
3. Joseph Monk, *Operations Management*, TMH Publishers, New Delhi, 2004.
4. Buffa Elwood S, *Modern Production /Operations Management* , John Wiley Publishers, Singapore, 2002
5. Everrete E. Adama & Ronald J. Ebert, *Production & Operations Management*, Prentice Hall of India, 5th Edition, 2005.
6. S.D. Sharma, *Operations Research*, Kedarnath, Ramnath & Co., Meerut,2009

CBIT MED 4/4 MECH



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ME 421

Production and Operations Management

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives:

1. Understand plant layout design to facilitate material flow and processing of a product in the most efficient manner
2. Understand work study methods to improve the performance of workers
3. Gain some ability to recognize situations in a production system environment that suggests the use of certain quantitative methods to assist in decision making on operations management and strategy.
4. Understand how Materials Requirement Planning and MRPII systems are used in managing operations
5. Recognize the importance of Inventory control to ensure their availability with minimum capital lock up.
6. Evaluate the quality processes in manufacturing and service sector to improve the operational performance

Outcomes: At the end of the course, the student will be able to

1. Identify and evaluate the processes, tools and principles of production and operations management to better understand the logistics and supply chain operations
2. Demonstrate the ability to apply mathematical forecasting techniques
3. Identify future challenges and directions that relate to production and operations management to effectively and efficiently respond to market changes
4. Apply the tasks, tools and underlying principles of operations management in the manufacturing an d service sectors to improve organizational performance
5. Explain and evaluate the quality process in manufacturing and service sector to improve the operational performance

UNIT-I

Production & Operations Management: Introduction: Types of Production Systems, job shop, batch, flow shop

Plant location and layout: Factors affecting plant location, plant layout objectives, types of layouts, merits and demerits.

Work Study: Introduction to method study and work measurement, standard time calculations, methods of rating, work sampling, wages and incentives, types of incentive plans.

UNIT-II

Forecasting: Introduction, forecasting objectives and uses, demand patterns, qualitative models, market survey, Delphi, quantitative models, moving average, weighted moving average, simple exponential smoothing, trend adjusted exponential smoothing, least square method, simple regression, multiple regression.

Forecast Errors: Mean Absolute Deviation (MAD), Mean Square Error (MSE), Mean Forecast Error (MFE), Mean Absolute Percentage Error (MAPE)

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UNIT-III

Aggregate planning and master scheduling: Introduction, objectives of aggregate planning, cost in aggregate planning, strategies in aggregate planning, master production scheduling

Materials Requirement Planning (MRP): Importance of MRP, MRP system inputs and outputs, MRP calculations, bill of materials.

UNIT-IV

Inventory Control: Importance of inventory control, types of inventory models, inventory costs deterministic inventory models, basic EOQ model, production model without shortages, purchase model with instantaneous replenishment and with shortages, production model with shortages, inventory model with price breaks, fixed order quality system, periodic review system and inventory model with probabilistic demand.

UNIT-V

Quality Control: Introduction, history and early contributions by quality gurus, quality tools, process capability, quality control by control charts, control charts for variables and attributes, sampling plans, operating characteristic curves, introduction to total quality management

Text Books:

1. Stevenson, *Production operation Management*, Mc-Graw Hill International
2. Joseph Monks, *Operations Management*, TMH Publishers, New Delhi, 2004.
3. Buffa Elwood S, *Modern Production /Operations Management* , John Wiley Publishers, Singapore, 2002

Suggested Reading:

1. Everrete E. Adama & Ronald J. Ebert, *Production & Operations Management*, Prentice Hall of India, 5th Edition, 2005
2. Panneer Selvam R, *Production and Operations Management*, Second Edition, PHI Learning Pvt. Ltd., New Delhi, 2006.
3. S.D. Sharma, *Operations Research*, Kedarnath, Ramnath & Co., Meerut,2009
4. S.N. Chary, *Production and Operations Management*, Tata McGraw Hill, 3rd Edition, 2006.

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ME 422

Production Drawing

Instruction	6 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Students will understand

1. The need and the importance of production drawing
2. How to make part drawing from given assembly drawings.
3. Indication of size, form and positional tolerances on the drawing sheets
4. Surface finish and heat treatment process on the drawing sheets.
5. Writing process sheets
6. Notations, symbols and abbreviations on production drawings

Outcomes: On completion of the course the students will develop abilities to

1. Draw part drawings from given assembly drawings of machine parts.
2. Indicate tolerance values on the parts drawn on sheet as per alpha numeric codes for given assembly drawings
3. Indicate form tolerances and position tolerances on the parts drawn on the sheet as per universally accepted norms for a given assembly drawing
4. Indicate values of surface finished and heat treatment process on the parts drawn for a given assembly drawings.
5. Write process sheet for every part that is drawn from given assembly drawings
6. Interpret a production drawing and process sheet.

UNIT-I

Parts-I: Format of drawing sheet, title block, columns for materials, Processes, parts list, conventional representation of parts: screwed joints, welded joints, springs, gears.

UNIT-II

Parts II: Elements of electrical, hydraulic and pneumatic circuits, machine tool elements), methods of indicating notes on drawing

UNIT-III

Limits and Fits: Basic definition of terms, alpha numeric designation of limits/fits, types of fits, Interchangeability and selective assembly, Exercises involving selection/interpretation of fits and calculation of limits, dimensional chains

UNIT-IV

Production Drawing: Conventional practices of indicating tolerance on size and geometrical form, position, surface finish, surface treatments, part drawing from assembled drawings (Stuffing box, Screw jack, I.C engine connecting rod, Revolving center, Square tool post, Single tool post, Universal coupling, Flange coupling, Steam engine cross head, Drill jig (plate type), Non return valve, Blow off cock), specification and indication of above features on the drawings, calculation of limits suggesting suitable fits for mating parts

UNIT-V

Assignments: Sketches of conventional representation of parts described with syllabus at (1) process sheets, tolerances and finishes obtainable from different processes. Study of IS 2709 on limits and fits

NOTE: Tolerance charts to be provided in the examination hall for calculation of limits

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Text Books:

1. K.L. Narayana, P. Kannaiah and K. Venkat Reddy, *Production Drawing*, New Age Intl., (P) Ltd., Revised Edition, 1997.
2. P. Narasimha Reddy, T.A. Janardhan Reddy and C. Srinivasa Rao, *Production Drawing Practice*, Hitech Publishers, 2001

Suggested Reading:

1. Venkata Reddy, *Production Drawing*. New Age International. ISBN 978-81-224-2288-7, 2009
2. Farazdak Haideri, *Machine Drawing & Computer Graphics*, Nirali Prakashan. ISBN 978-93-8072-527-7
3. R.L. Murthy, *Precision Engineering in Manufacturing*, New Age International Private Ltd., 1996
4. Doeblin, *Measurement Systems Application and Design*, TMH, 5 th Edn., 2004.

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With Effect from the Academic Year 2016 - 2017

ME 471

Power Plant Engineering (Elective – III)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student will learn

1. Different types of power plants and their site selection criteria
2. Operation of thermal power plant
3. About hydraulic power plant, dams and spillways
4. Different types of nuclear power plants including Pressurized water reactor, Boiling water reactor, Liquid metal fast breeder reactor and Gas cooled reactor
5. The power plant economics
6. The environmental and safety aspects of power plant operation.

Outcomes: At the end of the course, the student will be able to

1. Select the suitability of site for a power plant.
2. Propose ash handling, coal handling method in a thermal power plant
3. Understand the flow-sheet of hydro-power plant
4. Explain working principle of different types of nuclear power plant.
5. Know the various factors of plant load and economy
6. Indicate safety aspects of power plants

Unit - I

Introduction: Power plant, classification of power plants, conventional and non-conventional power plants

Steam power plant: Plant Layout, types of coals, coal handling equipment, Ash handling systems

UNIT II

Steam power plant: Combustion Process - Overfeed and Underfeed stokers-traveling grate stokers, spreader stokers, retort stokers- Pulverized fuel burning system-cyclone furnace-Fluidized bed combustion (FBC).

UNIT III

Hydro electric power plant: Hydrological cycle, flow measurement, Hydrographs - drainage area characteristics, Types of hydroelectric power plants- storage and pondage - classification of dams and spill ways.

UNIT - IV

Nuclear power plant: Nuclear fuel - breeding and fertile materials - types of reactors: Pressurized water reactor, Boiling water reactor, sodium-graphite reactor, fast Breeder Reactor, Gas cooled Reactor-Radioactive waste disposal.

UNIT - V

Power plant economics and environmental considerations:

Definitions of connected load, Maximum demand, demand factor, average load, load factor, diversity factor - related exercises-Fixed cost and variable cost-methods to find depreciation cost Effluents from power plants and Impact on environment – pollutants - Pollution control.

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Text Books:

1. R.K. Rajput, *A Text Book of Power Plant Engineering* 4th edition, Laxmi Publications (P) Ltd., New Delhi, 2015
2. P.K. Nag, *Power Plant Engineering* 4th edition, McGraHill Education(India) Private Limited, New Delhi, 2014
3. S.C. Arora and S. Domukundwar, *A Course in Power Plant Engineering*, Dhanpat Rai & Sons, New Delhi, 2005

Suggested Reading:

1. R. Yadav, *Fundamentals of Power Plant Engineering*, Central Publishing House, Allahabad, 2012
2. R.K. Hegde, *Power Plant Engineering*, Pearson Education India, 2015
3. P.C. Sharma, *A Text Book of Power Plant Engineering*, S.K. Kataria & sons, New Delhi, 2016

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With Effect from the Academic Year 2016 - 2017

ME 472

Intellectual Property Rights (Elective – III)

(for Mech, Prod, Civil, ECE, EEE, CSE, IT)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student will learn

1. Fundamental aspects of IP
2. Aspects of IPR acts.
3. Awareness of multi disciplinary audience
4. Awareness for innovation and its importance
5. The changes in IPR culture
6. About techno-business aspects of IPR

Outcomes: At the end of the course, a student

1. Will respect intellectual property of others
2. Learn the art of understanding IPR
3. Develop the capability of searching the stage of innovations.
4. Capable of filing a patent document independently.
5. Completely understand the techno-legal business angle of IP. .
6. Capable of converting creativity into IP and effectively protect it.

UNIT-I

Overview of Intellectual Property: Introduction and the need for intellectual property right (IPR), IPR in India – Genesis and Development, IPR abroad, Some important examples of IPR. Importance of WTO, TRIPS agreement, International Conventions and PCT

Patents: Macro economic impact of the patent system, Patent and kind of inventions protected by a patent, Patent document, How to protect your inventions. Granting of patent, Rights of a patent, how extensive is patent protection. Why protect inventions by patents. Searching a patent, Drafting of a patent, Filing of a patent, the different layers of the international patent system, (national, regional and international options), compulsory licensing and licensers of right & revocation, Utility models, Differences between a utility model and a patent. Trade secrets and know-how agreements

UNIT-II

Industrial Designs: What is an industrial design. How can industrial designs be protected? What kind of protection is provided by industrial designs? How long does the protection last? Why protect industrial designs?

UNIT-III

Trademarks: What is a trademark, Rights of trademark? What kind of signs can be used as trademarks. Types of trademark, function does a trademark perform, How is a trademark protected? How is a trademark registered. How long is a registered trademark protected for? How extensive is trademark protection. What are well-known marks and how are they protected? Domain name and how does it relate to trademarks? Trademark infringement and passing off.

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UNIT-IV

Copyright: What is copyright. What is covered by copyright. How long does copyright last? Why protect copyright? Related Rights: what are related rights. Distinction between related rights and copyright. Rights covered by copyright? Copy rights in computer programming.

UNIT-V

Enforcement of Intellectual Property Rights: Infringement of intellectual property rights Enforcement Measures Emerging issues in Intellectual property protection. Case studies of patents and IP Protection.

Unfair Competition: What is unfair competition. Relationship between unfair competition and intellectual property laws.

Text Books:

1. Ajit Parulekar and Sarita D' Souza, *Indian Patents Law – Legal & Business Implications*; Macmillan India ltd , 2006
2. B. L.Wadehra; *Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications*; Universal law Publishing Pvt. Ltd., India 2000
3. P. Narayanan; *Law of Copyright and Industrial Designs*; Eastern law House, Delhi 2010

Suggested Reading:

1. Cronish W.R1 *Intellectual Property; Patents, copyright, Trad and Allied rights*, Sweet & Maxwell, 1993.
2. P. Narayanan, *Intellectual Property Law*, Eastern Law Edn., 1997.
3. Robin Jacob and Daniel Alexander, *A Guide Book to Intellectual Property Patents, Trademarks, Copy rights and designs*, Sweet, Maxwell 4th Edition.

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With Effect from the Academic Year 2016 - 2017

ME 473

Mechatronics (ELECTIVE - III)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student will understand

1. How to identify, formulate, and solve engineering problems
2. The design a system, component, or process to meet desired needs within realistic constraints
3. The how to use the techniques, skills, and modern engineering tools necessary for engineering practice
4. The use of drive mechanisms and fluid power systems
5. The use of industrial electronic devices
6. The demonstrate the design of modern CNC machines, and Mechatronics elements

Outcomes: At the end of the course, the students will be able to

1. Model and analyze electrical and mechanical systems and their interconnection
2. Integrate mechanical, electronics, control and computer engineering in the design of mechatronics systems
3. Do the complete design, building, interfacing and actuation of a mechatronics system for a set of specifications
4. Be proficient in the use of fluid power systems in various mechatronics applications
5. Demonstrate the use of industrial electronic devices
6. Demonstrate the design of modern CNC machines, and mechatronics elements

UNIT-I

Introduction to mechanization & automation: Need of interface of electrical & electronic devices with mechanical elements, the concept of Mechatronics, Flow chart of Mechatronics system, elements of Mechatronics system, drive mechanisms, actuators, feedback devices and control system, application in industries and systems development

UNIT-II

Drive mechanisms: Feeding and indexing, orientation, escapement and sorting devices, conveyor systems

Introduction to electrical actuators: A.C. servomotors, D.C. servomotors, stepper motors

UNIT-III

Introduction to fluid power systems: Industrial Pneumatics and hydraulics, merits of fluid power, pneumatic & hydraulic elements symbols, study of hydraulic control valves, pumps & accessories, hydraulic circuits & mechanical servo control circuits, Electro-hydraulic and Hydro-pneumatic circuits

UNIT-IV

Introduction to industrial electronic devices: Diodes, Transistors, Silicon Controlled Rectifiers (SCR), Integrated Circuits (IC), Digital Circuits, Measurement systems & Data acquisition systems: sensors, digital to analog and analog-to-digital conversion, signal processing using operational amplifiers, introduction to micro processor & micro controller, Temperature measurement interface and LVDT interface, Systems response

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UNIT-V

Design of modern CNC machines and Mechatronics elements: machine structures, guide ways, spindles, tool monitoring systems, adaptive control systems, Flexible manufacturing systems, Multipurpose control machines, PLC programming

Text Books:

1. William Bolton, *Mechatronics: Electronic control systems in mechanical and electrical engineering*, 6th edition, Pearson Education
2. HMT Ltd, *Mechatronics*, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1998

Suggested Reading:

1. Michaels Histand & David G, Alciatore, *Introduction to Mechatronics and Measurement Systems*, Tata McGraw-Hill International Edition
2. Devdas Shetty, Richard A. Kolk, *Mechatronics System Design*, Cengage Learning
3. S.R. Majumdar, *Oil Hydraulic Systems – Principles & Maintenance,* McGraw-Hill Publishing Company Limited, New Delhi
4. Godfrey Onwubolu, *Mechatronics: Principles and Applications*, Butterworth-Heinemann

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With Effect from the Academic Year 2016 - 2017

ME 474

Mechanics of Composite Materials (ELECTIVE - III)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student will understand the

1. Properties of fiber and matrix materials used in commercial composites, as well as some common manufacturing techniques.
2. How to predict the elastic properties of long fiber composites based on the constituent properties. An ability to rotate stress, strain and stiffness tensors using ideas from matrix algebra.
3. Linear elasticity with emphasis on the difference between isotropic and anisotropic material behavior. An ability to analyze a laminated plate in bending using classical lamination theory.
4. How to predict the failure strength of a laminated composite plate. A knowledge of issues in fracture of composites.
5. Exposure to recent developments in composites, including metal and ceramic matrix composites.
6. How to use the ideas developed in the analysis of composites towards using in industrial application.

Outcomes: At the end of the course, a student should be able to

1. Understand the various fabrication methods of composite materials.
2. Understand the specifics of mechanical behavior of layered composites compared to isotropic materials.
3. Determine stresses and strains in composites.
4. Apply constitutive equations of composite materials and understand mechanical behavior at micro and macro level.
5. Understand the failure of composites including fracture.
6. Understand the theory of plate and shell; understand the bending analysis of composite beams.

Unit-I

Introduction: Fibers, matrix materials, interfaces, polymer matrix composites, metal matrix composites, ceramic matrix composites and carbon composites.

Unit-II

Micromechanics of lamina and mechanical properties: Prediction of elastic constants, micromechanical approach, Halpin-Tsai equations, thermal properties, hygro properties, mechanics of load transfer from matrix to fibre.

Unit-III

Macro-mechanics of lamina: Elastic constants of a lamina, relations between engineering constants and reduced stiffness and compliances, variation of lamina properties with orientation, analysis of laminated composites, stresses and strains with orientation, inter-laminar stresses and edge effects, simplified composite beam solutions, bending of laminated beams.

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Unit-IV

Strength, fracture, fatigue and design: Tensile and compressive strength of unidirectional fibre composites, fracture modes in composites: single and multiple fractures, de-bonding, fibre pullout and de-lamination.

Strength of an orthotropic lamina: Max stress theory, max strain criteria, maximum work (Tsai-Hill) criterion, quadratic interaction criteria, designing with composite materials

Unit-V

Manufacturing processes: Hand lay-up, prepregs, bag molding, autoclave processing, RTM, pultrusion, filament winding, gel time test for resins, curing cycle,

Measurement of basic composite properties: Fiber and matrix tests, tensile test, compressive test, in-plane shear test, inter-laminar shear test, flexure test.

Text Books:

1. Jones, R.M., *Mechanics of Composite Materials*, Mc Graw Hill Co., 1967
2. B.D. Agarwal et.al, *Analysis and performance of fiber composites*, 3rd edition, Wiley sons., 2013
3. P.K. Mallick, *Fiber Reinforced Composites Materials*, Manufacturing, and Design, Taylor & Francis, Third Edition 2007 ,

Suggested Reading:

1. Ever J Barbero, *Introduction to composite materials design*, Taylor &Francis, 1999.
2. Hyer, M.W., *Stress Analysis of Fibre Reinforced Composite Materials*, McGraw Hill Co., 1998.
3. Carl. T. Herakovich, *Mechanics of Fibrous Composites*, John Wiley Sons Inc., 1998.

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ME 475

Supply Chain Management (Elective – III)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student will understand

1. The significance of supply chain management in engineering.
2. The awareness about transportation and warehouse management systems.
3. The designing supply chain networks.
4. The concept of demand and supply and integrating it with supply chain management.
5. The acquainted with planning and managing inventories.
6. The pricing and revenue management

Outcomes: At the end of the course, the student is able to

1. Apply supply chain management concepts in engineering applications
2. Plan an effective transportation and warehouse management systems
3. Design an effective supply chain networks
4. Integrate and optimize demand and supply gaps
5. Apply inventory management techniques
6. Understand and design a pricing and revenue management systems

UNIT-I

Concept of SCM, Concept of Logistics Management, Supply Chain, Types of supply chain, functions in SCM, Transportation Management, Warehousing Management, Warehouse management systems.

UNIT-II

Designing the supply chain Network, Designing the distribution network, Network Design, Network Design in an uncertain environment.

UNIT-III

Planning and Demand:Planning demand & supply in a supply chain, demand forecasting, aggregate planning, planning supply & demand.

UNIT-IV

Planning & managing inventories in a supply chain, managing economies of scale, cycle inventory, and managing uncertainty safety inventory optimal level of product availability

UNIT-V

Sourcing, Transporting & Pricing Products, sourcing decisions, transportation, pricing & revenue management. Coordination & technology in the supply chains, coordination in supply chain, information technology and supply chain.

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Text Books:

1. N. J. Kumar & Mukesh Bhatia, *Supply Chain Management*, Neha publishers & Distributors,2010
2. Michael H. Hugos, *Essentials of Supply Chain Management*, 3rd edition, John Wiley & Sons, Inc, Hoboken, New Jersy,2011
3. Sunil Chopra & Peter Meindl, *Supply Chain Management* – Strategy, Planning and Operation, Pearson Education, Inc., Upper Saddle River, New Jersey, 2003

Suggested Reading:

1. Martin Christopher, *Logistics & Supply Chain Management*, 5th edition, Financial Times Series,2010
2. Dobler Donald. W, David.N.Burt, *Purchasing & supply Management Text & Cases*. McGraw-Hill, 1996
3. Chitale A.K. Gupta R.C, *Materials Management-Text and Cases*, Prentice-Hall Of India Pvt. Limited, 2007

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With Effect from the Academic Year 2016 - 2017

PE 471

Manufacturing Systems and Simulation (Elective – III)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student will understand

1. The systems, subsystems for manufacturing techniques
2. The information technologies relevant to manufacturing systems
3. The discrete and continuous systems
4. The system simulation and associated concepts
5. The queuing theory concepts applied to system simulation
6. The awareness about programming with GPSS and SIMSCRIPT

Outcomes:

1. Student is able to have overall view of various manufacturing processes
2. Capable of applying information systems and automation to manufacturing
3. Ability to build various models suitable for appropriate manufacturing facility
4. Able to understand and conceptualize systems simulations
5. Ability to simulate discrete and continuous systems
6. Capable of programming with GPSS and SIMSCRIPT

UNIT-I

Manufacturing Systems: Definition of systems, basic concepts and problems concerning systems, systems design, decision making procedures, Structural, transformational and procedural aspects of manufacturing, modes of production, process systems for manufacturing, logistic systems, material flow & technological information flow, management & information systems for manufacturing, managerial information flow in manufacturing systems

UNIT-II

Information Systems: Fundamentals of information technology, information systems, information networking, parts oriented production information systems and computerized production scheduling, online production control systems, Computer based production management systems, Automation systems for manufacturing, Industrial automation, Kinds of automation, principles of CIM, effectiveness of CIM, factory automation, automatic machine tools for mass production, NC machine tools, computer controlled manufacturing systems, FMS, automated assembly, automatic material handling, automatic inspection & testing, computer integrated automation systems- unmanned factory

UNIT-III

System Models: Concepts, continuous and discrete systems, systems modeling, type of models, subsystems, corporate model and system study

System simulation: Techniques, comparison of simulation and analytical methods, types of simulation, distributed log model, cobweb models

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UNIT-IV

Continuous system Simulation: Numerical solution of differential equation, analog computers, hybrid computers, continuous system simulation languages CSMP, system dynamic growth models, logistic curves

Discrete systems simulation: Events generation of arrival patterns, simulation programming tasks, analysis of simulation output

Queuing theory: Arrival pattern distribution, service times, queuing disciplines and measure of queues

UNIT-V

GPSS and SIMSCRIPT: General description of GPSS and SIMSCRIPT, programming in GPSS simulation programming techniques: Data structures, implementation of activities, event and queues, event scanning, simulation algorithms in GPSS and SIMSCRIPT

Text Books:

1. Geofery Gordan, *Systems Simulation*, Prentice Hall, 1980
2. Allan Carrie, *Simulation of Manufacturing Systems*, John Wiley & Sons Ltd,1998

Suggested Reading:

1. Adelaide Marzano, *Manufacturing system simulation*, VDM Verlag
2. Davi Bedworth & James Bailey, *Integrated Production Control system Management, analysis & design*, 2nd edition, John Wiley & Sons Ltd.,2010
3. Ronald Zskin & Charles Standridge, *Modeling and Analysis of Manufacturing Systems*, John Wiley & Sons Ltd.,2011
4. Deo. N., '*ystem simulation with Digital Computers*, Prentice Hall, 1980

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PE 412

Modern Machining and Forming Methods (ELECTIVE – IV)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student will learn

1. The importance of non-conventional machining processes
2. Various non-conventional machining processes and their process parameters
3. The relative merits, limitations and applications of various non-conventional machining processes
4. The knowledge regarding working media and its functions of non-conventional machining processes
5. The concepts of non-conventional forming processes such as rubber pad forming, hydro forming, stretch forming, etc.,
6. The concepts of HERF and to provide the description of HERF process

Outcomes: At the end of the course, the students are able to

1. Select the non-conventional machining process for a particular application
2. Demonstrate the capability of comparison of various non-conventional machining methods
3. Describe the various non-conventional machining processes
4. Exhibit the proficiency of selecting working media for various non-conventional machining processes
5. Exhibit the basic understanding of non-conventional forming processes
6. Compare various non-conventional forming processes based on their merits, limitations and applicability

UNIT-I

Mechanical Energy Methods:

Ultrasonic Machining (USM): Introduction, Process description, abrasive slurry, Abrasive materials and their characteristics, Functions of liquid medium in slurry, Types of transducers, effect of process parameters, applications and limitations

Abrasive Jet Machining (AJM): Principle of operation, process details, process variables and their effect on MRR and accuracy, equation for MRR, advantages, disadvantages and applications

Water Jet Machining (WJM): Schematic diagram, equipment used, advantages and applications

Abrasive Water Jet Machining (AWJM): Process, advantages, limitations and applications

UNIT-II

Thermal methods: Electro Discharge Machining (EDM): Process description with schematic diagram, process parameters, functions and characteristics of dielectric medium, dielectric fluids, over cut and side taper, flushing, mechanism of metal removal, crater volume, types of power supply circuits, mathematical analysis of metal removal rate (MRR), equations for surface finish, characteristics of spark eroded surfaces, advantages, disadvantages and applications

Wire EDM: Process description and applications

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LASER Beam Machining (LBM): Principle of LASER beam production, materials used, process parameters, advantages, limitations and applications,
Plasma Arc Machining (PAM): Introduction, equipment used, process description and parameters, types of plasma arc: transferred arc and non transferred arc and process applications,
Electron Beam Machining (EBM): Schematic of the process, process parameters, principle of production of electron beam, equipment used, advantages, disadvantages and applications,

UNIT-III
Electro chemical, Chemical and other machining processes: Electro-chemical machining (ECM): Schematic of process parameters, function and characteristics of electrolyte, chemistry of the process, MRR for pure metal and alloys, electrode feed rate (EFR), advantages, limitations and applications
Chemical Machining: Chemical blanking and chemical milling, advantages, limitations and applications
ION Etching: Process description, merits, limitations and applications, hot machining, high speed machining, process parameters, advantages and applications

UNIT-IV
High Energy Rate Forming Processes (HERF): Introduction, applications, advantages,
Explosive Forming: Principles, explosive materials, Equipment, types of explosive forming, standoff operation and contact operation, the pressure pulse, gas bubble and the process applications
Electro-Hydraulic Forming (EHF): Schematic of process, description and its applications,
Electro-Magnetic Forming (EMF): Process description, merits, limitations and applications

UNIT-V
Other Forming Processes:
Rubber Pad Forming: Principle of the process, process details and its types, Guerin, wheelon, Mar forming and Hydro forming processes and applications,
Stretch Forming: Introduction, types of stretch forming, stretch draw forming, rotary stretch forming or stretch wrapping, compression forming, radial draw forming.
Tube spinning: introduction, methods of tube spinning, backward spinning, forward spinning, machines and tools used, machine variables, speeds and feeds, effect of tube spinning on work metal properties and applications.

Text Books:

1. P.C. Pandey and H.S. Shah, *Modern Machining Process* Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1980
2. J Paulo Davim, *Modern Machining Technology, A Practical Guide*, 1st Edition, Woodhead Publishing in Mechanical Engineering

Suggested Reading:

1. Hassan Abdel-Gawad El-Hofy, *Advanced Machining Processes, Nontraditional and Hybrid Machining Processes*, McGraw Hill Publishing Co. Ltd.,
2. Davies and Austin, *Developments in High Speed Metal Forming*, The Machinery Publishing Co. Ltd., 1985
3. Production Technology, HMT
4. A. Bhattacharya, *New Technology*, The Institution of Engineers (India), 1984

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PE 481

Micro Manufacturing (ELECTIVE - IV)

Instruction	4	Periods per week
Duration of End Examination	3	Hours
End examination	75	Marks
Sessionals	25	Marks
Credits	3	

Objectives: Student will understand

1. The importance of micromachining, Nano polishing, Micro forming and Micro welding.
2. Micromachining processes
3. The Nano polishing methods
4. The micro forming processes
5. The concepts of micro welding to the students
6. The recent trends and applications of micro manufacturing

Outcomes: At the end of the course, the students are able to

1. Suggest suitable micromachining process to a particular application.
2. Select the process parameters of particular micro machining process
3. Describe the various micro, machining, welding and forming processes
4. Compare various micro machining / forming/ welding processes based on relative merits and demerits.
5. Demonstrate the understanding of various nano machining operations.
6. Exhibit the knowledge regarding the recent trends in micro-manufacturing processes

UNIT I

Micro Machining I: Introduction, scaling laws, mechanical micro machining, ultra sonic micro machining, abrasive jet micro machining, water jet micro machining, abrasive water jet micro machining, micro turning, chemical and electro chemical micro machining, electric discharge micro machining, electro discharge grinding.

UNIT II

Micro Machining II: Beam energy based micro machining, electron beam micro machining, laser beam micro machining, ion beam micro machining, plasma beam micro machining, hybrid micro machining, electro chemical spark micro machining, electrolytic in process dressing.

UNIT III

Nano Polishing: Abrasive flow finishing, magnetic abrasive finishing, magneto rheological finishing, magneto rheological abrasive flow finishing, magnetic float polishing, elastic emission machining, chemo-mechanical polishing

UNIT IV

Micro Forming and Welding: Micro extrusion, micro and nano structured surface development by nano plastic forming and roller imprinting, micro bending with laser, laser micro welding, electron beam for micro welding.

UNIT V

Recent Trends and Applications: Metrology for micro machined components, ductile regime machining, AE based tool wear compensation, machining of micro gear, micro nozzle, micro pins and applications.

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Text Books:

1. Jain V. K., *Micro Manufacturing Processes*, CRC Press, Taylor & Francis Group, 2012
2. Janocha H., *Actuators – Basics and applications*, Springer publishers, 2012
3. Jain V.K., Introduction to Micro machining, Narosa Publishing House, 2011

Suggested Reading:

1. Bharat Bhushan, *Handbook of nanotechnology*, springer, Germany, 2010.
2. Bandyopadhyay. A.K., *Nano Materials*, New age international publishers, New Delhi, 2008, ISBN:8122422578.
3. Jain V.K., *Advanced Machining Processes*, Allied Publishers, Delhi, 2002
4. Mcgeoug.J.A., *Micromachining of Engineering Materials*, CRC press 2001, ISBN-10:0824706447.

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PE 482

Non - Destructive Testing and Evaluation (ELECTIVE - IV)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student has to understand the

1. Need, basic concepts and technologies of Non Destructive Testing (NDT)
2. Security precautions from Radiography, protection from radiation and measurement of radiation received by personnel.
3. Technology of acoustic emission (AE), the associated instrumentation and applications
4. Technologies like neutron radiography; laser induced ultrasonics, surface analysis and thermography
5. Merits and demerits of the different NDT Technologies
6. Latest research and developments in NDT

Outcomes: At the end of the course, the students will be able to demonstrate

1. the knowledge of different NDT techniques.
2. clear understanding of liquid penetrant inspection and magnetic particle inspection.
3. view and interpret radiographs, utilize the various principles of radiography for different components of different shapes.
4. the knowledge of acoustic emission for NDT and the instrumentation used for NDT.
5. the ability to analyze and prepare a technical report.
6. the knowledge of latest research, developments and trends in NDT.

UNIT-I

Liquid penetrate inspection: Principles of penetrate inspection, characteristics of a penetrate, water washable system, post emulsification system , solvent removable system, surface preparation and cleaning, penetrate application, development, advantages limitations, and applications.

Magnetic particle instruction: Principle, magnetization methods, continuous and residual methods, sensitivities, demagnetization, magnetic particles, applications advantages and limitations.

UNIT-II

Eddy current testing: Principle, lift-off factor, and edge effect, skin effect, inspection frequency, coil arrangements, inspection probes, types of circuit, reference pieces, phase analysis, display methods and applications.

UNIT-III

Ultrasonic testing: Generation of ultra sound, characteristics of an ultrasonic beam, sound waves at interfaces, sound attenuation, display systems, probe construction, type of display, inspection techniques, identification of defects, Immersion testing , sensitivity and calibration. Reference standards. Surface condition, Applications.

UNIT-IV

Radiography: Principle and uses of radiography, limitation principle, radiation sources, production of X-Rays, x-ray spectra, attenuation of radiation, radiographic equivalence, shadow formation enlargement and distortion, radio graphic film and paper, Xeroradiography, fluoroscopy, exposure factors, radiographic screens, identification markers and image quality indicators, inspection of simple shapes, inspection of complex shapes, viewing and interpretation of radiographs, radiation hazard, protection against radiation, measurement of radiation received by personnel.

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UNIT-V

Acoustic Emission: Physical Principles, Sources of emission, instrumentation and applications, Other NDT Techniques: Neuron radiography, Laser induced ultrasonics, surface analysis, and thermography.

Text Books:

1. Barry Hull & Vernon John, *Non Destructive Testing*, 1988.
2. H J Frissell (Editorial Coordinator), Non-*Destructive Evaluation and quality control*, ASM handbook-International Publication USA, 1989..
3. Dove and Adams, *Experimental Stress analysis and Motion Measurement*, Prentice Hall of India, Delhi

Suggested Reading:

1. *Non-Destructive Examination and Quality Control*, ASM International, Vol.17, 9th edition (1989)
2. J. Prasad and C. G. K. Nair, *Non-Destructive Test and Evaluation of Materials*, Tata McGraw-Hill Education, 2nd edition (2011).
3. B. Raj, T. Jayakumar and M. Thavasimuthu, Practical *Non Destructive Testing*, Alpha Science International Limited, 3 rd edition (2002).
4. T. Rangachari, J. Prasad and B.N.S. Murthy, *Treatise on non-destructive testing and evaluation*, Navbharath Enterprises, Vol.3, (1983

CBIT MED 474 MECH

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With Effect from the Academic Year 2016 - 2017

PE 483

Product Design and Process Planning (ELECTIVE – IV)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student will understand

1. The Product Design and Process Functions
2. The essence of innovation in product development
3. The Human Machine Interactions (ergonomics)
4. The various Intellectual Property Rights
5. The interaction between Design, Manufacturing, Quality and Marketing
6. The awareness about overall view of Process Planning

Outcomes: At the end of the course, the student is able to

1. Have overall view of Product Design and Process Planning
2. Apply creativity techniques in Product Development
3. Applying ergonomically enabled concepts in developing a new product
4. Have awareness and apply Intellectual Property Rights
5. Integrate various stages of developing a new product
6. Develop and execute an effective Process Plan

UNIT-I

Product Design and Process Design functions: selection of right product, systematic procedure of product innovation, factors contributing to successful technological innovation, need for creativity and innovation, techniques of innovation like brain storming and Delphi techniques

UNIT-II

Product Selection and Evaluation: Function of design, design with Human Machine Interaction (HMI) and collection of ideas and purpose of project, selection criteria, screening ideas for new products using evaluation techniques, principles of ergonomics.

UNIT-III

New Product Planning: Interaction between the functions of design, manufacture, quality, testing and marketing, design and material selection, steps for introducing new products after evaluation.

UNIT-IV

New Product Development: Research and new product development, patents, definitions, patent search, patent laws, international code for patents, Intellectual Property Rights (IPR).

UNIT-V

Process Selection and Planning: Process selection, process planning, process sheets, selection of manufacturing process, estimation of machining time in various cutting operations, estimation of costs for manufacture, value engineering in product design, group technology, concepts of concurrent engineering.

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Text Books:

1. Niebel BW & Draper AB, *Production Design & Process Engg*, McGraw Hill, Kogakusha, 1974
2. K. G. Swift & J. D. Booker, *Process Selection*: From Design to Manufacture", Butterworth-Heinemann Ltd; 2nd Revised edition, 2003
3. Bhaskaran Gopalakrishnan, *Product Design and Process Planning in CE (Design & Manufacturing*", Chapman and Hall publishers, 1994

Suggested Reading:

1. Harry Nystrom, *Creativity and Innovation*, John Wiley & Sons,
2. Brain Twiss, *Managing Technological Innovation*, Pittrnan Publications, 1992
3. Harry, B.Waton, *New Product Planning*, Prentice Hall Inc., 1992
4. Chitale, A. K. & Gupta RC., *Product Design & Manufacturing*, PHI, 1997

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PE 484

Nano Materials and Technology (Elective – IV)
(for Mech, Prod and Chemical)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student will learn the

1. Nanotechnology approach and challenges
2. Materials of nanotechnology
3. Nano structures
4. Nano fabrication
5. Special nano materials
6. Bio materials

Outcomes: At the end of the course

1. Understand the developments and challenges in nano technology
2. Understand synthesis and properties of nanostructured materials
3. Analyze magnetic and electronic properties of nano materials
4. Analyze nano fabrication methods and their applications
5. Understand the characterization of nano and bio materials and their use
6. Analyze the synthesis and characterization of nano wires and tubes

Unit I

Introduction: Nanoscale, Properties at Nanoscale, advantages and disadvantages, importance of Nanotechnology, Bottom-up and Top-down approaches, challenges in nanotechnology, proximal probe technologies

Unit II

Materials of Nanotechnology: Introduction, Si-based materials, Ge-based materials, Ferroelectric materials, Polymer materials, GaAs& InP (HI-V) group materials, Nanotribology and materials, characterization using Scanning Probe Microscope, AFM, FFM

Unit III

Nano Structures: Zero dimensional Nanostructure (Nano particles), synthesis procedure, characterization techniques, properties and applications of Nano particles

One dimensional Nanostructures (Nano Wires, Nano Tubes), various Synthesis procedure, characterization procedure and principles involved, properties and applications of Nano Wires, Types of Nano Tubes, Synthesis procedure, characterization properties and applications of Nano Tubes

Unit IV

Nano Fabrication: Introduction, Basic fabrication techniques (Lithography, thin film deposition, and doping), MEMS fabrication techniques, Nano fabrication techniques (E-beam Nano-imprint fabrication, Epitaxy and strain engineering, Scanned probe techniques)

Unit V

Special Nano Materials: Nano Composites: Introduction, Synthesis procedures, various systems (metal-polymer, metal-ceramics and Polymer-ceramics), Characterization procedures, applications,

Nano Biomaterials: Introduction, Biocompatibility, anti-bacterial activity, principles involved, applications

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Text Books:

1. A.K. Banopadyay, *Nano Materials*, New Age Publications
2. T. Pradeep, *Textbook of Nanoscience and Nanotechnology*, McGraw Hill Education (India) Private Limited, New Delhi
3. Dieter Vollath, *Nanomaterials: An Introduction to Synthesis, Properties and Applications*, Wiley, 2013

Suggested Reading:

1. Carl C. Koch, *Nano Materials Synthesis, Properties and Applications*, Jaico Publishing House
2. Willia Tllsey Atkinson, *Nano Technology*, Jaico Publishing House
3. George W. Hanson, *Fundamentals of Nanoelectronics*, Pearson Education, 2009
4. T. Pradeep, *Nano: Essentials-understanding Nano Science and Technology*, TMH, 2007
5. Sabu Thomas, Nandakumar Kalarikkal, A. Manuel Stephan, B. Raneesh, *Advanced Nano-materials*: Synthesis, Properties, and Applications, Apple Academic Press

CBIT MED 4/4 M.Ch

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With Effect from the Academic Year 2016 - 2017

CSE 481

Information Security (Elective – IV)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student will understand the

1. Information assurance as practiced in computer operating systems, distributed systems, networks and representative applications.
2. Several ethical issues in information system
3. Principal concepts, major issues, technologies, and basic approaches in information security.
4. Prevalent network and distributed system attacks, defenses against them, and forensics to investigate the aftermath.
5. Cryptography, how it has evolved, and some key encryption techniques used today.
6. Security policies (such as authentication, integrity and confidentiality), as well as protocols to implement such policies in the form of message exchanges.

Outcomes: At the end of the course, the students are able to understand the

1. Basic concepts and goals of Information security such as Confidentiality, Integrity, Authentication, Non-Repudiation, Authorization, and Availability and their relevance in various Contexts.
2. Classical cryptosystems and techniques used to break them.
3. Ideas of public key cryptosystems and digital signature schemes
4. Different network issues as well as database security issues and the solutions for them through firewall, intrusion detection system
5. Critical evaluation of a range of access control and authentication mechanisms
6. Legal privacy and ethical issues in computer security

Unit I

Introduction: History, critical characteristics of information, NSTISSC SECURITY MODEL, Components of an information system, securing the components, balancing security and access, The SDLC, The Security SDLC

Need for security: Business needs, Threats, Attacks-secure software development

Unit II

Legal, Ethical and Professional Issues: Law and Ethics information security, relevant U.S. laws, international laws and legal bodies, Ethics and information security

Risk Management: Overview, Risk Identification, risk assessment, Risk Control Strategies, selecting a risk control strategy, Quantitative versus qualitative risk control practices, Risk Management discuss points, recommended risk control practices

Unit III

Planning for security: Security policy, standards and practices, security blue print, security education, continuity strategies, Security technology

Firewalls and VONs: Physical design, firewalls, protecting remote connections

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Unit IV

Security Technology: Intrusion detection, access control and other security tools, Intrusion detection and prevention systems, scanning and analysis tools, access control devices

Cryptography: Foundations of cryptology, cipher methods, crypryptographic algorithms, cryptographic tools, protocols for secure communications, attacks on cryptosystems

Unit V

Implementing Information Security: Information security project management, technical topics of implementation, Non-technical aspects of implementation, security certification and accreditation,

Security and personnel: Positioning and staffing security function, Employment policies and practices, internal control strategies

Information Security Maintenance: Security management models, the maintenance model, digital forensics

Text Books:

1. Michael E. Whitman and Hebert J. Mattord, *Principles of Information Security*, 4th edition, Ed. Cengage Learning, 2011
2. Thomas R. Peltier, Justing Peltier, John Blackley, *Information Security Fundamentals*, Auerbacj Publications, 2010

Suggested Reading:

1. Detmar W Straub, Seymor Goodman, Richard L Baskerville, *Information Security Policy Processes and Practices*, PHI, 2008
2. Marks Merkow and Jim Breithaupt, *Information Security, Principle and Practices'*, Pearson Education, 2007
3. Mark Rhodes-Ousley, *Information Security, The Complete Reference* McGraw-Hill Education, New York, 2013
4. Alberts, Christopher and Dorofee, Audrey, *Managing Information Security Risks*: *The OCTAVE Approach* Addision-Wesley Publications, 2003

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With Effect from the Academic Year 2016 - 2017

ME 423

Seminar

Instruction	3 Periods per week
Sessionals	25 Marks
Credits	1

Oral presentation is an important aspect of engineering education. The objective of the seminar is to prepare the student for a systematic and independent study of state of the art topics in a broad area of his /her specialization.

Seminar topics may be chosen by the students with advice from the faculty members. Students are to be exposed to following aspects of seminar presentations.

- Literature survey
- Consolidation of available information
- Power point Preparation
- Technical writing

Each student is required to:

1. Submit a one page synopsis of the seminar talk for display on the notice board.
2. Give twenty(20) minutes presentation through OHP/ PPT/ Slide Projector followed by Ten(10) minutes discussion
3. Submit a report on the seminar topic with list of references and hard copy of the slides.

Seminars are to be scheduled from 3rd week to the last week of the semester and any change in schedule should be discouraged.

For the award of sessional marks students are judged by three (3) faculty members and are based on oral and written presentations as well as their involvement in the discussions during the oral presentation.

Note: Topic of the seminar should be from any peer reviewed recent journal publications.

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ME 901

Project

Instruction	6 Periods per week
Duration of End Examination	Viva Voce
End Examination	100 Marks
Sessionals	50 Marks
Credits	9

Dealing with a real time problem should be the focus of under graduate project.

All projects will be monitored at least four times in the II-semester through individual presentations (Project batch wise).

Every student should maintain a project dairy, wherein he/she needs to record the progress of his/her work and get it signed at least once in a week by the guide(s). If working outside and college campus, both the external and internal guides should sign the same.

Sessional marks should be based on the marks, awarded by a project monitoring committee of faculty members as well as the marks given by the guide.

Common norms are established for final documentation of the project report, the students are directed to download from the website regarding the guidelines for preparing the project report and the project report format.

The project report shall be evaluated for 100 Marks by the External Examiner.

If the project work found inadequate in the end examination, the candidate should repeat the project work with a new problem or improve the quality of work and report it again.

Break up for 100 Marks in the end examination:

1. Power point presentation 30 Marks
2. Thesis/Report preparation 20 Marks
3. Viva-voce 30 Marks

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CBIT MED M4 MTECH

18MT CO1

MATHEMATICS– I

(Common to all branches and except for Bio-Tech)

Instruction	3 L+1T Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation:	30 Marks
Credits	4

Course Objectives:

1. To solve linear system of equations using Matrix Methods.
2. To know the convergence of the Series.
3. To represent the function in series form.
4. To know the Partial Derivatives and use them to interpret the way a function of two variables behaves.
5. To learn Vector Differential Operator and its Physical interpretations on Scalars and vector functions.
6. To solve improper integrals.

Course Outcomes: On the successful completion of this course student shall be able to

1. Solve system of linear equations and identify the Eigen values and Eigen vectors in engineering problems.
2. Check the series convergence.
3. Find the evolutes of the given curves.
4. Expand and find extreme values of functions of two variables.
5. Understanding the significance of gradient, divergence and curl.
6. An ability to solve the problems and interpret in geometrical approach.

UNIT-I: Matrices;

Rank of the matrix, Echelon form, System of linear equations, Linearly dependence and independence of vectors, Eigenvalues, Eigenvectors, Properties of eigenvalues, Cayley-Hamilton theorem, Quadratic forms, Diagonalization of Matrices, Reduction of quadratic form to canonical form by linear transformation, Nature of quadratic forms.

UNIT-II: Sequences and Series:

Definition of Convergence of sequence and series. Tests for convergence of series: comparison test, limit comparison test, D'Alembert ratio test, Raabes test, Cauchy's n^{th} root test, logarithmic test, alternative series, absolute and conditional convergence.

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UNIT-III: Calculus:
Rolle's Theorem, Lagranges Mean value theorem, Cauchy's mean value theorem (without proofs). Curvature, radius of curvature, Evolutes and involutes, Fourier series, half range sine and cosine series.

UNIT-IV: Multivariable Calculus (Differentiation):
Functions of two variables, Partial derivatives, Total differential and differentiability, Derivatives of composite and implicit functions (Chain rule), Change of variables, Jacobian, Higher order partial derivatives, Taylor's series of functions of two variables, Maximum and minimum values of functions two variables, Lagrange's multipliers method.

UNIT-V: Vector Calculus (Differentiation):
Scalar and vector fields, Gradient of a scalar field, Directional derivative, Divergence and Curl of a vector field, vector identities. Improper integrals: Beta and Gamma functions and their properties.

Text Books:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
2. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
3. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.

Suggested Reading:

1. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
2. R.K. Jain, S.R.K. Iyengar, Advanced engineering mathematics Narosa Publications, 5th edition, 2016. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.

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18PY C03

INTRODUCTION TO MECHANICS AND ELECTROMAGNETIC THEORY
(for Civil, Mech & Prod)

Instruction:	3L+1T Hours per Week
Duration of Semester End Examination:	3 Hours
Semester End Examination:	70 Marks
Continuous Internal Evaluation:	30 Marks
Credits:	4

Course Objectives:

The objectives of the course is to make the student

1. Understands the fundamentals of oscillations and ultrasonics.
2. Gains knowledge of rigid body dynamics.
3. Learns the basics of electrostatics.
4. Understands the fundamentals of magnetostatics.
5. Familiar with electromagnetic waves.

Course Outcomes:

At the end of the course, the student will be able to

1. Describe the types of oscillations and analyze them.
2. Develop the concepts of dynamics and apply them to solve the related problems.
3. Analyze the role of different laws in electrostatics.
4. Discuss the significance of magnetostatics.
5. Develop the concepts related to electromagnetic behavior.

UNIT- I :Oscillations:

Simple harmonic motion, Harmonic oscillator; Damped harmonic motion – over-damped, critically damped and lightly- damped oscillators; Forced oscillations and resonance.

Ultrasonics: Production of ultrasonics by piezoelectric and magnetostriction methods – Detection of ultrasonics — Determination of ultrasonic velocity in liquids – Applications.

UNIT-II: Rigid body Dynamics:

Definition and motion of a rigid body in the plane; Rotation in the plane; Kinematics in a coordinate system rotating and translating in the plane; Angular momentum about a point of a rigid body in planar motion; Euler's laws of motion, their independence from Newton's laws, and their necessity in describing rigid body motion; Examples. two-dimensional motion in terms of (a) Angular velocity vector, and its rate of change and (b) Moment of inertia tensor.

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UNIT- III :Electrostatics in Vaccum:
Calculation of electric field and electrostatic potential for a charge distribution; Divergence and curl of electrostatic field; Laplace's and Poisson's equations for electrostatic potential and uniqueness of their solution and connection with steady state diffusion and thermal conduction, Boundary conditions of electric field and electrostatic potential.

UNIT - IV : Magnetostatics:
Bio-Savart law, Divergence and curl of static magnetic field; vector potential and calculating it for a given magnetic field using Stokes' theorem; the equation for the vector potential and its solution for given current densities: ferromagnetic, paramagnetic and diamagnetic materials, B-H curve.

UNIT- V : Electromagnetic Waves:
The wave equation; Plane electromagnetic waves in vacuum, their transverse nature and polarization; relation between electric and magnetic fields of an electromagnetic wave; energy carried by electromagnetic waves, Maxwell's equation in vacuum and non-conducting medium; Energy in an electromagnetic field; Flow of energy and Poynting vector with examples.

TEXT BOOKS:

1. B.K. Pandey and S. Chaturvedi, *Engineering Physics*, Cengage Publications, 2012.
2. M.N. Avadhanulu and P.G. Kshirsagar, *A Text BookEngineering Physics*, S. Chand Publications, 2014.
3. M. Arumugam, *Materials Science*, Anuradha Publications, 2015.
4. S.L. Gupta and Sanjeev Gupta, *Modern Engineering Physics*, Dhanpat Rai Publications, 2011.

SUGGESTD READING:

1. R. Murugeshan and Kiruthiga Sivaprasath, *Modern Physics*, S. Chand Publications S. Chand Publications, 2014.
2. V. Rajendran, *Engineering Physics*, McGahill Education Publications, 2013.
3. P.K. Palanisamy, *Engineering Physics*, Scitech Publications, 2012.
4. V. Raghavan, *Materials Science and Engineering*, Prentice Hall India Learning Private Limited; 6th Revised edition, 2015.

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Pl. check the word.

18CS C01

Programming for Problem Solving
(Common to All Programs)

Instruction	3 Periods per week
Duration of Semester-End Examination	3 Hours
Semester-End Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives

1. Identification of computer components, Operating environments, IDEs
2. Understanding the steps in problem solving and formulation of algorithms to problems.
3. Develop programming skills as an means of implementing an algorithmic solution with appropriate control anddata structures.
4. Develop intuition to enable students to come up with creative approaches to problems.
5. Manipulation of text data using files.

Course Outcomes: At the end of the course, students will be able to:

1. Identify the computing environments.
2. Formulate solutions to problems and represent them using algorithms/ Flowcharts.
3. Choose proper control statements and data structures to implement the algorithms.
4. Trace the programs with test the program solution.
5. Decompose a problem into modules and use functions to implement the modules.
6. Develop applications using file I/O.

UNIT -I

Introduction to computers and Problem Solving: Components of a computer, Operating system, compilers, Program Development Environments, steps to solve problems, Algorithm, Flowchart / Pseudocode with examples.

Introduction to programming: Programming languages and generations, categorization of high level languages.

Introduction to C: Introduction, structure of C program, keywords, identifiers, Variables, constants, I/O statements, operators, precedence and associativity.

UNIT – II

Introduction to decision control statements: Selective, looping and nested statements.

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Functions: Introduction, uses of functions, Function definition, declaration, passing parameters to functions, recursion, scope of variables and storage classes.

Case study:

UNIT – III

Arrays: Introduction, declaration of arrays, accessing and storage of array elements, 1-dimensional array, Searching (linear and binary search algorithms) and sorting(selection and Buble) algorithms, 2-D arrays, matrix operations.

Strings: Introduction, stringsrepresentation, string operations with examples.

Case study:

UNIT – IV

Pointers: Understanding computer's memory, introduction to pointers, declaration pointer variables, pointer arithmetic, pointers and strings, array of pointers, function pointers, array of function pointers, dynamic memory allocation, advantages and drawbacks of pointers.

Structures: Structure definition, initialization and accessing the members of a structure, nested structures, structures and functions, self- referential structures, unions and enumerated data types.

UNIT-V

Files: Introduction to files, file operations, reading data from files, writing data to files, error handing during file operations.

Preprocessor Directives: Types of preprocessor directives, examples.

Suggested Reading:

1. AK Sharma "**Computer Fundamentals and Programming**", 2nd Edition, University Press, 2018.
2. PradeepDey and Manas Ghosh, "**Programming in C**", Oxford Press, 2nd Edition, 2017.

References:

1. Byron Gottfried, Schaum's"**Outline of Programming with C**", McGraw-Hill.
2. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.
3. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill.
4. ReemaTharaja "**Introduction to C Programming**", Second Edition, OXFORD Press,2015.
5. https://www.tutorialspoint.com/cprogramming/index.htm
6. https://onlinecourses.nptel.ac.in/noc18-cs10/preview.

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18EG C01

ENGLISH

(Common to all branches)

Instruction	2Hours per week
Duration of Semester End Examination	2 Hours
Semester End Examination	50 Marks
Continuous Internal Evaluation:	20 Marks
Credits	2

Course Objectives:

1. To enable the students to understand the role and importance of communication and to develop their basic communication skills in English.
2. To equip the students with basics of writing correct sentences to coherent paragraphs.
3. To equip the students with techniques of writing a précis and an essay by using accurate grammar and appropriate vocabulary.
4. To train the students to describe, define and classify processes and to draft formal reports by adhering to the proper structure.
5. To develop the reading skills and reading comprehension techniques of the students.
6. To develop the students reading, writing, grammatical, lexical and communicative competence.

Course Outcomes:

1. The students will understand the nature, process and types of communication and will communicate effectively without barriers.
2. The students will write correct sentences and coherent paragraphs.
3. The students will know how to condense passages by writing précis and write essays by using accurate grammar and appropriate vocabulary.
4. The students will demonstrate advanced writing skills by drafting formal reports.
5. The students will apply their reading techniques and analyze reading comprehension passages.
6. The students will become effective communicators and will display their advanced skills of reading and writing and use correct grammar and appropriate vocabulary in all contexts.

UNIT-IUnderstanding Communication in English:

Introduction, nature and importance of communication.Process of communication.Basic types of communication - verbal and non-verbal.Barriers to communication.Intrapersonal and interpersonal communication.Johari Window

Vocabulary &Grammar: The concept of Word Formation. Importance of proper punctuation.Articles.

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UNIT- II Developing Writing Skills I:
Types of sentences.Use of phrases and clauses in sentences.Cohesion and coherence.Paragraph writing.Organizing principles of paragraphs in documents.Vocabulary & Grammar: Cohesive devices. Root words from foreign languages and their use in English. Prepositions.

UNIT- III Developing Writing Skills II:
Techniques for writing precisely. Précis Writing. Essay Writing.
Vocabulary and Grammar: Subject-verb agreement, Noun-pronoun agreement Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives, Redundancies, Clichés.

UNIT- IV Developing Writing Skills III:
Describing, Defining, Classifying, Providing examples or evidence.Writing introduction and conclusion.
Report writing – Importance, structure and elements of style of formal reports.
Vocabulary and Grammar: Misplaced modifiers. Synonyms, antonyms.

UNIT-VDeveloping Reading Skills:
The reading process, purpose, different kinds of texts. Reading comprehension.Techniques of comprehension – skimming, scanning, drawing inferences and conclusions.
Vocabulary and Grammar : Words often Confused. Standard abbreviations.

Text Books:

1. Language and Life: A Skills Approach, Board of Editors, Orient Black Swan, 2017.
2. Swan Michael,Practical English Usage.OUP. 1995.

Suggested Readings:

1. Wood F.T,Remedial English Grammar, Macmillan,2007
2. Zinsser William,On Writing Well, Harper Resource Book, 2001
3. Sanjay Kumar and PushpLata,Communication Skills.Oxford University Press, 2011.

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18PY C06

MECHANICS AND ELECTROMAGNETIC LABORATORY
(for Civil, Mech & Prod)

Instruction:	3 Hours per Week
Duration of Semester End Examination:	3 Hours
Semester End Examination:	50 Marks
Continuous Internal Evaluation:	25 Marks
Credits:	1.5

Course Objectives:

The objectives of the course is to make the student

1. Apply theoretical physics knowledge in doing experiments.
2. Understand the various kinds of oscillators.
3. Analyze the behavior of magnetic and dielectric materials.

Course Outcomes:

At the end of the course, the student will be able to

1. Understand the concept of errors and find the ways to minimize the errors
2. Demonstrate the various kinds of oscillations.
3. Determine the loss of energy of a ferromagnetic material and its uses in electrical engineering .
4. Understand the suitability of dielectric materials in engineering applications.
5. Use LCR circuits in different applications.

Experiments

1. *e/m* of Electron by Thomson's Method.
2. B-H curve – Determination of Hall coefficient, carrier concentration & mobility of charge carriers of given semiconductor specimen.
3. Stewart & Gee's.
4. Mutual induction.
5. Dielectric constant – Determination of dielectric constant of given PZT sample.
6. Error analysis – Estimation of errors in the determination of time period of a torsional pendulum.
7. Helmholtz's resonator.
8. Compound pendulum.
9. Flywheel.
10. Coupled oscillator.
11. LCR circuit.
12. Melde's experiment.
13. Young's modulus.
14. Viscosity by oscillating disc (Lamp scale method).

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15. Ultrasonic interferometer – Determination of velocity of ultrasonics in a given liquid.

SUGGESTED READING:

1. *Engineering Physics Manual* by Department of Physics, CBIT, 2016.
2. S.K. Gupta, *Engineering Physics Practical*, Krishna's Educational Publishers, 2014.
3. O.P. Singh, V. Kumar and R.P. Singh, *Engineering Physics Practical Manual*, Ram Prasad & Sons Publications, 2009.
4. Indu Prakash, Ram Krishna and A.K. Jha, *A Text Book of Practical Physics*, Kitab Mahal Publications, 2012.

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18CS C02

Programming for Problem Solving
(Programming Lab – I)
(Common to All Programs)

Instruction	4 Periods per week
Duration of Semester-End Examination	3 Hours
Semester-End Examination	50 Marks
Sessional	25 Marks
Credits	2

Course Objectives

1. Setting up programming environment.
2. Develop Programming skills to solve problems.
3. Use of appropriate C programming constructs to implement algorithms.
4. Identification and rectification of coding errors in program.
5. Develop applications in a modular fashion.
6. Manage data using files.

Course Outcomes:

At the end of the course students will be able to:

1. Identify and setup program development environment.
2. Implement the algorithms using C programming language constructs.
3. Identify and rectify the syntax errors and debug program for semantic errors.
4. Analyze the results to evaluate the solutionsof the problems.
5. Solve problems in amodular approach using functions.
6. Implement file operations with simple text data.

Lab experiments

1. Familiarization with programming environment.
2. Simple computational problems using arithmetic expressions.
3. Problems involving if-then-else structures.
4. Iterative problems e.g., sum of series.
5. 1D Array manipulation.
6. 2D arrays and strings.
7. Matrix problems, String operations.
8. Simple functions.
9. Recursive functions.
10. Pointers and structures.
11. Dynamic memory allocation and error handling.
12. File handling.

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Design the experiments in such a way that the students will be able to end up the solution for a real world problem that uses most of the concepts of C programming language. For example: A banking application where it uses the concepts of operators, control structures, switch case for menu, structures, functions, error handling, files etc.

Suggested Reading:

1. Pradeep Dey and Manas Ghosh, "**Programming in C**", Oxford Press, 2nd Edition, 2017.
2. ReemaTharaja "**Introduction to C Programming**", Second Edition, OXFORD Press,2015.

References:

1. https://www.tutorialspoint.com/cprogramming/index.htm
2. https://www.w3resource.com/c-programming/programming-in-c.php
3. https://www.w3schools.in/c-tutorial/

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18ME C02

WORKSHOP/ MANUFACTURING PRACTICE

Instruction	1T+4P Hours per week
Duration of End Examination	3 Hours
Semester End Examination	50 Marks
Continuous Internal Evaluation:	25 Marks
Credits	3

Course Objectives:

1. Give a feel of Engineering Practices & develop holistic understanding of various Engineering materials and Manufacturing processes.
2. Develop skills of manufacturing, safety, precision, quality, intelligent effort, optimization, positive & team work attitude to get things right the first time.
3. To provide basic knowledge of Steel, Plastic, Composite and other materials for suitable applications.
4. Study of Principle and hands on practice on techniques of fabrication, welding, casting, manufacturing, metrology, and allied skills.
5. To advance important hard & pertinent soft skills, productivity, create skilled manpower which is cognizant of industrial workshop components and processes and can communicate their work in a technical, clear and effective way.
6. Engineering Skill development with regard to making components, system integration and assembly to form a useful device.

Course Outcomes – (Laboratory): Student will be able to

1. Fabricate components with their own hands.
2. Get practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.
3. Assembling different components, student will be able to produce small mechanisms/devices of their interest.
4. Gain practical skills of carpentry, tinsmithy, fitting, house wiring.
5. Gain knowledge of different Engineering Materials and Manufacturing Methods.
6. Understand trades and techniques used in Workshop and chooses the best material/ manufacturing process for the application.

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List of Exercises

CYCLE 1

Exercises in Carpentry

1. To plane the given wooden piece to required size
2. To make a lap joint on the given wooden piece according to the given dimensions.
3. To make a dove tail-joint on the given wooden piece according to the given dimensions.

Exercises in Tin Smithy

4. To make a rectangular box from the given sheet metal with base and top open. Solder the corners.
5. To make a scoop.
6. To make a pamphlet box.

Exercises in Fitting

7. To make a perfect rectangular MS flat and to do parallel cuts using Hack saw
8. To make male and female fitting using MS flats-Assembly1
9. To make male and female fitting using MS flats-Assembly2

Exercises in House Wiring

10. Wiring of one light point controlled by one single pole switch, a three pin socket controlled by a single pole switch, and wiring of one buzzer controlled by a bell push
11. Wiring of two light points connected in series and controlled by single pole switch. Verify the above circuit with different bulbs. Wiring of two light points connected in parallel from two single pole switches and a three pin socket
12. Stair case wiring-wiring of one light point controlled from two different places independently using two 2-way switches.

CYCLE 2

Exercises in Casting

1. Study of Sand casting processand its applications.
2. Green sand moulding practice for a single piece pattern
3. Green sand moulding practice for a split pattern with a horizontal core

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Exercises in Welding

4. Study of gas welding equipment and process. Identification of flames, makingof Butt joint with gas welding.
5. Study of Arc welding process, making Butt joint with DCSP, DCRP
6. Study of Arc welding process, making Lap joint with A.C

Exercises in Machine shop

7. Study of Machine Tools like Lathe, Drilling, Milling and Shaper.
8. Facing, Plain turning and Step turning operations on Lathe machine.
9. Knurling and Taper turning on Lathe machine

Open ended Exercise:

1. Student should produce a component /mechanism by applying the knowledge of any one trade or combination of trades.

TextBooks:

(i) HajraChoudhury S.K., HajraChoudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.

(ii) Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology",4th edition, Pearson Education India Edition, 2002.

Suggested Reading:

(i) Gowri P. Hariharan and A. Suresh Babu,"Manufacturing Technology –I" Pearson Education, 2008.

(ii) Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.

(iii) Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGrawHill House, 2017.

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18EG C02

ENGLISH LAB

(Common to all branches)

Instruction	2 Hours per week
Duration of Semester End Examination	2 Hours
Semester End Examination	35 Marks
Continuous Internal Evaluation:	15 Marks
Credits	1

Course Objectives:

1. To introduce students to phonetics and the different sounds in English.
2. To familiarize the students with the software and give them sufficient practice in correct pronunciation.
3. To enable students to speak English correctly with focus on stress and intonation.
4. The students will enhance their listening skills by practicing IELTS and TOEFL material.
5. To help students overcome their inhibitions while speaking in English and to build their confidence. The focus shall be on fluency rather than accuracy.
6. To help students to understand team work, role behavior and to develop their ability to discuss in groups and make oral presentations.

Course Outcomes:

1. The students will differentiate the speech sounds in English.
2. The students will interact with the software and understand the nuances of pronunciation in English.
3. The students will speak with the proper tone, intonation and rhythm and apply stress correctly.
4. The students will demonstrate their listening skills by analyzing the IELTS and TOEFL listening comprehension texts.
5. The students will speak with clarity and confidence.
6. The students will work in teams and discuss various topics and demonstrate their presentation skills through posters.

Exercises

1. **Introduction to English Phonetics**: Introduction to auditory, acoustic and articulatory phonetics, organs of speech: the respiratory, articulatory and phonatory systems.
2. **Sound system of English**: Phonetic sounds and phonemic sounds, introduction to international phonetic alphabet, classification and description of English phonemic sounds, minimal pairs . The syllable: types of syllables, consonant clusters.
3. **Word stress**: Primary stress, secondary stress, functional stress, rules of word stress.

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4. **Rhythm &Intonation** : Introduction to Rhythm and Intonation. Major patterns, intonation of English with the semantic implications.
5. **Listening skills** – practice with IELTS and TOEFL material.
6. **Situational dialogues and role play** – Dialogue writing, – Role behavior and role enactment.
7. **Group Discussions** - Dynamics of a group discussion, group discussion techniques, body language.
8. **Public speaking** – Speaking with confidence and clarity in different contexts on various issues.
9. **Poster presentation** – Theme, poster preparation, team work and presentation.

Suggested Reading

1. T Balasubramanian. A Textbook of English Phonetics for Indian Students, Macmillan, 2008.
2. J Sethi et al. A Practical Course in English Pronunciation (with CD), Prentice Hall India, 2005.
3. PriyadarshiPatnaik. Group Discussions and Interviews, Cambridge University Press Pvt Ltd 201.
4. ArunaKoneru, Professional Speaking Skills, Oxford University Press, 2016.

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18MT CO3

MATHEMATICS– II

(Common to all branches and except for Bio-Tech)

Instruction	3 L+1T Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation:	30 Marks
Credits	4

Course Objectives

1. To evaluate double and triple integrals of various functions and their significance.
2. To evaluate vector line, surface and volume integrals.
3. To know the relevant method to solve higher order differential equations.
4. To evaluate complex integration.
5. To evaluate real and definite integrals.
6. To know the methods to solve real life problems.

Course Outcomes: On the successful completion of this course student shall be able to

1. Find the areas, volumes and surface of solids revolution.
2. Use Greens, Gauss and Stoke's theorems to find the surface and volume integrals.
3. Able to solve solutions of differential equations with initial and boundary value problems.
4. Solve the problems on analytic functions, Cauchy's theorem and Cauchy's integral formula.
5. Real and complex integrals by using Cauchy's theorems.
6. Solve physical and engineering problems.

UNIT-I: Multivariable Calculus (Integration):

Applications of definite integrals to evaluate surface areas and volumes of revolutions. Double integrals, Change of order of integration, Triple integrals, Change of variables in integrals, Applications: areas and volumes, Centre of mass and Gravity (constant and variable densities).

UNIT-II: Vector Integral Calculus:

Line, Surface and Volume integrals, Green's theorem in a plane, Gauss's divergence theorem and Stroke's theorem (without proof).

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First Order Ordinary Differential Equations: Exact first order differential equations , Integrating factors, Linear first order equations , Bernoulli's, Riccati's and Clairaut's differential equations ,Orthogonal trajectories of a given family of curves.

UNIT-III: Ordinarydifferential equations of higher orders:

Solutions of higher order linear equations with constants coefficients, Method of variation of parameters, solution of Euler-Cauchy equation. Ordinary point, singular point and regular singular point, Power Series solution. Legendre Polynomial of first kind (without proof), Rodrigues formula, Generating function, recurrence relations, orthogonality of Legendre polynomials, Bessel's function of first kind (without proof), recurrence relations and problems.

UNIT- IV: Complex Variables –I :

Differentiation, analytic functions, Cauchy-Riemann equations, harmonic functions, finding harmonic conjugate, elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties. Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof).

UNIT- V: Complex Variables – II:

Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, Laurent's series, zeros of analytic functions, singularities, Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine. Improper real integrals with singular points on the upper half plane.

Text Books:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
2. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

Suggested Reading:

1. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
2. R.K. Jain, S.R.K. Iyengar, Advanced engineering mathematics Narosa Publications,5th edition,2016.
3. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.

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18CY C01

CHEMISTRY

(Common to all branches)

Instruction:	3L+1T Hours per Week
Duration of Semester End Examination:	3 Hours
Semester End Examination:	70 Marks
Continuous Internal Evaluation:	30 Marks
Credits:	4

Course Objectives

1. The aim of framing the syllabus is to impart intensive and extensive knowledge of the subject so that students can understand the role of chemistry in the field of engineering.
2. This syllabus helps at providing the necessary introduction of the inorganic chemistry principles and concepts of chemical bonding involved in a comprehensive manner understandable to the students aspiring to become practicing engineers.
3. Thermodynamic and Electrochemistry units give conceptual knowledge about spontaneous processes and how can they be harnessed for producing electrical energy and efficiency of systems.
4. To teach students the value of chemistry and to improve the research opportunities knowledge of stereochemistry and organic reactions is essential.
5. New materials lead to discovering of technologies in strategic areas like defense and space research for which an insight into nano and composite materials of modern chemistry is essential.

Course Outcomes

The concepts developed in this course will aid in quantification of several concepts in chemistry that have been introduced at the 10+2 levels in schools. Technology is being increasingly based on the electronic, atomic and molecular level modifications. Quantum theory is more than 100 years old and to understand phenomena at nanometer levels; one has to base the description of all chemical processes at molecular levels. The course will enable the student to:

1. Analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.
2. Rationalize bulk properties and processes using thermodynamic considerations & Ionic Equilibria.
3. List major chemical reactions that are used in the synthesis of molecules.
4. Apply the various methods used in treatment of water for domestic and industrial use.

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5. Discuss the various Engineering materials & Drug synthesis & their applications.

UNIT-I Atomic and molecular structure:

Molecular Orbital theory - atomic and molecular orbitals.Linear combination of atomic orbitals (LCAO) method. Molecular orbitals of diatomic molecules. Energy level diagrams of diatomics (H_2, He_2^+, N_2, O_2, O_2^-, CO, NO). Pi- molecular orbitals of butadiene , benzene and their aromaticity. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties.

UNIT-II Use of free energy in chemical equilibria and Ionic Equilibria:

Use of free energy in chemical equilibria : Thermodynamic functions: Internal energy, entropy and free energy. Significance of entropy and free energy(criteria of spontaneity).Free energy and emf (Gibbs Helmholtz equations and its applications). Cell potentials –electrochemical series.Nernst equation and its applications.Potentiometric Acid base & Redox Titrations.Numericals.

Ionic Equilibria: Solubility product, Determination of solubility product, Applications of solubility product- Determination of solubilities of sparingly soluble salts; Predicting precipitation reactions; Precipitation of an insoluble salt; Precipitation of soluble salts ; Inorganic analysis .Numericals.

UNIT- III Stereochemistry and Organic reactions

Stereochemistry: Representations of 3 dimensional structures , Symmetry and chirality, Stereoisomers - Configurational isomers (Geometrical&Optical isomers), Conformational isomers - Newman and sawhorse representations of n-butane ,enantiomers (lactic acid), diastereomers (Tartaric acid) , optical activity, absolute configurations , Sequence rules for R&S notation.

Organic reactions

Types of Organic reactions:

Substitution Reactions- Electrophilic substitution (Nitration of Benzene) ;Nucleophilic Substitution(S_N1& S_N2) ; Free Radical Substitution(Halogenation of Alkanes)

Additions Reactions:

Electrophilic Addition – Markonikoff's rule

Nucleophilic Addition – (Addition of HCN to carbonyl compounds)

Free radical Addition - Anti Markonikoff's rule (Peroxide effect)

Eliminations-E_1 and E_2 (dehydrohalogenation of alkyl halides)

Oxidation with $KMnO_4$, $K_2Cr_2O_7$; **Reduction** with $LiAlH_4$,$NaBH_4$

Cyclization (Diels - Alder reaction)

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UNIT–IV Water Chemistry:

Hardness of water – Types, units of hardness, Disadvantages of hard water , Boiler troubles - scales & sludge formation , causes and effects , Softening of water by ion exchange method and Reverse Osmosis. Specifications of potable water & industrial water. Disinfection of water by Chlorination , Ozonisation & UV radiation.

UNIT-V Engineering Materials and Drugs:

Nano materials-Introduction to nano materials and general applications, basic chemical methods of preparation- Sol gel method. Carbon nanotubes and their applications.

Composite materials- Definition, types of composites, fibre reinforced, glass fibre reinforced and carbon fibre reinforced composites and applications.

Conducting polymers- Definition, classification and applications.

Drugs-Introduction,Synthesis and uses of Aspirin (analgesic), Paracetamol (Antipyretic), Atenolol (antihypertensive).

TEXT BOOKS

1. P.C. Jain and M. Jain, "Engineering Chemistry", Dhanpat Rai Publishing Company Ltd., New Delhi,16th edition (2015).
2. W.U. Mali, G.D.Tuli and R.D.Madan, "Selected topics in Inorganic Chemistry", S Chand & Company Ltd, New Delhi, reprint (2009).
3. R.T. Morrison, R.N. Boyd and S.K. Bhattacharjee, "Organic Chemistry", Pearson, Delhi, 7th edition(2011).
4. G.L. David Krupadanam, D. Vijaya Prasad, K. Varaprasad Rao, K.L.N. Reddy and C. Sudhakar, "Drugs", Universities Press (India) Limited, Hyderabad (2007).

SUGGESTED READINGS

1. B. H. Mahan, "University Chemistry", Narosa Publishing house, New Delhi, 3rd edition (2013).
2. B.R. Puri, L.R. Sharma and M.S. Pathania, "Principles of Physical Chemistry", S. Nagin Chand & CompanyLtd.,46th edition(2013).
3. T.W. Graham Solomons, C.B. Fryhle and S.A. Snyder, "Organic Chemistry", Wiley,12th edition (2017).
4. P.W. Atkins, J.D. Paula, "Physical Chemistry", Oxford, 8thedition (2006).

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18CE C01

ENGINEERING MECHANICS

Instruction:	3L+1T Hours per Week
Duration of Semester End Examination:	3 Hours
Semester End Examination:	70 Marks
Continuous Internal Evaluation:	30 Marks
Credits:	4

Course Objectives:

1. The objective of this course is to understand the resolution of forces and to obtain resultant of all force systems, to understand moment of a force and equilibrium conditions of static loads for smooth and frictional surface
2. To obtain centroid, centre of gravity and moment of inertia for various regular and composite areas and bodies.
3. To understand the basic structural analysis, principles of virtual work and energy methods.
4. To know the basic concepts of dynamics and analysis as a particle and rigid bodies.
5. To understand the work energy principles, impulse momentum and their applications and to know the concept of simple harmonic motion and free vibration.

Course Outcomes: The students will be able to

1. Solve problems dealing with forces in plane and space force systems, draw free body diagrams to analyze various problems in equilibrium, for smooth and frictional surface.
2. Determine centroid and moment of inertia for elementary, composite areas and bodies.
3. Analyze simple trusses for forces in various members of a truss.
4. Solve problem in kinematics and kinetics of particles and rigid bodies.
5. Analyze body motion using work energy principles, impulse and momentum approach and able to apply the concepts of simple harmonic motion and free vibrations in dynamics.

Unit–I: Resolution, Resultant and Equilibrium of force system and Friction:
Concepts of force, System of forces, components of forces in a plane and in space systems.Resultant of force systems.Moment of forces and its applications.Couples and its applications.Equilibrium of Force systems. Free body diagrams, equation of equilibrium of coplanar and spatial force systems. Static indeterminacy. Types of friction, Laws of friction, application of friction to a single body & connecting systems, wedge friction.

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Unit–II: Centroid, centre of gravity and moment of Inertia:
Centroid of simple figures from first principle, centroid of composite sections. Centre of gravity and its implications, Definition of Area moment of Inertia, Moment of inertia of plane section from first principles, Theorems of moment of inertia, moment of inertia of standard sections and composite sections, Mass moment of inertia of rectangular and circular plates, cylinder, cone & sphere.

Unit–III: Analysis of simple trusses, Virtual work and Energy methods:
Analysis of simple trusses using method of joints, methods of sections. Determine if a member is in tension or compression, zero force members. Virtual displacements, Principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom.Conservative forces and potential energy, energy equation for equilibrium.

Unit–IV: Particle Dynamics:
Rectilinear and curvilinear translation using rectangular, normal and tangential components.Relative and constrained motion. Newton's 2nd Law, rectangular and path coordinates. Basic terms, general principles in dynamics, D'Alembert's principle and its application in plane motion and connected bodies.Instantaneous centre of rotation in plane motion and simple problems.

Unit–V: Work- Energy, Impulse-momentum and Mechanical Vibrations:
Equation of work energy for translation and fixed axis rotation, work energy principles applied to particle motion, connected systems. Introduction to linear impulse momentum, principle of conservation of linear momentum, Impact, direct and oblique. Introduction to vibration, free and forced vibrations, simple harmonic motion, simple pendulum and compound pendulum.

Text Books:

1. Reddy Vijaykumar K. and J. Suresh Kumar," Singer's Engineering Mechanics Statics and Dynamics", B. S. Publications 2011.
2. A. Nelson, "Engineering Mechanics", Tata McGraw Hill, New Delhi, 2010.

Suggested Reading:

1. Irving H. Shames, "Engineering Mechanics", 4th Edition, Prentice Hall, 2006.
2. F. P. Beer and E. R .Johnson, "Vector Mechanics for engineers, Vol. I - Statics, Vol. II - Dynamics", 9th edition, Tata McGraw Hill, 2011.
3. R. C. Hibbeler, "Engineering Mechanics: Principles of Statics and Dynamics", Pearson Press, 2006.

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18ME C01

ENGINEERING GRAPHICS AND DESIGN

Instruction	1T+4D Hours per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation:	30 Marks
Credits	3

Course Objectives:

1. to prepare to design a system, component, or process to meet desired needs within realistic constraints.
2. to prepare the student to communicate effectively.
3. to prepare the student to use the techniques, skills, and modern. engineering tools necessary for engineering practice.
4. to get exposure to a CAD package.

Course Outcomes:

1. Introduction to engineering design and its place in society.
2. Exposure to the visual aspects of engineering design.
3. To become familiar with engineering graphics standards.
4. Exposure to solid modelling.
5. Exposure to computer-aided geometric design.
6. Exposure to creating working drawings.
7. Exposure to engineering communication.

Detailed contents

Traditional Engineering Graphics:

Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Perspective; Reading a Drawing; Sectional Views;
Dimensioning & Tolerances; True Length, Angle; intersection, Shortest Distance.

Computer Graphics:

Engineering Graphics Software; -Spatial Transformations; Orthographic Projections; Model Viewing; Coordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modeling; Solid Modeling; Introduction to Building Information Modeling (BIM).

(Except the basic essential concepts, most of the teaching part can happen concurrently in the laboratory).

UNIT-1 Introduction to Engineering Drawing:

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute;

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UNIT-2 Orthographic Projections:

Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes (without traces) ; Projections of planes inclined Planes;

Introduction to CAD package:

Listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids.

UNIT-3 Projections of Regular Solids:

Projection of Prism, Cylinder, Pyramid and Cone : Simple position, axis inclined to one of the reference plane only. Customization & CAD Drawing: consisting of set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;

UNIT-4 Sections and Sectional Views of Right Angular Solids:

Sections of solids in simple position Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids.

Annotations, layering & other functions:

applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); rinting documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer-aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and twodimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multi view, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling;

UNIT-5 Isometric Projections:

Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Viceversa, Conventions;

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Demonstration of a simple team design project:
Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; geometric dimensioning and tolerancing;
Use of solid-modeling software for creating associative models at the component and assembly levels; (Examples of specific components to the branch of study may be included).

Text Books:

1. N.D.Bhatt, Elementary Engineering Drawing, Charotar Publishers,2012.
2. K.L.Narayana and P.K.Kannaiah, –Text Book of Engineering Drawing Scitech Publications, 2011.
3. Basanth Agrawal and C M Agrawal –Engineering Drawing 2e –, McGraw-Hill Education(India) Pvt.Ltd.

Suggested Reading:

1. Shaw M.B and Rana B.C., –Engineering drawing Pearson, 2ndedition, 2009.
2. K.Veenugopal, –Engineering Drawing and Graphics + Autocad New Age International Pvt.Ltd,2011.
3. Bhattacharya. B, –Engineering Graphics I. K. International Pvt.Ltd, 2009.

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18EE C01

BASIC ELECTRICAL ENGINEERING

Instruction:	3L+1T Hours per Week
Duration of Semester End Examination:	3 Hours
Semester End Examination:	70 Marks
Continuous Internal Evaluation:	30 Marks
Credits:	4

Course Objectives:

1. To understand the behavior of different circuit elements R,L & C, and the basic concepts of electrical circuit analysis.
2. To know the concepts of AC circuits, RMS value, Average value, Phasor analysis etc., 3. To understand the basic principle of operation of Transformer and DC machines.
4. To understand the basic principle of operation of DC machines and AC machines.
5. To know about different types of electrical wires and cables, domestic and industrial wiring.
6. To understand safety rules and methods of earthing.

Course Outcomes: At the end of the course, the student will be able to

1. Acquire the concepts of Kirchhoff's laws and network theorems and able to get the solution of simple dc circuits.
2. Obtain the steady state response of RLC circuits and also determine the different powers in AC circuits.
3. Acquire the concepts of principle of operation of Transformers and DC machines.
4. Acquire the concepts of principle of operation of DC machines and AC machines.
5. Acquire the knowledge of electrical wiring and cables and electrical safety precautions.
6. Recognize importance of earthing and methods of earthing and electrical installations.

UNIT-I: DC Circuits

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation, Superposition, Thevenin and Norton Theorems, Time-domain analysis of first order RL and RC circuits.

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UNIT-II: AC Circuits

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor, Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel). Three phase balanced circuits, voltage and current relations in star and delta connections.

UNIT-III: Transformers

Construction, Working principle, EMF Equation, Ideal and Practical transformer, Equivalent circuit of Transformer, OC and SC tests on a transformer, Efficiency and Regulation, Auto transformer

UNIT-IV: DC and AC Machines

DC Generators: Construction, Principle of operation, EMF equation, Classification, Characteristics of shunt, series and compound generators. DC Motors: Classification, Torque equation, Characteristics, Efficiency, Speed Control of Series and Shunt Motors. Three - Phase Induction Motors: Construction, Principle of operation, Torque equation, torque-slip characteristics, Power stages, speed control of induction motors.

UNIT-V: Electrical Installations

Electrical Wiring: Types of wires and cables, Electrical Safety precautions in handling electrical appliances, electric shock, first aid for electric shock, safety rules. Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Earthing, Elementary calculations for energy consumption.

Text books:

1. L. S. Bobrow, Fundamentals of Electrical Engineering, Oxford University Press, 2011.
2. E. Hughes, Electrical and Electronics Technology, Pearson, 2010.

Suggested Reading:

1. D. P. Kothari & I. J. Nagrath, –Basic Electrical Engineering .Tata McGraw Hill, 2010.
2. V. D. Toro, –Electrical Engineering Fundamentals Prentice Hall India, 1989.
3. D.C. Kulshreshtha, –Basic Electrical Engineering McGraw Hill,2009
4. P.V.Prasad, S.sivanagaraju, R.Prasad, "Basic Electrical and Electronics Engineering" Cengage Learning, 1st Edition, 2013.

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18EE C02

BASIC ELECTRICAL ENGINEERING LAB

Instruction	2 Hours per week
Duration of Semester End Examination	2 Hours
Semester End Examination	35 Marks
Continuous Internal Evaluation:	15 Marks
Credits	1

Course Objectives:

1. To acquire the knowledge of different types of electrical elements.
2. To verify the basic electrical circuit laws and theorems.
3. To determine the parameters and power factor of a coil.
4. To calculate the time and frequency responses of RLC circuits
5. To determine the characteristics of Transformers.
6. To determine the characteristics of dc and ac machines.

Course Outcomes: At the end of the course, the students are expected to

1. Get an exposure to common electrical components and their ratings.
2. Make electrical connections by wires of appropriate ratings.
3. Understand the circuit analysis techniques.
4. Determine the parameters of the given coil.
5. Understand the basic characteristics of transformer.
6. Understand the basic characteristics of dc and ac machines.

List of Laboratory Experiments/Demonstrations:

1. Demonstration of Measuring Instruments and Electrical Lab components
2. Verification of KCL and KVL.
3. Time response of RL and RC circuits.
4. Calculation of permittivity of a choke or coil by Wattmeter Method.
5. Verification of Thevenin's and Norton's theorems.
6. Turns ratio /voltage ratio verification of 1-Ph Transformers.
7. OC and SC tests on a given 1-Ph Transformer.
8. Observation of Excitation Phenomenon in Transformer.
9. Measurement of 3-Ph power in a balanced system (By 2- Wattmeter method).
10. Measurement of 3-Ph Energy by an Energy Meter (Demonstration of Principle).
11. Load test of DC Shunt motor.
12. Speed control of DC Shunt motor.
13. Load test of 3-Ph Induction motor.
14. Demonstration of LT Switchgear Equipment/Components.
15. Demonstration of cut - out section of Machines like DC Machine, Induction Machine, etc.

Note: at least **TEN** experiments should be conducted in the semester.

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18CY C02

CHEMISTRY LAB

(Common to all branches)

Instruction:	3 Hours per Week
Duration of Semester End Examination:	3 Hours
Semester End Examination:	50 Marks
Continuous Internal Evaluation:	25 Marks
Credits:	1.5

Course Objectives

1. To impart fundamental knowledge in handling the equipment / glassware and chemicals in chemistry laboratory
2. The student should be conversant with the principles of volumetric analysis and identification of organic functional groups.
3. To apply various instrumental methods to analyze the chemical compounds and to improve understanding of theoretical concepts.

Course Outcomes

The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering.

The students will learn to:

1. Estimate rate constants of reactions from concentration of reactants/ products as a function of time.
2. Measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water, etc
3. Synthesize a small drug molecule and Identify the organic compounds.
4. understand importance of analytical instrumentation for different chemical analysis.
5. Perform interdisciplinary research such that the findings benefit the common man.

Chemistry Lab

1. Estimation of temporary and permanent hardness of water using EDTA solution.
2. Estimation of amount of chloride in water.
3. Determination of rate constant for the reaction of hydrolysis of methyl acetate (first order).
4. Estimation of amount of HCl Conductometerically using NaOH solution.

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5. Estimation of (a) amount of CH_3 COOH Conductometerically using NaOH solution. (b) amount of HCl and CH_3 COOH present in the given mixture of acids Conductometerically using NaOH solution.
6. Estimation of amount of HCl Potentiometrically using NaOH solution.
7. Estimation of amount of Fe^{+2} Potentiometrically using $KMnO_4$ solution.
8. Distribution of acetic acid between n-butanol and water.
9. Synthesis of drug - Aspirin.
10. Organic Chemistry- Identification of Functional groups - neutral group (carbonyl groups-acetaldehyde and acetone); acidic group(benzoic acid) ; basic group (aniline).
11. Determination of surface tension of organic solvents (ethanol, ethyl acetate).
12. Determination of Viscosity.

TEXT BOOKS

1. J. Mendham and Thomas ,"Vogel' s text book of quantitative chemical analysis", Pearson education Pvt.Ltd., New Delhi , 6th ed. 2002.

SUGGESTED READINGS

1. Dr. Subdharani , "Laboratory Manual on Engineering Chemistry", Dhanpat Rai Publishing, 2012.
2. S.S. Dara , "A Textbook on experiment and calculation in engineering chemistry", S.Chand and Company, 9th revised edition, 2015.

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16MT C05

ENGINEERING MATHEMATICS-III

Instruction	3 Hours per week
Duration of End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course objectives:

1. To study the expansion of functions in various intervals.
2. To form P.D.E and to find its solution.
3. To solve Wave, Heat & Laplace equations.
4. To learn Differentiation and Integration of complex valued functions.
5. To evaluate Complex Integration.
6. To evaluate Real definite integrals.

Course outcomes: On the successful completion of this course the student will be able to

1. Expand functions in the given intervals.
2. Solve linear and non linear PDEs.
3. Solve one-dimension, two-dimension, Heat steady state equations and also one-dimension wave equation.
4. Solve problems on Analytic functions, Cauchy's theorem and Cauchy's integral formula.
5. Expand functions by using Taylor's and Laurent's series.
6. Solve Real and Complex integrals by using Cauchy Theorems.

UNIT – I

Fourier series: Definition of Periodic, Single valued, finite maxima and minima of functions. Euler's Formulae, Dirichlets Conditions for Fourier expansion, Functions having points of discontinuity, Change of interval, Expansion of odd and even functions, Half-range sine series and cosine series.

UNIT-II:

Partial differential equations: Formation of partial differential equations by eliminating the arbitrary constants or arbitrary functions, solutions of linear partial differential equation of first order by using Lagrange's Method, solution of Non-linear partial differential equations of first order by using standard types, Charpit's Method.

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UNIT - III

Applications of Partial differential equations: Solution of partial differential equations by using method of separation of variables, solution of vibration of a stretched string (1D-Wave equation), one dimensional heat equation, Two dimensional heat equation under steady state conditions.

UNIT - IV

Theory of Complex variables: Analytic functions, Cauchy Riemann equations (Cartesian and polar forms), construction of Analytic functions by using Milne-Thomson's method. Harmonic function. Complex line integrals, Cauchy's theorem, Cauchy's Integral formula and its derivatives and problems related to the above theorems.

UNIT - V

Expansion of functions, Singularities & Residues: Taylor's and Laurent's series Expansions (Only statements). Zeros, types of singularities, Residues and Cauchy's Residue theorem, Evaluation of real integrals by Cauchy's residue theorem. Evaluation of improper real integrals of the type: $\int_{-\infty}^{\infty} f(x)dx$ Where f(x) has no poles on real axis and $\int_0^{2\pi} f(\sin\theta, \cos\theta)d\theta$.

Text Books:

1. B.S. Grewal, Higher Engineering Mathematics, 43rd Edition, Khanna Publishers, 2015.
2. M.D. Raisinghania, Advanced Differential equations, 7th edition, S Chand publishers, 2013.
3. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th edition, McGraw Hill publishers, 2003.

Suggested Reading:

1. N P Bali and Manish Goyal, A Text Book of Engineering Mathematics, 9th Edition, Laxmi publishers, 2016.
2. Alan Jeffrey, Mathematics for Engineers and Scientists, 6th Edition, Chapman & Hall/CRC publishers, 2013.
3. A R Vasistha and R K Gupta, Integral transforms, Krishna prakashan publishers, 2004.
4. R.K.Jain & S.R.K.Iyenger, Advanced Engineering Mathematics, 3rd edition, Narosa Publications, 2007.

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16ME C04

MATERIAL SCIENCE AND METALLURGY

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: Students will

1. Enable the student to understand structure property relations, analyze the failures of metals and their prevention.
2. Broad understanding of phase diagrams.
3. Acquire basic knowledge in various heat treatment operations, their purpose and applications.
4. Expose to various methods of extractive metallurgy techniques.
5. Understand various modes of failure and suggest mechanisms for preventions of failures.
6. Understand applications of conventional metals and alloys.

Course Outcomes: On the successful completion of this course the student will be able to

1. Know the fundamental science and engineering principles relevant to material.
2. Suggest appropriate physical metallurgy methods (phase diagrams).
3. The type of heat treatment operation to be given to any metal in order to improve desire Mechanical properties.
4. Basic ability to plan an extraction process for given ore.
5. Suggest the appropriate methods for prevention of failures.
6. To analyze the applications of conventional metals and alloys

UNIT–I

Imperfections in crystals, dislocation in crystals, types of dislocations, effect of slip and twinning on the plastic deformation, cold and hot working, strain hardening and Bauchinger effect, recovery, recrystallization, grain growth and its effect on mechanical properties of metals.

Fracture: Types of fracture in metals, modes of fracture, Griffith theory of brittle fracture, crack propagation, ductile fracture, fracture under combined stress.

UNIT–II

Fatigue: S–N curve, Structure of fatigue fracture specimen. Fatigue crack propagation, effect of metallurgical variables on fatigue of metal, low cycle fatigue, experimental determination of fatigue strength (RR–Moore Test).

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Creep: Creep strength, creep curve, creep deformation mechanisms, creep test.

Diffusion: Fick's law of diffusion, application of diffusion theory in mechanical engineering.

UNIT–III

Structure of Alloys: study of eutectic, eutectoid, peritectic peritectoid reactions, iron–iron carbide equilibrium diagram, construction and interpretation.

Types of plain carbon steels, cast iron and their properties and characteristics.

UNIT–IV

Heat Treatment: Annealing, normalising, hardening, tempering, construction and interpretation of T–T–T diagram, austempering and martempering, case hardening, carburizing, nitriding, carbo–nitriding, flame hardening, induction hardening.

UNIT–V

Introduction to Extractive Metallurgy: Method of production of pig iron by blast furnace, cast iron by cupola furnace, method of production of steel by Bessemer convertor, L.D process, electric arc process.

Alloy Steels: Effects of alloying elements like nickel, chromium, manganese, silicon and tungsten, titanium, study about stainless steels, HSS, brass, bronze their composition and properties.

Text Books:

1. V. Raghavan, Materials Science and Engineering, Prentice Hall of India Ltd., 4th Edn., 2005.
2. S.H. Avner, Introduction to Physical Metallurgy, Tata McGraw Hill Publishers, 2nd Edn., 2005.

Suggested Reading:

1. S.P. Nayak, Engineering Metallurgy and Material Science, Charoter Publishing House, 6th Edn., 2005.
2. E. Dieter, Mechanical Metallurgy, Metric Edition, Tata McGraw Hill, 3rd Edn, 2005.
3. K.L. Kakani, Material Science, New Age Publications (P) Ltd.,2008.

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16ME C05

MECHANICS OF MATERIALS

Instruction	3L+1T Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	4

Pre-Requisites: Engineering Mathematics, Engineering Mechanics.

Course Objectives:

1. Student is exposed to the concept of different types of loads, stresses, strains and analysis of members for axial loads.
2. Student will acquire knowledge in drawing bending and shear force diagrams of beams for various loads.
3. Student becomes familiar with methods of evaluation of deflection of beams of various configurations and stresses that arise due to simple bending.
4. Student is exposed to the concept of principal stresses and phenomenon of torsion.
5. Student will acquire knowledge in estimating stresses for thin and thick cylindrical shells.
6. Student will acquire knowledge in estimating crippling load in buckling for various columns and struts.

Course Outcomes:

Students who successfully complete this course will have demonstrated ability to:

1. Classify the materials, stresses, strains and understand engineering constants, poisons ratio along with relation between them. Also analyze axially loaded members.
2. Draw shear force, bending moment diagrams for different types of beams and calculate stresses and strains due to simple bending.
3. Determine slope and deflection for various configurations of beams using different methods and stress, strain and deflection due to torsion of circular members.
4. Analyze shear stress distribution in different sections of beams.
5. Understand compound stresses, calculation of principal stresses analytically and graphically using Mohr's circle.

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6. Estimate stresses in thin and thick cylinders. Also estimate critical load in buckling for various columns and struts.

UNIT–I

Stresses and Strains: Definitions, types of stresses and strains, elasticity and plasticity. Hooke's law, stress-strain diagrams for engineering materials, modulus of elasticity. Poisson's ratio, relationship between elastic constants, linear and volumetric strains, bars of uniform strength, temperature stresses, compound bars.

UNIT–II

Beams: Definition of bending moment and shear force; relationship between intensity of loading, shear force and bending moment; bending moment and shear force diagrams for cantilever, simply supported and overhanging beams; simple theory of bending, moment of resistance, modulus of section.

UNIT–III

Slopes and Deflections: Slope and deflection measurements of cantilever, simply supported beams with Macaulay's and double integration methods subjected to point loads and uniformly distributed loads.

Torsion: Derivation of torsion formula for circular sections, torsional stresses, angle of twist, power transmission, effect of combined bending and torsion.

UNIT–IV

Shear Stresses in beams: Distribution of shear stresses in rectangular, I-section and T-section for solid and hollow sections.

Compound stresses, principal stresses and strains. Mohr's circle of stress.

UNIT–V

Cylinders: Stresses in thin and thick cylinders with internal and external pressures. Hoop and longitudinal stresses in cylinders, stresses in compound cylinders.

Columns and struts: Euler's and Rankine's formulae for axial load applications. Secant and Perry formulae for eccentrically loaded columns.

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Text Books:

1. S.S.Rattan, Strength of materials, Tata Mc-Graw Hill, 3rd Edition, 2016.
2. S. Ramamrutham, Strength of Materials, Dhanpatrai and Sons, 1993.
3. G.H.Ryder, Strength of materials, 3rd Edition in SI Units, Macmillan India Limited, Delhi 2002.

Suggested Reading:

1. S.S. Bhavakatti, Strength of Materials, Vikas Publication, 2003.
2. B.C. Punmia, Strength of Materials and Theory of Structures, Laxmi Pub., 1992.
3. G.H. Ryder, Strength of Materials, 3rd Edition in SI units, Macmillan India Limited, Delhi, 2002.

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16ME C06

FLUID DYNAMICS

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: Student will understand

1. the fluid properties and different fluids.
2. the centre of pressure and stability conditions.
3. the importance of stream function and velocity potential function.
4. the equations related to Fluid dynamics.
5. different types of fluid flows.
6. major and minor losses of fluid flows.

Course Outcome: On the successful completion of this course the student will be able to

1. differentiate different types of fluids.
2. calculate centre of buoyancy and metacentric height.
3. differentiate rotational and irrotational flows.
4. determine forces exerted on fluid body.
5. differentiate laminar over turbulent flows.
6 determine various losses incurred in fluid flows.

UNIT–I

Properties of fluids: Definition of fluid and concept of continuum. Difference between ideal and real fluids. Classification of fluids. Fluid properties: Pressure, Density, Specific weight, Specific volume, Dynamic and Kinematic viscosity, Compressibility and Bulk modulus, Surface tension and Capillarity.

Pressure measurement: Fluid pressure at a point, pascal's law, Hydrostatic law, Measurement of pressure by different manometers.

UNIT–II

Fluid Statics: Total pressure, centre of pressure, total pressure and centre of pressure on plane surfaces like horizontal plate, vertical plate, inclined plate and curved surfaces.

Buoyancy and Floatation: Buoyancy, buoyant force, centre of buoyancy, Meta centre, stability for submerged and floating bodies.

UNIT-III

Fluid Kinematics: Classification of fluid flow: steady and unsteady, uniform and non-uniform, laminar and turbulent, rotational and irrotational

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one, two and three dimensional flows, General concepts of path line, stream line and stream tube. Definition and properties of stream function, velocity potential function and use of flow nets.

UNIT–IV

Fluid Dynamics: Energy of fluid body, potential energy and potential head, pressure energy and pressure head, kinetic energy and kinetic head, derivation of Euler's and Bernoulli's equations and their applications like venturi meter, orifice meter, pitot tube, impulse momentum equation and applications. Discharge equations for weirs and notches.

UNIT–V

Laminar and Turbulent flow in pipes: Distinction between laminar and turbulent flows, Reynold's number and its significance, upper and lower critical values of Reynold's number for flow in pipes, development of laminar and turbulent flow in circular pipes. Hagen–Poiseuille equation, frictional losses in pipes, Darcy equation, estimation of Darcy's friction factor, empirical formulae and Moody's chart.

Flow through pipes: Loss of energy in pipes, Major losses, Minor losses, Hydraulic gradient and total energy lines.

Text Books:

1. P.N.Modi and S.M.Seth, Hydraulic and Fluid Mechanics, Standard Book House, 2010.
2. R.K.Rajput, Fluid Mechanics and Hydraulic Machines, S. Chand and Company, 2010.

Suggested Reading:

1. K.L.Kumar, Engineering Fluid Mechanics, Eurasia Publishing House, 2005.
2. V.L.Streeter, Fluid Mechanics, Mc.Graw Hill Co. Ltd., 2005.
3. D.S.Kumar, Fluid Mechanics, S.K. Kataria and Sons, 2010.

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16ME C07

MACHINE DRAWING

Instruction	1L+2D Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	2

Pre-Requisites: The student is required to have an idea about Engineering Drawing

Course Objectives:

1. Understand drawing and develop capacity to represent any object with the help of sketch.
2. Study the conventions and rules to be followed by engineers for making accurate drawings.
3. Understand the basic dimensioning practices that have to be followed in the preparation of Drawings.

Course Outcomes:

On successful completion of this course the students will be able to:

1. Draw conventional representation of different materials and mechanical components.
2. Read the working drawings in the machine shop.
3. Draw the orthographic projections and sectional views of machine parts.
4. Draw missing views as well as to analyze and interpret drawings of machine components.
5. Understand the shape and structure of different types of screws, keys, couplings, and rivets.
6. Draw assembly drawings of certain Machine Tools, Engine parts and Valves etc.

1. INTRODUCTION:

Format of drawing sheet, title block, conventions of drawing lines and dimensions, First and third angle projections, conversion of Pictorial view to orthographic views, convention for sectional views. Orthographic projections including sectional views of simple machine elements.

2. DRAWING OF FASTENERS, JOINTS AND COUPLINGS:

Practices of sketching work: Free hand sketches of typical machine elements for simple cases for riveted and screwed fastening, joints, and couplings (To indicate proportions).

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3. ASSEMBLY DRAWING:

Preparation of assembly drawings from given details, Ability to supply additional views. The exercises will be drawings of typical machine parts like:

1. Bearings-Plummer block(Pedestal bearing),
2. Petrol Engine Connecting rod,
3. Eccentric,
4. Cross head,
5. Stuffing box,
6. Pipe vice,
7. Screw jack,
8. Lathe Tail-stock
9. Single Tool Post,
10. Revolving centre.

Note: The test is for the ability of the student to read and interpret drawing. The drawing should include part list in standard format.

Text Books:

1. N. Siddeshwar, Machine Drawing, Tata McGraw Hill Publishing Co., Ltd., 5th edition, 2004.
2. N.D. Bhatt, V.M. Panchel, Machine Drawing, Cherotar Publishing house, Anand, New Delhi, 49th edition, 2014.

Suggested Reading:

1. K.L. Narayan, P. Kanniah, K. Venkat Reddy, Machine Drawing, New Age International (P) Ltd., 2nd 2009.
2. K.C. John, Text book of Machine Drawing, PHI Learning, 2010.
3. Ajeet Singh, Machine Drawing, Galgotia Publications, 2010.

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16MB C01

ENGINEERING ECONOMICS AND ACCOUNTANCY

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: Students will:

1. Introduce managerial economics and demonstrate its importance in managerial decision making.
2. Develop an understanding of demand and relevance of its forecasting in the business.
3. Provide the basics of market structure and the concept of equilibrium in different market structures.
4. Examine the economic analysis of production process, types of inputs and to explain different costs and their relationship with the output.
5. Understand the importance of project evaluation in achieving a firm's objective.
6. Explain the concept of Accountancy and provided knowledge on preparation and analysis of Final accounts.

Course Outcomes: After completion of the course, student will be able to:

1. Apply fundamental knowledge of Managerial economics concepts and tools.
2. Understand various aspects of demand analysis and forecasting.
3. Understand price determination for different markets.
4. Study production theory and analyze various costs and benefits involved in it so as to make best use of resources available.
5. Analyze different opportunities and come out with best feasible capital investment decisions.
6. Apply accountancy concepts and conventions, Final accounts and financial analysis.

UNIT-I:

Introduction to Managerial Economics: Introduction to Economics and its evolution - Managerial Economics - its scope, importance, Its usefulness to engineers - Basic concepts of Managerial economics.

UNIT-II:

Demand Analysis: Demand Analysis - Concept of demand, determinants, Law of demand, its assumptions, Elasticity of demand, price, income and cross elasticity, Demand Forecasting – Types of Market structures. (Simple numerical problems).

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UNIT-III:

Production and Cost Analysis: Theory of Production - Firm and Industry - Production function - input-out relations - laws of returns - internal and external economies of scale. Cost Analysis: Cost concepts - fixed and variable costs - explicit and implicit costs - out of pocket costs and imputed costs - Opportunity cost - Cost output relationship - Break-even analysis. (Theory and problems).

UNIT-IV:

Accountancy: Book-keeping, principles and significance of double entry book keeping, Journal, Subsidiary books, Ledger accounts, Trial Balance concept and preparation of Final Accounts with simple adjustments.

UNIT-V:

Capital Budgeting: Introduction to capital budgeting, Methods: traditional and discounted cash flow methods. Introduction to Working capital management. (Numerical problems).

Text Books:

1. Mehta P.L., Managerial Economics – Analysis, Problems and Cases, Sultan Chand and Son's Educational publishers, 2013.
2. Maheswari S.N., Introduction to Accountancy, Vikas Publishing House, 2013.
3. Panday I.M., Financial Management, Vikas Publishing House, 11th Edition, 2015.

Suggested Reading:

1. Varshney and KL Maheswari, Managerial Economics, Sultan Chand, 2014.
2. M.Kasi Reddy and S.Saraswathi, Managerial Economics and Financial Accounting, Prentice Hall of India Pvt Ltd, 2007.
3. A.R.Aryasri, Managerial Economics and Financial Analysis, McGraw-Hill, 2013.

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16ME C08

MATERIAL SCIENCE AND METALLURGY LAB

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	25 Marks
Credits	2

Course Objectives: Students will

1. Acquire basic knowledge by understanding iron-carbide diagram and its application in engineering.
2. Expose to Metallographic study and analysis of various metals.
3. Acquire knowledge in determining the hardness of metals before and after various Heattreatment operations.
4. Understand differences between different heat treatment methods.
5. Expose to T-T-T curve and its application in engineering metallurgy.
6. Understand the relation between micro structure and properties.

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Course Outcomes: On successful completion of this course the students will be able to:

1. identify crystal structure of various metals.
2. measure hardness and can correlate with microstructure.
3. perform a suitable heat treatment operation based on desired properties.
4. underlines the importance of grain size in evaluating the desired mechanical properties.
5. Understand the process of heating and cooling for various heat treatment methods.
6. Correlate the heat treatment methods and the mechanical properties obtained.

List of the Experiments

1. Study of: Metallurgical Microscope, Allotropes of Iron, Iron-Iron carbide diagram, Procedure for specimen preparation.
2. Observations for the following specimens - i) Low carbon steels, ii) Medium carbon steels, iii) Eutectoid steels, iv) High Carbon steels, v)Stainless steels, vi) Case carburized, vii)HSS, viii) White, cast iron, ix) Gray cast iron, x) Malleable cast iron, xi)Spheroidal cast iron, xii) Al–Si alloy and determination of grain size using Image Analyzer.
3. Preparations of the following specimens : i) $\alpha-\beta$ Brass, ii)Normalised steel iii)Medium carbon steel iv)Nodular cast iron v) Grey cast iron.

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4. Heat Treatment Processes i) Annealing, ii) Normalizing, iii) Hardening.

Text Books:

1. V. Raghavan, Materials Science and Engineering, Prentice Hall of India Ltd., 4th Edn., 2005.
2. S.H. Avner, Introduction to Physical Metallurgy, Tata McGraw Hill Publishers, 2nd Edn., 2005.

Suggested Reading:

1. S.P. Nayak, Engineering Metallurgy and Material Science, Charoter Publishing House, 6th Edn., 2005.
2. E. Dieter, Mechanical Metallurgy, Metric Edition, Tata McGraw Hill, 3rd Edn, 2005.
3. K.L. Kakani, Material Science, New Age Publications (P) Ltd, 2008.

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16ME C09

MECHANICS OF MATERIALS LABORATORY

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	25 Marks
Credits	2

Course Objectives:

1. To apply mechanics of materials theory on real specimens and learn the practical testing procedures and concepts.
2. Demonstrate an understanding of tension, and the relationship between stress, strain and application of Hooke's law.
3. Demonstrate an understanding of types of beams, deflections and measurement of material property through deflections.
4. Demonstrate an understanding of torsion and deformations resulting from torsion.
5. To demonstrate the understanding of hardness and its measurement using different scales like Brinnel and Rockwell.
6. To demonstrate an understanding of measurement of shear modulus and young's modulus for machine members like helical and leaf springs through loading respectively.

Course Outcomes: Students who successfully complete this course will have demonstrated ability to:

1. Draw stress-strain curve for an isotropic material and understand the salient features of it.
2. Demonstrate in determining the Young's modulus of various beam materials by conducting load-deflection test.
3. Evaluate rigidity modulus of a given shaft specimen by torsion test.
4. Able to find out Young's modulus and shear modulus for mechanical components like leaf spring and closely coiled helical spring through load-deflection test respectively.
5. Evaluate hardness of different materials using different scales and also estimate the impact resistance of a material by conducting impact tests.

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6. Find the compressive and crushing strengths of concrete cubes and bricks.

List of Experiments

1. Uni-axial tension test using UTM.
2. Brinnel's and Rockwell's hardness tests.
3. Deflection test on propped cantilever.
4. Deflection test on a helical spring to determine the rigidity modulus.
5. Torsion of shaft to determine the rigidity modulus of shaft material.
6. Defection test on a cantilever beam to determine the Young's modulus.
7. Deflection test on a simply supported beam to determine the Young's modulus.
8. Deflection test on continuous beam to determine the Young's modulus.
9. Load-deflection test on a leaf spring to find out the young's modulus of leaf material.
10. Crushing and compression test on bricks and concrete cubes.

Text Books:

1. S.S.Rattan, Strength of materials, Tata Mc-Graw Hill, 3rd Edition, 2016.
2. S. Ramamrutham, Strength of Materials, Dhanpatrai and Sons, 1993.
3. G.H.Ryder, Strength of Materials, 3rd Edition in SI Units, Macmillan India Limited, Delhi 2002.

Suggested Reading:

1. S.S. Bhavakatti, Strength of Materials, Vikas Publication, 2003.
2. B.C. Punmia, Strength of Materials and Theory of Structures, Laxmi Pub., 1992.
3. G.H. Ryder, Strength of Materials, Third Edition in SI units, Macmillan India Limited, Delhi, 2002

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16ME C10

COMPUTER DRAFTING LAB

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	25 Marks
Credits	2

Course Objectives: Students will

1. Student will acquire knowledge in solid modeling by exposing to Solid works.
2. Student will acquire knowledge in graphic communication.
3. Student is exposed to design methodologies.
4. Student will acquire knowledge in concept of layers.

Course Outcomes On successful completion of this course the students will be able to:

1. demonstrates Graphics and design competencies.
2. apply CAD techniques for 2D modeling.
3. develops an ability to think 3D and interpret data from blue prints and sketches, layers concepts.
4. apply and draw orthographic projections with the knowledge of correct graphics communication (drawings).
5. draw 2D drawings and sectional views of part models.
6. draw 2D drawings and sectional views of assembly models.

Application Software Tool: Auto CAD / Solid Works

1. INTRODUCTION TO SOLIDWORKS DRG EDITOR/ AUTOCAD :

XY Coordinate system, Angular measurement, Setting of Units, Limits, Absolute, Relative and Polar Coordinates, zoom Text, Multiline Text, Creating Title Block – Title, Drawing Number, Drawn, Checked, Approved, Angle of Projection, Scale, Basic Toolbars and commands - Format, View, Draw, Dimension, Modify Tool bars, Draw tool bar options - line, Circle, Rectangle, Ellipse, Spline and Arc , Modify tool bar options - Trim, Extend, Offset, Fillet, Chamfer, Mirror, Break, Array, Polar, Rectangular, Move, Copy, Stretch, Rotate ESNAP, SNAP, Grid, Ortho, Dimension Tool bar –aligned, angular, linear and annotations, leader line. Setting Dimension Style. View Tool bar - Orbit, Render, 3D Views (SW, SE, NE, NW Isometric Views).

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2. **EXERCISES FOR PRACTICE:**
Square headed spanner, circular, rectangular components, concentric squares, circle inscribed in a square and rectangle. Fork, Depth Stop, Pump Housing, Geneva Wheel. Importance of Layer - Layer and object properties; construction line, object line, hidden line, centre line, hatching, dimensioning, leader, Options like - Region, Extrude.

3. **EXERCISES FOR PRACTICE:** 2D drawings and sectional views - Shaft support, Sliding Block, Bearing Bracket, Shaft bracket, Anchor bracket, Piston of Petrol Engine, Petrol Engine Connecting Rod.

4. **EXERCISES FOR PRACTICE**: 2D drawings of Components of Screw Jack, and Components of Plummer Block.

Text Books:

1. Machine Drawing, K L Narayana.
2. Solidworks Drawing and Training Manual.
3. Autocad Command Reference manual.

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16ME C14

KINEMATICS OF MACHINES

Instruction	3L+1T Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	4

Course Objectives: Student will acquire knowledge in

1. analysis of mechanisms.
2. drawing displacement diagrams for followers with various types of motions.
3. cam profile drawing for various followers.
4. estimation of transmission of power by belts and application of various gears and gear trains.

Course Outcomes: Student will demonstrate knowledge in

1. Understanding basic elements of machinery and their motion characteristics.
2. Designing a suitable mechanism depending on application.
3. Drawing displacement diagrams and cam profile diagram for followers.
   Executing different types of motions and various configurations of followers.
4. Drawing velocity and acceleration diagrams for different mechanisms.
5. Selecting gear and gear train depending on application.
6. Selection of suitable clutch, brake.

UNIT–I

Introduction: Definition of link, element, pair, kinematic chain, mechanism and machine, Grubler's criterion, single and double slider chains, inversions of quadratic cycle chain, inversions of single and double slider crank chains. Mechanism with lower pairs and straight line motion mechanism, Pantograph and Geneva mechanisms. Ackerman and Davis steering gear mechanisms and Hooke's Joint. Peaucellier, Hart, Scott-Russel, Watt and Tchebicheff mechanisms.

UNIT–II

Analysis of mechanisms: Graphical methods to find velocities of mechanisms, instantaneous centre, body centre and space centre, Kennedy's theorem, graphical determination of acceleration of different mechanisms including Coriolis component of acceleration, analytical method to find the velocity and acceleration, analysis of four bar mechanism with turning pairs, Freudenstein's method for four bar linkage synthesis.

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UNIT–III

Laws of Friction: Friction in screw threads, pivots, collars, Clutches - Single and Multi plate, Cone and centrifugal clutches. Friction circle and friction axis of a link.

Brakes and Dynamometers: Block or shoe, band and block, internal expanding shoe brake, Prony, rope brake, belt transmission, torsion dynamometers.

UNIT–IV

Cams: Types of cams and followers, displacement diagrams for followers, uniform motion, parabolic motion, simple harmonic motion, cycloidal motion, drawing cam profile with knife–edge follower, translating roller follower and translating flat follower. cams of specified contour. Cams of specified contours, tangent cam with roller follower, circular arc (convex) cam with roller follower.

UNIT–V

Gears: Classification of gears, spur gears, nomenclature, law of gear tooth action, involute as gear tooth profile, interference of involute gears, minimum number of teeth to avoid interference, contact ratio, cycloidal tooth profile, comparison of involute and cycliodal tooth profile.

Helical Gears: Helical gear tooth relations, contact of helical gear teeth,

Gear trains: Gear trains–simple and compound, reverted and epicyclic gear trains. Differential of an Automobile.

Text Books:

1. Thomas Bevan, Theory of Machines, CBS Publishers, 2009.
2. S.S. Rattan, Theory of Machines, Tata McGraw Hill Publishers, 4th Edition, 2013.
3. J.E.Shigley, Theory of Machines, Tata Mc.Graw Hill Publishers, New Delhi, 3rd Edition, 2005.

Suggested Reading:

1. C.S. Sharma and Kamlesh Purohit, Theory of Mechanisms and Machines PHI Learning Pvt. Limited, 2006.
2. Amitabh Ghosh and A.K.Mallik, Theory of Machines, East West Publications, 3rd Edition, 2009.

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16ME C15

THERMODYNAMICS

Instruction	4 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	4

Course Objectives: Student will understand

1. Basic definitions of thermodynamics and significance of Zeroth law of thermodynamics.
2. The importance and application of first law of thermodynamics.
3. The various laws associated with second law of thermodynamics.
4. Properties of pure substances and use of Molier diagram.
5. Various air standard cycles, their importance and their comparison.
6. Calculation procedures of the air-fuel ratio.

Course Outcomes: Student will be able to

1. Estimate the temperature of different scales of thermometers.
2. Apply the first law of thermodynamics process to various thermodynamics processes.
3. Understand the meaning of perpetual motion of machine of second kind and its significance.
4. Read data from the chart of Mollier diagram and its applications.
5. Distinguish working principles of various IC engines like diesel engine, petrol engine.
6. Calculate theoretical air–fuel ratios required for combustion of fuels and also convert from gravimetric analysis to volumetric analysis and vice versa.

UNIT–I

Introduction: Thermodynamics, Macroscopic and Microscopic approaches, thermodynamic systems, properties, processes and cycles, thermodynamic equilibrium, quasi – static process, measurement of pressure, Zeroth law of thermodynamics and its significance, measurement of temperature, reference points, ideal gas equation.

UNIT–II

First Law of Thermodynamics: Concept of heat and work, first law of thermodynamics for closed system, energy- a property of the system, application of first law to various thermodynamic processes like isobaric, isochoric, isothermal, adiabatic and polytropic, definition of enthalpy, PMM1, first law applied to flow processes, application of SFEE to nozzle and diffuser, throttling device, turbine and compressor.

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UNIT–III

Second Law of Thermodynamics: Limitations of first law of thermodynamics, Kelvin–Planck and Clausius statements of second law of thermodynamics, PMM2, equivalence of Kelvin-Planck and Clausius statement, reversible and irreversible processes, Carnot theorem, Clausius inequality, calculation of entropy change during various thermodynamic processes, principle of entropy increase, T–S diagrams, application of entropy principle for mixing of two fluids. Helmholtz and Gibb's functions.

UNIT–IV

Thermodynamic Properties of Fluids: Properties of pure substances, p–v diagram, p–T diagram, p–v–T surface, T–s diagram, h–s diagram, dryness fraction, use of steam tables, Maxwell relations.

UNIT–V

Air Standard Cycles: Air standard cycles - Otto, Diesel, Dual Combustion Cycles, working principle, derivation of expression for air standard efficiency, comparison of otto, diesel and dual cycles-for the same compression ratio, for the same maximum pressure and temperature.

Vapour Power Cycles: Vapour power cycles - Carnot cycle, Simple Rankine cycle.

Fuels and Combustion: Characteristics of an ideal fuel, classification of fuels, Stoichiometric air-fuel ratio, equivalence ratio, relation between volumetric and gravimetric analysis.

Text Books:

1. P.K. Nag, Engineering Thermodynamics, Tata McGraw Hill Publishers, 5th edition, 2013.
2. D.S. Kumar, Thermal science and Engineering, S.K.Kataria and Sons, 4th edition, 2013.
3. D.P.Mishra, Engineering Thermodynamics, Cengage Learning, 2012.
4. Y.A. Cengel and M.A. Boles, Thermodynamics: An Engineering Approach, Tata McGraw Hill Publishers, 7th edition, 2014.

Suggested Reading:

1. R.K. Rajput, Thermal Engineering, Laxmi Publications (P) Ltd, 8th edition, 2011.
2. Mahesh M Rathor, Thermal Engineering, Tata McGraw-Hill Publishers, 2013.

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16PE C01

METAL CASTING AND WELDING

Instruction	4 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	4

Course Objectives: To enable the students to

1. select the suitable manufacturing process for a given component.
2. design the pattern, gating system and rises for a simple casting.
3. identify the defect and suggest remedy for the same.
4. describe various welding processes.
5. illustrate the terminology of welding, the characteristics of power sources used for welding and the consumables required.
6. compare various arc, resistance, solid state and other welding processes.

Course Outcomes: Student will be able to

1. select the suitable manufacturing process for a given component.
2. design the pattern, gating system and rises for a simple casting.
3. identify the defect and suggest remedy for the same.
4. describe various welding processes.
5. illustrate the terminology of welding, the characteristics of power sources used for welding and the consumables required.
6. compare various arc, resistance, solid state and other welding processes.

UNIT–I

Pattern design and methoding: Introduction, classification, pattern design: types of patterns pattern materials, pattern allowances, gating system, propose, elements, requirements, types of gates, choke, gating ratio, types of gating systems, gating system design, Risering: purpose, requirements, chvorinov's rule, optimum shape and dimensions of riser, riser design by Caine's method, modules method and NRL method.

UNIT–II

Moulding, melting, defect analysis and inspection techniques: Moulding sand: ingredients, types of sand clays, additives, moulding sand preparation, required properties, Core: purpose, core prints, core sand preparation, core preparation, chaplets, types of cores, net force on the core Melting furnaces: Cupola, Inductionand Arc furnace, casting defects and remedies, inspection and testing of castings.

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UNIT–III

Special casting processes: Gravity die casting pressure die casting, centrifugal casting, shell moulding, investment casing, continuous casting, slush casting, lost foam process, squeeze casting, vacuum moulding CO_2 moulding and ceramic moulding.

UNIT–IV

Arc welding: Introduction, classification of welding processes, physics of arc, DCSP, DCRP, AC, arc initiation, arc stability, parts of arc, arc length characteristics, static V-I characteristics of power sources arc, duty cycle, shielded metal arc welding, submerged arc welding, Gas tungsten arc welding, Plasma arc welding, Atomic Hydrogen welding.

UNIT–V

Other welding processes: Resistance welding: spot, projection, seam, butt and percussion welding, Oxy-Acetylene welding, Thermit welding, laser beam welding, electron beam welding, Soldering and Brazing, weld defects, solid state welding, forge welding, friction welding, ultrasonic welding, explosive welding, weldability, effect of various parameters on weldability and weld defects.

Text Books:

1. P.N. Rao, Manufacturing Technology, Vol. 1, Tata McGraw Hill Publishers, 3rd edition, 2011.
2. Amitabh Ghosh and Mallick, Manufacturing science, Assoc. East West Press Pvt. Ltd.,, 4th edition, 2011.
3. Schey, Introduction to Manufacturing Processes, McGraw Hill Education, 2nd edition.

Suggested Reading:

1. Roy A. Lindberg, Materials and Process of Manufacturing, Prentice Hall of India, 5th editin, 1992.
2. Serope Kalpak Jian, Manufacturing Engineering and Technology, Addision, Wesley Publishing company, 2006.
3. Mikeli P. Grover, Fundamentals of Modern Manufacturing Materials, Processes and Systems, 3rd edition, Wiley A.

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16PE C02

METAL FORMING TECHNOLOGY

Instruction	4 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	4

Objectives:

1. To introduce students to metal forming technology while understanding the fundamentals of theory of plastic deformation and stress strain relations.
2. To explain the working principle of various operations like sheet metal operations, extrusion, drawing, rolling, forging etc with their applications, merits and demerits.
3. To explain different deformation mechanisms and effect of the process variables on different process and product quality.
4. To enable the students to determine loading and energy required for metal forming tools and machines.
5. To enable the students to understand different defects that occurring forming operations with remedial measures.

Outcomes: After learning this course, students will be able to

1. Define what is meant by metal forming and its specific advantages over other manufacturing processes.
2. Apply theory of plasticity to analyze metal forming processes.
3. Understand the basic principles and practical aspects of metal forming operations.
4. Understand various process parameters that affect product quality in various processes under different conditions.
5. Determine load, energy and power required for various processes and machines.
6. Propose suitable metal forming processes for making different products.

UNIT-I

Theory of Plasticity: Plastic deformation, work hardening, cold, warm and hot working with their advantages and disadvantages, true stress and true strain, flow curve, effect of strain-rate and temperature on flow stress. yield criterion: von-Mises and Tresca.

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UNIT-II

Forging: Open and closed die forging, Drop, Press and Machine forging operations, types of hammers and presses, their principles of operation and applications, Forging load calculation with slab method and empirical methods, forge ability , forging defects, Methods of heating and types of furnaces, Isothermal forging Hot Isostatic Pressing.

UNIT-III

Extrusion and Drawing: Types of extrusion, Tube extrusion Rod/wire/tube drawing ,load calculation of extrusion and drawing using uniform deformation energy method and slab method. maximum reduction in drawing, effect of friction, die angles, deformation speeds on extrusion/drawing forces, die materials and lubrication in these operations, extrusion and drawing defects.

UNIT-IV

Rolling: Principles of Metal rolling, roll load, torque and mill power calculation for homogenous deformation, classification and description of rolling mills, their applications, rolling defects, shape rolling, ring rolling thread rolling, roll bending and powder rolling.

UNIT-V

Sheet Metal Working: Sheet Metal working operations-shearing, blanking, piercing, bending, drawing and squeezing operations, estimation of loads and energy required for these operations, Formability, FLD, types of presses, specifications and their applications, comparison of simple, compound, progressive and combination dies. Other sheet metal forming operations like Embossing, Stretch forming, Spinning and Flow forming.

Text Books:

1. Serope Kalpakjian, Manufacturing Engineering and Technology, Pearson education INC., 4th Edn, 2015.
2. George.E. Dieter, Mechanical Metallurgy, SI Metric Edition, McGraw –Hill, 1988.
3. P.N. Rao, Manufacturing Technology, TMH, 4th Edn., 2015.

Suggested Readings:

1. Jan R.K. and Gupta S.C, Production Technology, Khanna Publications,17th Edn, 2012.
3. Roy A lindberg, Materials and Process of manufacturing, PHI, 4th edn, 2004.
4. John A Schey, Introduction To Manufacturing Processes Mcgraw Hill education, 3rd Edn, 2012.

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16EE C14

ELECTRICAL MACHINES AND MICROCONTROLLER APPLICATIONS

(Common to BE-Mech. and Prod.)

Instruction	4 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	4

Course Objectives:

1. To understand the concepts of transformers.
2. To comprehend the need of DC and AC machines and their control aspects.
3. To know the features of 3-phase induction motors.
4. To understand the concepts of 8051 of microcontrollers.
5. To understand the basics of interfacing with 8051.

Course Outcomes: The student will be able to

1. Identify the compatibility of DC machines for a given application.
2. Identify the applications of 3-phase induction motor.
3. Know the calculation of Efficiency and regulation of transformer.
4. Program using 8051.
5. Use 8051 for basic applications.

UNIT- I

D.C. Generators: Constructional details, Principle of operation, EMF equation, Classification of generators, Armature reaction, Characteristics of shunt, series and compound generators.

DC Motors: Working Principle, back EMF, Classification of motors, Torque developed in motors, Characteristics of shunt, series and compound motors, Three point starter, Speed control of DC motors.

UNIT- II

Transformers: Construction, Working principle, EMF equation, Ideal transformer, Practical transformer on no load and load conditions, Equivalent circuit of transformer, Efficiency and regulation of transformer, OC and SC tests.

UNIT-III

Three Phase Induction Motors: Production of rotating magnetic field, construction and principle of operation, Torque Calculation, speed-torque characteristics, Speed control of 3-phase induction motors.

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UNIT-IV

8051 Microcontrollers: Introduction to microprocessor, microcontroller classification, Internal architecture of 8051 and its pin configuration, Memory organization and expansion. **SFR's:** Counter and timers, serial data I/O, Interrupts.

8051 Instruction set: Addressing modes and Instruction set. Assembly Language Programming with 8051.

UNIT-V

8051 Interfacing: Expansion of I/O ports, A/D converter, D/A converter, Stepper motor interfacing with 8051, DC motor interfacing with 8051.

Text Books:

1. D.P. Kothari and Nagrath, Basic Electrical Engineering, Tata McGraw Hill Publications, 2nd edition, 2007.
2. V.K.Mehta, Principles of Electrical Engineering, S.Chand and Co, 1st edition, 2003.
3. Muhammad Ali Mazidi, Jainice Gilispie Mazidi and Rolin D. MCkinlay, The Microcontroller and Embedded Systems using Assembly and 'C', 2/e Pearson Education, 2007.
4. Ayala K.J, The 8051 Micro Controller Architecture, Programming and Application, Penram International, 2007.

Suggested Reading:

1. B. L.Theraja and A.K. TherajaA Text book of Electrical Technology, S.Chand and Co, 24th revised edition, 2007.
2. P. V. Prasad, S. Sivanagaraju, Electrical Engineering: Concepts and Applications, Cengage Learning, 1st Edition, 2012.

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16PE C03

METAL CASTING AND WELDING LAB

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	25 Marks
Credits	2

Course Objectives: To enable the students to

1. Prepare the mould for a single piece and split patterns.
2. Test the moulding sand and anlalyse the same.
3. Test the bead geometry and correlate the results to the input parameters.
4. Able construct the cooling curves and analyse the same.
5. Able to distinguish the type of the flame and recommend for different materials.
6. Able use TIG, MIG and Spot welding machines and experiment with them.

Course Out comes: Students are able to

1. Prepare the mould for a single piece and split patterns.
2. Test the moulding sand and anlalyse the same.
3. Test the bead geometry and correlate the results to the input parameters.
4. Construct the cooling curves and analyse the same.
5. Distinguish the type of the flame and recommend for different materials.
6. Use TIG, MIG and Spot welding machines and experiment with them.

EXPERIMENTS

Casting:

1. Design and manufacturing of a simple pattern with various allowances.
2. Green sand moulding practice for a single piece pattern.
3. Green sand moulding practice for a split pattern with a horizontal core.
4. Moulding sand testing: GCS, GSS, DCS and DSS Permeability and shatter index.
5. Finding out the GFN, Moisture content and clay content for a given sand sample.
6. Melting and Pouring of Aluminum.
7. Dimensional inspection and visual inspection of the casting and analysis of dimensional variation and defects.

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Welding:

1. Study of gas welding equipment and process. Identification of flames, making Butt joint with gas welding.
2. Study of Arc welding process, comparison of the bead geometry with DCSP, DCRP and A.C.
3. Study of resistance welding process and plot the variation of spot area with time and current variation.
4. Study of TIG welding process and plotting cooling curve in TIG welding process.
5. Study of SAW Welding process and finding out deposition efficiency of the process.
6. Study of MIG welding process and testing of weld bead formed by MIG welding.

Note: Minimum 4 Experiments need to be conducted.

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CBIT(A) with effect from the academic year 2017-18

16PE C03

METAL FORMING TECHNOLOGY LAB

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	25 Marks
Credits	2

Objectives:

1. To demonstrate various operations like sheet metal operations-blanking, punching, deep drawing, extrusion etc with their applications, merits and demerits.
2. To explain different deformation mechanisms and effect of the process variables on process or bustness and product quality.
3. To enable the students to determine loading and energy required for metal forming tools and machines.
4. To enable the students to understand different defects that occurring forming operations with remedial measures.
5. To make the students understand working principle, types, and applications of forging process.
6. To make students understand working principle, parameters, types and applications of extrusion 1process.

Outcomes: The students will be able to:

1. Understand the practical aspects of metal forming operations.
2. Understand various process parameters that affect product quality under different conditions.
3. Work independently with various presses and dies to produce different components.
4. Determine load, energy and power required for various processes and machines.
5. Propose suitable metal forming processes for making different products.
6. Design and Fabricate various types of dies for sheets metal operations.

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List of Experiments:

1. Evaluation of Formability of a given sheet material using Erichsen cupping test.
2. Study of Simple Diedesign for Blanking/ Piercing operations in sheet metal forming and manufacturing of circular blanks using a mechanical press(capacity30Tons) and measurement of forces and comparing with the oretical loads.
3. Study of Progressive die design and manufacturing of washer components using the same on a fly press (capacity6Tons)and estimation of forces.
4. Studyof Compound diedesign and manufacturing of washer components using the same on double body fly press (capacity8 Tons)and estimation of forces.
5. Study of Combination diedesign and manufacturing of cylindricalcup susing the same on a Hydraulic power press(capacity 50Tons) and estimation of drawing force.
6. Study of deep drawing die design and measuring forces with/without blank holder for cylindrical/square cups using 10 T load cell on a Hydraulic power Press and comparing them with theoretical values.
7. Measurement of cutting forcef or Blanking operation using 10T load cell on Mechanical power Press for different materials and comparing the oretical and practical values.
8. Estimation of True stress and True strain for ferrous/ non ferrous materials encounter edin metal forming operations using Universal Testing Machine.
9. Study of extrusion dies and demonstration of extruding lead material.
10 Demonstration of Simulation software for metal forming operations.

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16EG C03

SOFT SKILLS AND EMPLOYABILITY ENHANCEMENT LAB

Instruction	2 hours per week
Duration of Semester End Examination	2 Hours
Semester End Examination	35 Marks
CIE	15 Marks
Credits	1

Course Objectives: To help the students

1. Participate in group discussions and case studies with confidence and to make effective presentations. Also to learn the art of communication.
2. With- resume packaging, preparing and facing interviews.
3. Build an impressive personality through effective time management & goal setting, self confidence and assertiveness.
4. Understand what constitutes proper grooming and etiquette in a professional environment. Also to understand academic ethics and value systems.
5. To understand the elements of research and hone their soft skills through a live, mini project.

Course Outcomes: The students will be able to

1. Be effective communicators and participate in group discussions and case studies with confidence. Also be able to make presentations in a professional context.
2. Write resumes, prepare and face interviews confidently.
3. Be assertive and set short term and long term goals. Also learn to mange time effectively and deal with stress.
4. Make the transition smoothly from Campus to Corporate. Also use media with etiquette and know what academic ethics are.
5. To do a live, mini project by collecting and analyzing data and making oral and written presentation of the same.

Exercise 1

Group Discussion and Case studies: Dynamics of group discussion, intervention, summarizing, modulation of voice, body language, relevance, fluency and coherence.

Elements of effective presentation, Structure of presentation, Presentation tools, Body language, Creating an effective PPT.

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Exercise 2

Interview Skills: Resume writing, structure and presentation, planning, defining the career objective, projecting ones strengths and skill-sets.

Interview Skills, concept and process, pre-interview planning, opening strategies, answering strategies, mock interviews.

Exercise 3

Personality Development: Effective Time Management, setting realistic goals, self confidence and assertiveness, stress management, moral values.

Exercise 4

Corporate Culture: Grooming and etiquette, communication media etiquette,

Academic ethics and integrity.

Exercise 5

Mini Project: General/Technical. Research, developing a questionnaire, data collection, analysis, written report and project seminar.

Suggested Reading:

1. Dr. Shalini Verma, *Body Language- Your Success Mantra*, S Chand, 2006.
2. Ramesh, Gopalswamy, and Mahadevan Ramesh, *The ACE of Soft Skills*, New Delhi: Pearson, 2010.
3. Covey and Stephen R, *The Habits of Highly Effective People*, New York: Free Press, 1989.

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16ME C20

DYNAMICS OF MACHINES

Instruction	3 Hours + 1 Tutorial per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives:

1. To find static and dynamic forces on planar mechanisms.
2. To know the causes and effects of unbalanced forces in machine members.
3. To determine natural frequencies of undamped, damped and forced vibrating systems of one, two and multi degree freedom systems.

Course Outcomes:

1. Graduates are expected to demonstrate the ability of the analysis of forces in mechanism which provide them the required inputs to design the systems which withstand operating conditions
2. Graduates are expected to understand the turning moment diagram, cyclic fluctuation in speed, fluctuation in energy and get the ability of designing flywheel.
3. Graduates are expected to understand gyroscopic and centrifugal actions of vehicles and will be able to reckon additional bearings reactions due to gyroscopic and centrifugal effects
4. Graduates will have ability to control speed using governors
5. Graduates will have ability to identify the unbalance in rotor and engines and will get the knowledge of balancing.
6. Graduates will understand the concepts of vibration thereby they are able to design the systems free from ill effects of vibration.

UNIT-I: Static and Dynamic Force Analysis:
Force analysis of Four bar and slider crank mechanisms: Study of dynamically equivalent system, Inertia forces on connecting rod.
Flywheels: Functions, Turning moment diagrams, flywheels analysis for I.C. Engines and Presses.

UNIT-II: Gyroscope: Gyroscopic couple, gyroscopic effects on vehicles.
Governors: Classification of governors, Watt, Porter, Hartnell and Hartung governors, Controlling Force, Stability, Isochronism, Sensitivity, Power and Effort of governors.

UNIT-III: Balancing of Rotating masses:
Forces on bearings due to rotating shaft carrying several masses in several planes. Determination of balance masses from the forces on the bearings.
Balancing of Reciprocating masses: Shaking forces in single cylinder engine, Partial balancing of reciprocating engine. Balancing of two cylinder locomotive engine. Balancing of multi cylinder in-line engines. Balancing of radial engines by direct and reverse cranks method.

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UNIT-IV: Vibrations:
Vibrations of Single degree freedom system, (axial, transverse and torsional). Equivalent system of combination of springs, stepped shaft, whirling speed of shafts.

Damped vibrations:
Types of damping, Vibrations with viscous damping.

Forced vibrations:
Vibrations with harmonically applied force with viscous damping. Dynamic magnifier, Resonance, Vibration isolation and Transmissibility

UNIT-V:Two degree freedom systems: Natural frequencies and modes of vibration

Approximate Methods: Dunkerley and Rayleigh's methods

Multi rotor system : Holzers method

Text Books:

1. S.S. Rattan, *Theory of Machines*, Tata-Mc Graw Hill, 1995.
2. John.J.Vicker, Gordon R. Pennock, Joseph E. Shigley, *Theory of Machines & Mechanisms*, Oxford University Press, 2003.
3. Benson H. Tangue, Principles of Vibration, 2nd Edn., Oxford University Press, 2007

Suggested Reading:

1. A. Ghosh and Mallick, *Theory of mechanisms and machines*, Affiliated to E-W Press, 1988.
2. Ashok G Ambedkar, Mechanism and Machine Theory, PHI, 2013
3. Robert L. Norton, *Design of Machinery*, Tata Mc Graw Hill, 2005.
4. J.S. Rao and Gupta, 'Theory and Practice of Mechanical Vibrations, PHI, 1984
5. Theory of Vibration with Application, J.J. Thompson, Dec-2002

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16ME C21

APPLIED THERMODYNAMICS & HEAT TRANSFER

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives:

1. To demonstrate basic knowledge by understanding the basic working principles of reciprocating air compressor and its applications in engineering.
2. Students will come to know the working principle of diesel and petrol engine, their combustion phenomena and problems pertaining to abnormal combustion
3. Student will understand the configurational features of IC engine like ignition system and injection system
4. To demonstrate basic knowledge by understanding different modes of heat transfer
5. Students will understand the basic principles of radiation
6. Student will understand the working principles of parallel and counter-flow heat exchangers

Course Outcomes: Students will be able to

1. Estimate power required for reciprocating air compressor, used for many engineering applications.
2. Evaluate the performance of diesel and petrol engines and suggest some suitable methods for remedy of abnormal combustion
3. Understand the importance of accessories of IC engines
4. Apply appropriate equations depending on mode of heat transfer
5. Distinguish the radiation heat transfer from other modes of heat transfer
6. Design heat exchangers with the basic knowledge acquired in heat exchangers

UNIT-I: Reciprocating Air Compressors:

Single stage and multi stage compressors with and without clearance volume, work done, various Efficiencies of multi stage compression.

UNIT-II: Internal Combustion Engines:

Classification, Working principles of 2 stroke, 4 stroke SI and CI engines. Performance of IC Engines. Heat balance sheet.

UNIT-III: Combustion Phenomena:

Normal and abnormal combustion phenomenon in SI and CI engines. Cooling, lubrication systems, Battery and magneto ignition systems of IC engines. Working principle of Simple Carburetor and Fuel Injector

UNIT-IV: Modes of heat transfer:

General 3-D conduction equation in Cartesian and cylindrical coordinates, one dimensional steady state conduction through slabs, hollow cylinders without heat generation, critical radius of insulation for cylinders.

Convection: Free and forced convection, dimensionless numbers and their physical significance, simple problems on free and forced convection

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UNIT-V: Radiation: Various laws of radiation, concept of black-body, surface resistance, space resistance, radiation shield.

Heat Exchangers: Classification, LMTD and NTU Concepts
Concept of Condensation and boiling

Text Books:

1. Mahesh M. Rathore, "Thermal Engineering," TMH, New Delhi, 2010
2. Ganeshan, V., " Internal Combustion Engines", Tata Mcgraw Hill Publishing, New Delhi,2015
3. Holman, J.P., "Heat Transfer", McGraw Hill Publication, New Delhi,

Suggested Reading:

1. R.K. Rajput.," Thermal Engineering", Laxmi Publishers, New Delhi, 2014
2. D.S. Kumar; Heat Transfer S K Kataria Publishers, 2015
3. R.K. Rajput, 'Heat Transfer', Laxmi Publications, 2014

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16ME C22

DESIGN OF MACHINE ELEMENTS
(USAGE OF DATA BOOK IS COMPULSORY)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	4

Course Objectives:

1. To understand the basics of mechanics of materials and design of machine elements for static and fatigue strength, rigidity and wear criterions, use of codes and standards.
2. To know the principles of ergonomic design.
3. To learn the principles to design shafts, keys, belt drives, joints and couplings.
4. To Develop and solve mechanical component design problems based upon given data and requirements

Course Outcomes: Students will able to

1. Select material based on type of load and manufacturing considerations.
2. Design the components subjected to static loads.
3. Design the components subjected to fluctuating loads.
4. Become familiar with mechanical elements like shafts, keys, couplings and pulleys.
5. Become familiar with permanent types of joints and their design concepts.
6. Become familiar with detachable joints and power screws.

UNIT-I : Introduction:

Materials used in machine design and their specifications to Indian standards. . Codes and standards used in design. Reliability, Principles of good Ergonomic Design, Manufacturing considerations. Preferred numbers. Value analysis. Analysis of Stress and Strain: Definition of stress and strain, Types of loading, direct normal stress, Bending stress, Torsional stress, Crushing and bearing stresses, Biaxial stress and triaxial stress. Theories of elastic failure, Stress concentration factor, Factor of safety, Design of components for static loads.

UNIT-II: Design for Fatigue and Impact Loads:

Importance of fatigue in design, Fluctuating stresses, fatigue strength and endurance limit. Factors affecting fatigue strength. S-N Diagram, Soderberg and Modified Goodman's diagrams for fatigue design. Cumulative fatigue, Miner's rule, Design of components for fatigue. Design of components for impact loading.

UNIT-III: Design of keys:

Design of Shafts, Solid, hollow, stepped shafts and splined shafts under torsion and bending loads.

Design of couplings – Muff and Split muff Couplings, Flange, Flexible and Marine type of couplings.

Design of belt drive systems , selection of belts and design of pulleys.

UNIT-IV: Design of Riveted Joints:

Types of joints, efficiency of the joints, structural joints, and joints subjected to direct and eccentric loads.

Design of welded joints - types of joints, joints subjected to direct and eccentric loading.

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UNIT-V: Design of Machine Elements:

Design of cotter and knuckle joints.
Design of bolts and nuts, locking devices, bolt of uniform strength, design of gasket joints.
Design of power screws and screw jack.

Text Books:

1. V.B. Bhandari, *Machine Design*, Tata Mc Graw Hill Publication, 2010.
2. J.E. Shigley, C.R. Mischne, *Mechanical Engineering Design*, Tata Mc Graw Hill Publications, 2011.
3. Siraj Ahmed, 'Mechanical Engineering Design, PHI, 2014.

Suggested Reading

4. Robert L. Norton, *Machine Design: An Integrated Approach*,2/e Pearson Education, 2013
5. P. Kannaiah, *Machine Design*, Science-Tech Publications, 2010
6. M.F. Spotts, *Design of Machine Elements*, Prentice Hall of India, 2013.

Machine Design Data Books:

1. Design Data Hand book for Mechanical Engineers, K. Mahadevan, K. Balaveera Reddy, CBS Publisher 3rd Edition.
2. Design Data book by PSG College – 2012

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16ME E01

REFRIGERATION AND AIR CONDITIONING (Elective-I)

Instruction	3Hours per week
Duration of Semester End Examination	3Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives:

1. Students will acquire the basic knowledge about the importance of refrigeration, its applications in aircraft refrigeration
2. To demonstrate basic knowledge of vapor compression refrigeration system , cascade and compound refrigeration
3. Student will understand various types of absorption refrigeration systems like ammonia, Electrolux and lithium bromide refrigeration systems
4. Students will acquire the basic knowledge on various psychrometric processes
5. Student will understand the importance of comfort air conditioning
6. Students will acquire knowledge in estimating air conditioning loads

Course Outcomes:

1. Students will be able to differentiate refrigeration from air conditioning
2. Students will be able to understand merits and demerits of vapor compression refrigeration system over air refrigeration system
3. Student will be able to know the importance of absorption refrigeration system over vapor refrigeration system
4. Students will be able to apply a suitable sychrometric process depending on requirement or application
5. Student will be able to know the condition necessary for comfort condition
6. Student will be able to estimate the load required for AC system depending on application

UNIT-I: Introduction to Refrigeration:
Application of Refrigeration, Definition of COP, Tonne of Refrigeration, Designation, Carnot cycle, Eco-friendly Refrigerants
Properties of Refrigerants:

Air Refrigeration Systems:
Analysis of Bell-Coleman Cycle, Application to aircraft refrigeration, Simple cooling system, Bootstrap simple evaporating system, Regenerative cooling system and Reduced ambient cooling system.

UNIT-II: Vapour compression system:
Working principle and analysis of Simple vapor compression Refrigeration cycle.
Effect of operating conditions like evaporating pressure, condenser pressure, Liquid sub-cooling and Vapor super heating, Performance of the system. Low temperature refrigeration system (with single load system), Compound compression with water inter cooler and Flash intercooler, Cascade refrigeration system-Analysis and advantages

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UNIT-III: Vapour Absorption Refrigeration System:
Simple absorption systems, COP, Practical ammonia absorption refrigeration system, Lithium bromide absorption system, Electrolux refrigerator, Common refrigerants and absorbents properties, Comparison with vapor compression refrigeration system
Steam Jet Refrigeration:
Principle of working, Analysis of the system, Advantages, limitations and applications.

UNIT-IV: Psychrometry:
Psychrometric properties, Psychrometric chart, construction, Representation of **Various** Psychrometric processes on the chart,

Introduction to Air Conditioning:
Requirements of comfort air conditioning, Thermodynamics of human body, ASHRE comfort chart, Effective temperature

UNIT-V: Cooling Load Calculations in Air Conditioning:
Concept of by pass factor, Sensible heat factor, Apparatus Dew Point, Various Heat Load
Design of air conditioning systems:
Simple Problems on Summer, Winter and Year Round Air conditioning systems Energy conservation in air conditioned building,

Air Conditioning Systems:
Components of air conditioner equipments, Humidifier, Dehumidifier, Filter.

Text Books

1. Arora C.P., " *Refrigeration and Air conditioning*", Tata McGraw Hill, New Delhi, 2004.
2. Stocker, W.S., "*Refrigeration and Air conditioning*", McGraw Hill, New Delhi, 2004.
3. R.K. Rajput, "*Refrigeration and Air Conditioning*" Laxmi Publications, New Delhi, 2007

Suggested Reading

1. V.K. Jain, "*Refrigeration and Air Conditioning*", S Chand & Company, New Delhi, 2004.
2. Manohar Prasad, "*Refrigeration and Air Conditioning*", New Age International, Allahabad, 2007.
3. Edward G Pita, Air conditioning Principles and Sytems: An Energy Approach,4th edn,PHI,2012

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16ME E02

MECHANICAL VIBRATIONS (Professional Elective-I)

Instruction	4 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives:

1. To gain the knowledge of mathematical modeling of a physical system and applying the principles of Newton's Second Law and conservation of energy to derive the equations of motion.
2. To study the response of a vibrating system with periodic excitation and understand the principle of vibration isolation.
3. To develop the equations of motion for a continuous system in elongation, bending and torsion to find the natural frequencies and mode shapes.

Course Outcomes:

1. Ability to construct a Free Body Diagram, formulates the equations of motion, analytically solves the equations of motion for arbitrary linear single-degree-of-freedom systems in undamped, damped cases.
2. Ability to analyze the basic principles of vibration isolation and absorption and ability to apply them to the design of mechanical systems such as automotive suspensions.
3. Ability to formulate the equations of motion analytically solves the equations of motion for arbitrary linear two -degree-of-freedom systems in undamped, damped, free and forced cases,
4. Ability to analyze normal mode vibration, coordinate coupling and orthogonal property of modeshape.
5. Ability to differentiate discrete and continuous systems, formulate equation of motion and solve for string, bar and beams in continuous systems.
6. Ability to understand vibration measuring instruments, display and recording to elements, frequency analysis.

UNIT-I: Free Vibration Analysis-Single Degree of Freedom Systems Undamped and Damped Translation and Torsional Systems:
Different methods for equation of motion- Energy method, Rayleigh method, principal of virtual work, principal of conservation energy, Rayleigh's method. Viscously damped free vibration, logarithmic decrement, coulomb damping,

UNIT-II: Harmonically Excited Vibration:
Forced harmonic vibration, Rotating unbalance, whirling of rotating shafts, support motion, vibration isolation, energy dissipated by damping. Equivalent viscous damping, structural damping.

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UNIT-III: Damped and Undamped Vibrations of two Degree of Freedom System:
Free and forced vibration analysis of two degree of freedom system-different methods for the formulation of equation equations of motion, natural frequencies,
Normal mode vibration, Coordinate coupling and principal coordinates, semi definite systems, influence coefficients-flexibility, stiffness. Eigen values and Eigen vectors, orthogonal properties of Eigen vectors, repeated roots, modal matrix.

UNIT-IV: Vibrations of Continuous Systems:
Vibrations of strings, bars and beams, formulation of equation of motion, characteristic equation, identification of node and mode shape.

UNIT-V: Vibration Measurements and Applications:
Vibration pickup, Vibrometer, accelerometer. Transducers, piezoelectric transducers, Electrodynamic transducers. Vibration exciters, mechanical and electro dynamic shakers. Frequency measuring instruments.

Text Books:

1. Theory of Vibration with Application, J.J. Thomson, Dec-2002
2. S.S. Rao ,Mechanical vibration, 4th edn, Pearson, 2009
3. G.S. Grover & Nigam ,Mechanical Vibrations,Nem Chand & Bros, 6th edn,1998

Suggested Reading:

1. V.P. Singh , Mechanical vibration, Dhanpath Rai &Co.,3rd edn,2006
2. Graham Kelley,S., Mechanical vibration – Schaums Outline Series, TMH
3. F.S. Tse, Morse & Hinkle ,Mechanical vibration, Allyn and Bacon, 1978

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16PE E02

PRODUCT DESIGN AND PROCESSES PLANNING (Professional Elective-I)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives:

1. The Product Design and Process Functions
2. The essence of innovation in product development
3. The Human Machine Interactions (ergonomics)
4. The various Intellectual Property Rights
5. The interaction between Design, Manufacturing, Quality and Marketing
6. The awareness about overall view of Process Planning

Course Outcomes:

1. Have overall view of Product Design and Process Planning
2. Apply creativity techniques in Product Development
3. Applying ergonomically enabled concepts in developing a new product
4. Have awareness and apply Intellectual Property Rights
5. Integrate various stages of developing a new product
6. Develop and execute an effective Process Plan

UNIT-I: Product Design and Process Design:
Functions, Essential factors of product design, Selection of right product, Systematic procedure of product innovation, function of design, value of appearance, colors and laws of appearance.

UNIT-II: Product Selection and Evaluation:
Need for creativity and innovation. Techniques of innovation like brain storming and Delphi techniques, collection of ideas. Selection criteria - screening ideas for new products using evaluation techniques. Principles of ergonomics, Anthropometry, Design with Human Machine Interaction (HMI)

UNIT-III: New Product Planning and Development:
Interaction between the functions of design, manufacture, and marketing, design and material selection, Steps for introducing new products after evaluation, Product life cycle, Research and new product development

UNIT-IV: Intellectual Property Rights (IPR):
Patents, definitions, Types of Patent, Patent search, Patent laws, International code for patents, Trademark, Trade Secret, Copy Rights and Industrial Design

UNIT-V: Process Selection and Planning:
Process selection, process planning, process sheets, Selection of manufacturing process, estimation of machining time in various cutting operations, Estimation of costs for manufacture, value engineering in product design, Group technology, concepts of concurrent engineering

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Text Books:

1. Niebel BW & Draper AB, *Production Design & Process Engg*, McGraw Hill, Kogakusha, 1974
2. K. G. Swift & J. D. Booker, *Process Selection*: From Design to Manufacture", Butterworth-Heinemann Ltd; 2nd Revised edition, 2003
3. Bhaskaran Gopalakrishnan, *Product Design and Process Planning in CE (Design & Manufacturing*", Chapman and Hall publishers, 1994

Suggested Reading:

1. Harry Nystrom, *Creativity and Innovation*, John Wiley & Sons,
2. Brain Twiss, *Managing Technological Innovation*, Pittrnan Publications, 1992
3. Harry, B.Waton, *New Product Planning*, Prentice Hall Inc., 1992
4. Chitale, A. K. & Gupta RC., *Product Design & Manufacturing*, PHI, 1997

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16PE E01

POWDER PROCESSING – (Professional Elective-I)

Instruction	: 3 Hours per week
Duration of Semester End Examination	: 3 Hours
Semester End Examination	: 70 Marks
Continuous Internal Evaluation	: 30 Marks
Credits	: 3

Course Objectives: To understand the different

1. Powder processing methods
2. Powder properties & characteristics
3. Powder mixing & compaction methods.
4. Powder Sintering methods.
5. Post Sintering processes
6. Testing's of sintered parts.

Course Outcomes: Students will be able to

1. Know the fundamentals in powder manufacturing methods
2. Characterize the Powders in different techniques
3. Suggest appropriate compaction technique for a particular powder
4. Suggest appropriate sintering technique for a particular powder
5. Choose correct post sintering processes
6. Have ability to choose the appropriate testing for sintered parts.

UNIT-I : Introduction:
Importance and advantages of powder processing.
Powder Manufacture: Comminution, solid state reduction, electrolysis, thermal decomposition, and Atomization (water atomization, oil atomization, gas atomization, centrifugal atomization).

UNIT-II : Powder Properties, Characterization, And Mixing:
Chemical composition, particle shape, powder density, particle size, size distribution compressibility, green strength. Blending and mixing. Compaction: Compact size, tool materials, design of sintered part, Olivetti process hot pressing, injection moulding, cold iso-static pressing, and hot iso-static pressing.

UNIT-III: Sintering:
Theory of sintering, Sintering practice – furnace design, furnace atmospheres, vacuum sintering, control of shrinkage, liquid phase sintering, activated sintering, and loose powder sintering.

UNIT-IV: Post-Sintering Operations: Re-press and re-enter, hot re-press, hot forge in a closed die, sizing, coining, HIP, steam treatment, infiltration, and impregnation. Heat treatment, hardening, and tempering, surface hardening, electro-plating, and other coatings. Deburring, machining and joining. Sinter forging.

UNIT-V: Testing of Sintered Parts and Applications:
Porous bearings, filters Magnetic Materials, super alloys, High speed steels, Stainless steels, ODS materials, Production of Near-net shapes, rapidly solidified powders, and spray forming. Manufacturing of Cutting tools, forming dies using powder metallurgy.

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Text books:

1. J. S. Hirsch horn: Introduction to Powder Metallurgy, American Powder Metallurgy Institute, Princeton, NJ, 1976.
2. P. C. Angelo and R. Subramanian: Powder Metallurgy- Science, Technology and Applications, PHI, New Delhi, 2008.
3. E.P. DeGarmo, J.T. Black, R.A. Kosher, Materials and processes in manufacturing – 8th Ed., PrenticeHall, 1997.

Suggested Reading:

1. Roy A. Lindberg, Processes and materials of manufacture – 4th Ed., Prentice Hall of India Pvt. Ltd., NewDelhi, 1995
2. H.H. Hausner – Hand book of powder metallurgy.
3. ASM Hand Book, vol. 7: Powder Metallurgy, ASM International.
4. Powder Metallurgy Technology, Cambridge International Science Publishing, 2002

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16 ME E04

HYDRAULIC MACHINES (Professional Elective-II)

Instruction	3	Hours per week
Duration of Semester End Examination	3	Hours
Semester End Examination	70	Marks
Continuous Internal Evaluation	30	Marks
Credits	3	

Course Objectives: The student will

1. Learn laws related to Fluid Machinery
2. Demonstrate his/her knowledge of principles and problems associated with reciprocating pumps
3. Understand various principles related to rotary pumps
4. Come to know the working principles of Hydraulic turbines
5. Learn the performance characters and selection of turbines.
6. Understand the fundamental principles of hydraulic systems

Course Outcomes: Student will

1. Be able to apply the various fluid laws to different hydraulic machines
2. Be able to understand the methodology of selection of reciprocating pumps
3. Acquire the knowledge the functionality of rotary pumps
4. Understand the selection procedure and estimate the power developed by various hydraulic turbines
5. Compare the performance of hydraulic turbines and pumps based on characteristics curves
6. Acquire knowledge the functionality of various hydraulic systems

UNIT-I: Hydraulic Machines:

Classification- Impulse-momentum equation- Lay-out of hydraulic power plant- working principle- Impact jet on vanes- Force exerted by a jet striking (i) a fixed flat vertical vane held normal to the jet flow (ii) at the centre of a fixed symmetrical curved vane (iii) at one end of fixed symmetrical curved vanes (iv) flat vertical vane moving in the direction of jet (v) a series of flat vertical moving vanes (vi) symmetrical curved vanes moving in the same direction as that of jet at inlet (vii) at one end of a series of un-symmetrical moving curved vanes

UNIT-II: Reciprocating Pumps:

Classification- working principle- single and double acting pumps- discharge, work done and power required to drive the pumps- slip, % slip and negative slip- Variation of pressure head in the suction and delivery pipes due to acceleration of piston- Variation of pressure head due to friction in the suction and delivery pipes- Indicator diagrams- Ideal and actual diagrams- Effect of piston acceleration and pipe friction on indicator diagram- Maximum speed at which the pump must run to avoid separation during suction and delivery strokes- Air vessels- Function of air vessels- Work saved by fitting air vessels to single and double acting pumps- Discharge of liquid into and out of air vessels- Performance characteristic curves

UNIT-III: Centrifugal Pumps:

Classification- Working principle- Comparison over reciprocating pumps-Velocity triangles- Manometric head- work done per second- Head equivalent of work done- Manometric, mechanical and overall efficiencies- Pressure rise in the impeller- Minimum starting speed- Specific speed- Physical significance of specific speed- Model testing- Conditions of similarity of CF pumps- Priming- Performance characteristic curves

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UNIT-IV: Hydraulic Turbines:
Classification- Impulse and reaction turbines- Construction and working of Pelton wheel, Francis turbine and Kaplan turbine- Velocity triangles- Work done (power developed)- Hydraulic, Mechanical and Overall efficiencies- Maximum efficiency-Specific speed- Physical significance of specific speed- Unit testing -Unit quantities- Model testing of turbines- Conditions for similarity of turbines- Performance characteristic curves

UNIT-V: Hydraulic Systems (appliances):
Working of hydraulic press- accumulator- intensifier- Ram- jack- lift- direct acting hydraulic lift- Suspended hydraulic lift- crane- air lift pump- gear wheel pump

Text Books:

1. Bansal, R.K., "A Text Book of Fluid Mechanics and Hydraulic Machines", Laxmi Publication (P) Ltd., New Delhi,2004
2. Modi, P.N. and Seth. S.M., "Hydraulics and Fluid Machines", Standard Book House, New Delhi, 2004
3. Ramamrutham, S., "Hydraulics,Fluid Mechanics and Fluid Machines", Dhanpat Rai and Sons, New Delhi,2004

Suggested Reading:

1. Kumar, K.L., "Engineering Fluid Mechanics", Eurasia Publishing House (P) Ltd., New Delhi,2004
2. White, Frank. M., Fluid Mechanics, 5th Edn., McGraw Hill 2003.
3. Madan Mohan Das., "Fluid Mechanics and Turbo machines", PHI Learning Private Limited, New Delhi, 2009

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16PE E03

NON-DESTRUCTIVE TESTING AND EVALUATION (Professional Elective - II)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives: Student has to understand the

1. Need, basic concepts and technologies of Non Destructive Testing (NDT)
2. Security precautions from Radiography, protection from radiation and measurement of radiation received by personnel.
3. Technology of acoustic emission (AE), the associated instrumentation and applications
4. Technologies like neutron radiography; laser induced ultrasonics, surface analysis and thermography
5. Merits and demerits of the different NDT Technologies
6. Latest research and developments in NDT

Course Outcomes: At the end of the course, the students will be able to demonstrate

1. The knowledge of different NDT techniques.
2. Clear understanding of liquid penetrant inspection and magnetic particle inspection.
3. View and interpret radiographs, utilize the various principles of radiography for different components of different shapes.
4. The knowledge of acoustic emission for NDT and the instrumentation used for NDT.
5. The ability to analyze and prepare a technical report.
6. The knowledge of latest research, developments and trends in NDT.

UNIT-I: Liquid Penetrate Inspection:
Principles of penetrate inspection, characteristics of a penetrate, water washable system, post emulsification system , solvent removable system, surface preparation and cleaning, penetrate application, development, advantages limitations, and applications.

Magnetic Particle Instruction:
Principle, magnetization methods, continuous and residual methods, sensitivities, demagnetization, magnetic particles, applications advantages and limitations.

UNIT-II: Eddy Current Testing:
Principle, lift-off factor, and edge effect, skin effect, inspection frequency, coil arrangements, inspection probes, types of circuit, reference pieces, phase analysis, display methods and applications.

UNIT-III: Ultrasonic Testing:
Generation of ultra sound, characteristics of an ultrasonic beam, sound waves at interfaces, sound attenuation, display systems, probe construction, type of display, inspection techniques, identification of defects, Immersion testing , sensitivity and calibration. Reference standards. Surface condition, Applications.

UNIT-IV: Radiography:
Principle and uses of radiography, limitation principle, radiation sources, production of X-Rays, x-ray spectra, attenuation of radiation, radiographic equivalence, shadow formation enlargement and distortion, radio graphic film and paper, Xeroradiography, fluoroscopy, exposure factors, radiographic screens, identification markers and image quality indicators, inspection of simple shapes, inspection of complex shapes, viewing and interpretation of radiographs, radiation hazard, protection against radiation, measurement of radiation received by personnel.

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UNIT-V: Acoustic Emission:
Physical Principles, Sources of emission, instrumentation and applications, Other NDT Techniques: Neuron radiography, Laser induced ultrasonic, surface analysis, and thermography.

Text Books:

1. Barry Hull & Vernon John, *Non Destructive Testing*, 1988.
2. H J Frissell (Editorial Coordinator), Non-*Destructive Evaluation and quality control*, ASM handbook-International Publication USA, 1989.
3. Dove and Adams, *Experimental Stress analysis and Motion Measurement*, Prentice Hall of India, Delhi

Suggested Reading:

1. *Non-Destructive Examination and Quality Control*, ASM International, Vol.17, 9th edition (1989)
2. J. Prasad and C. G. K. Nair, *Non-Destructive Test and Evaluation of Materials*, Tata McGraw-Hill Education, 2nd edition (2011).
3. B. Raj, T. Jayakumar and M. Thavasimuthu, Practical *Non Destructive Testing*, Alpha Science International Limited, 3 rd edition (2002).
4. T.Rangachari, J. Prasad and B.N.S. Murthy, *Treatise on non-destructive testing and evaluation*, Navbharath Enterprises, Vol.3, (1983)

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16PE E04

PLASTICS, CERAMICS AND COMPOSITE MATERIALS (Professional Elective-II)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives: To make the students to

1. Understand various types of plastics, their properties and uses
2. Understand various methods of manufacturing plastic components
3. Understand types of ceramics, refractoriness, their uses.
4. Familiarize with white wares ceramic coatings and glass.
5. Understand the manufacturing processes of ceramics.
6. Understand composites and their uses

Course Outcomes: Students should able to

1. Describe about types of plastics, their properties and uses
2. Suggest the suitable method of manufacturing a plastic component.
3. Describe about types of ceramics, refractoriness, their uses.
4. Express the details about white wares ceramic coatings and glass.
5. Suggest the suitable method of manufacturing processes of ceramics.
6. Describe about types composites and their uses

UNIT I: Introduction to polymers:
Plastics and elastomeres, polymerization, degree of polymerization thermoplastics and thermosetting plastics, properties and applications of various thermo and thermosetting plastics, mechanical properties of plastics and their influencing parameters.

UNIT II: Manufacturing Methods of Plastics:
Injection moulding, Extrusion, calendering, thermoforming, Blow moulding, compaction moulding, transfer moulding

UNIT III: Introduction to Ceramics, Classification of Ceramic Materials , Conventional and Advanced; Refractories:
Classification of Refractories, Modern trends and developments, Basic raw materials, Elementary idea of manufacturing process technology, Flow diagram of steps necessary for manufacture, basic properties and areas of application

UNIT IV: White wares:
Classification and type of White wares, Elementary idea of manufacturing process technology including body preparation, basic properties and application area;. Ceramic Coatings : Types of glazes and enamels, Elementary ideas on compositions, Process of enameling & glazing and their properties. Glass: Definition of glass, Basic concepts of glass structure, glass manufacturing processes, Different types of glasses. Application of glasses.

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UNIT V: Fundamentals of composites:

Need for composites – enhancement of properties – classification of composites – Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Reinforcement – particle reinforced composites, Fibre reinforced composites. Applications of various types of composites. Fiber production techniques for glass, carbon and ceramic fibers. Manufacturing methods of composites.

Text Books:

1. Mikell P. Groover, "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems" Wiley publications, 6th edition'2015.
2. Kalpak Jain "Manufacturing Engineering and Technology" Pearson publications, 7th edition 2013
3. P.N. Rao, Manufacturing Technology, Vol.-1, McGraw Hills Publication, 4th Edn., 2016

Suggested Reading:

1. R.K.Rajput 'a text book of Manufacturing Technology", laxmi Pub., Vol-I, 2007
2. P.C. Sharma, 'A Text book of production Technology', S. Chand & Co., Pvt.Ltd., 8th Edn 2014.

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16MT EO4

PROBABILITY AND NUMERICAL METHODS (Professional Elective-II)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Exam	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3 Credits

Course Objectives:

1. To compute the statistical averages& different properties.
2. To study the probability distributions for stochastic data.
3. To understand for finding solution of non-linear equations
4. To study the process of calculating the value of the numerical derivative of a functions & numerical integration of a given data.
5. To identify the solution for initial value problem numerical differential equations

Course Outcomes: On the successful completion of this course, the student shall be able to

1. Analyse the statistical averages and different properties for probability function.
2. Fit the probability distribution for the random data.
3. Solve the non-linear equations for finding the roots.
4. Solving the Differentiation & Integration for numerical data.
5. Solving the ordinary differential equations using single & multi-step methods

UNIT I: Random Variables: Mathematical Expectation, Variance, Co-Variance, and its properties, Probability function, Moments, mgf, cgf and its properties.

UNIT II: Probability Distributions: Discrete distribution: Binomial, Poison distributions, finding Mean and Variance through mgf. Continuous distribution: Normal distribution, Exponential & Uniform distributions.

UNIT III: Solution For Non-Linear Equations: Algebraic & transcendental equations, Bisection method, Regular False Method and Newton Raphson method, interpolation, Newton's forward and backward formulas.

UNIT IV: Numerical Differention & Integration: Numerical differentiation using numerical forward & backward interpolation formula, Numerical integration: Simpson's $3/8^{th}$ rule, Weddle's rule.

UNIT V: Numerical Solution Of Oridinary Differential Equations: Picard's method, Euler's method, R.K method (fourth order) and Milne Thompson's method (predictor & corrector)

Text Books:

1. S.C Gupta and V.K.Kapoor, Fundamentals of Mathematical statistics, S.Chand& Co.2006 Publishers.
2. M.K.Jain, S.R.K Iyengar and R.K.Jain: Numerical methods for Scientific and Engineering Computation. New Age International publications, 2008.

Suggested Reading:

1. Miller and Freund, Probability and Statistics for Engineers, Pearson, 2005.
2. Numerical Methods by S.S.Shastry, PHI Learning Pvt. Ltd.

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16ME C23

DYNAMICS AND VIBRATIONS LAB

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
Continuous Internal Evaluation	25 Marks
Credits	02

Course Objectives:

1. To demonstrate basic principle and exposure to evaluate CAM Follower Motion and Gyroscopic effects.
2. Students will understand the importance of static and dynamic balancing
3. Students will acquire the knowledge in evaluating the stability of dynamic systems.

Course Outcomes: Students will be able to

1. Evaluate the effect of gyroscopic couple
2. Evaluate the effect of CAM Follower Motions in machines
3. Estimate the performance of governors
4. Evaluate the static and dynamic balancing of rotating masses
5. Estimate the natural frequency of different un-damped vibrating systems
6. Estimate the natural frequency of different damped vibrating systems

List of experiments:

(1) To study the motion of follower with the given profile of the cam. (To plot the n-q (Follower displacement Vs Angle of rotation) curves for different cam follower pairs.

(2) To study the gyroscopic effect on a rotating disc.

(3) Determination of the frequency of torsional vibration.

(4) Static and Dynamic balancing in a Rotating mass system.

(5) Study the effect of varying mass on the centre of sleeve in porter governor.

(6) Study the effect of varying the initial spring compression in Hartnell governor.

(7) Undamped torsional vibrations of double rotor system.

(8) To study the longitudinal vibrations of helical coiled spring.

(9) To study the undamped forced vibration of spring mass system.

(10) To study the force damped vibration of spring mass system.

(11) Determination of critical speed of the given shaft with the given end conditions. (Whirling of Shafts)

(12) Frequency response of spring mass system with damping.

Text Books:

1. S. Rattan, *Theory of Machines*, Tata-Mc Graw Hill, 1995.
2. John.J.Vicker, Gordon R. Pennock, Joseph E. Shigley, *Theory of Machines & Mechanisms*, Oxford University Press, 2003

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16ME C24

APPLIED THERMODYNAMICS & HEAT TRANSFER LAB

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
Continuous Internal Evaluation	25 Marks
Credits	2

Course Objectives

1. To demonstrate basic knowledge and exposure to determine valve and port diagram and also to evaluate the performance of the petrol engine and diesel engine
2. Student will determine the importance of heat balance sheet of IC engine n
3. Students will acquire knowledge in evaluating the performance of multi-stage reciprocating compressor
4. To demonstrate knowledge in evaluating thermal conductivity and heat transfer coefficient under natural convection phenomena and forced convection phenomena
5. Students will understand the basic concepts of radiation heat transfer
6. Student will understand the effectiveness of parallel and counter flow heat exchanger

Course Outcomes: Students will be able to

1. Evaluate the performance of petrol and diesel engine
2. Estimate the heat losses in heat balance sheet of and IC engine
3. Evaluate the performance of multi stage reciprocating air compressor and its importance over single stage air compressor
4. Estimate the effect of insulation on conduction heat transfer and also estimate the value of convection heat transfer coefficients under different scenario
5. Determine Steffan and Boltzman constant and emissivity in radiation heat transfer
6. Estimate the properties of radiating body and effectiveness of heat exchangers .

Applied Thermodynamics:

1. Determination of Valve timing diagram and Port diagram of IC engine.
2. Determination of Performance characteristics of a multi-cylinder petrol engine.
3. To conduct Morse test on multi cylinder petrol engine.
4. To conduct performance test on a variable compression ratio petrol engine.
5. To conduct performance test on single cylinder diesel engine.
6. To conduct heat balance test on single cylinder diesel engine.
7. To determine volumetric efficiency, isothermal efficiency of multi -stage reciprocating air compressor.

Heat Transfer:

1. Determination of Thermal conductivity of insulating powder.
2. Determination of thermal conductivity of composite wall.
3. Determination of convective heat transfer coefficient under Natural and Forced convection phenomena using pin-fin apparatus.
4. Determination of Emissivity of a given plate.
5. Determination of the value of Stefan-Boltzman constant.
6. Determination of Heat transfer coefficient in parallel and counter flow heat exchanger

Text Books:

1. R.K. Rajput, " Thermal Engineering", Laxmi Publishers, New Delhi, 2014
2. Mahesh M. Rathore, "Thermal Engineering," TMH, New Delhi, 2010

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Note: Minimum 12 Experiments taking 6 from each section

16EE C22

ELECTRICAL MACHINES AND MICROCONTROLLER APPLICATIONS LAB
(Common to BE3/4, Mech. & Prod, V- SEM)

Instruction	1T + 2 Periods per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
Continuous Internal Evaluation	25 Marks
Credits	2

Course Objectives:
1. To understand the testing of 1-phase transformers.
2. To comprehend various characteristics of DC machines.
3. To understand the characteristics of different AC machines.
4. To learn operations on 8051 microcontroller
5. To understand basics of interfacing devices with 8051 microcontroller

Course Outcomes: The student will be able to
1. Test the 1-phase transformer.
2. Know the right instrument and its usage for the given circuit.
3. Identify the suitable machine for required application.
4. Process the data using 805i microcontroller
5. Interface the given device with 8051 microcontroller

List of Experiments:

Cycle -I
1. Magnetization characteristics of a separately excited DC generator.
2. Load characteristics of a shunt generator.
3. Performance characteristics of a shunt motor.
4. Performance characteristics of a compound motor.
5. Speed control of DC shunt motor.
6. O.C. and S.C. tests on single phase transformer.
7. Load test on a three phase induction motor. .
8. Speed control methods of induction motor.
9. To determine the load characteristics of a DC series motor.

Note: At least **SIX** experiments should be conducted in the semester from cycle - I

Cycle -II
1. 8051 Microcontroller Experiments
2. Data Transfer - Block move, Exchange, sorting, Finding largest element in an array
3. Arithmetic Instructions :Multi byte operations
4. Boolean & Logical Instructions (Bit manipulations)
5. Use of JUMP and CALL instructions.
6. Control of stepper Motor using 8051
7. A/D converter interface with 8051 Microcontroller
8. D/A converter Interface with 8051 Microcontroller

Note: At least **FOUR** experiments should be conducted in the semester from cycle - II

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16PE C05

INDUSTRY VISIT

A minimum of two industrial visits will be arranged by department and students have to attend the visits and prepare a data report of their visits to the industries and submit to the department. Students are required to present a seminar based on their report which is evaluated by Head of the Department and two senior faculty to award the grade and these grades are categorized as follows.

Excellent / Very Good / Good / Satisfactory / Unsatisfactory

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CAD AND CAM

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives:

1. Understand the basic and advanced concepts of computer aided design. Learn the application of CAD in geometric modeling.
2. Students will develop an understanding of the theory and construct the elements of curved surface representation.
3. Explain solid modeling representation schemes and the Euler operators. Understand and be able to perform two-dimensional and three-dimensional geometric transformations on objects.
4. Have an overview of advantages and disadvantages of modeling and analysis packages.

Course Outcomes: After completion of course, the student will able to

1. Apply design concepts in design , analysis and modeling of entities and curves
2. Apply surface and solid modeling techniques for the generating various parts and implement transformations on various geometric models for manipulation.
2. Visualize the models through the graphics standards and implement NC,CNC systems and programming
3. Implement and practice the DNC and AC controls , analyze the manipulator motions, configurations including end effectors, actuators, drives and sensors and programming.
4. Learn and Implement GT and Coding methods and CAPP.
5. Understand and implement FMS,CIMS,RPT ,QC- methods & controls and Turnkey CAD/CAM systems.

UNIT-I: Design Process:
Design criteria, Alternative solutions, Alternative design, Computer aided design and review
Drafting techniques: Basic geometric elements and their creation
Geometric modeling: Wire frame entities and their definition, interpolation and approximation curves. Concept of Parametric and non-parametric representation of circle and helix curves,
properties of splines. Synthetic curves: parametric representation of cubic spline, Bezier and B-spline curves, continuity, properties and characteristics. Introduction to NURBS.

UNIT-II: Surface Modeling:
Analytic surfaces: Definition of planar, Ruled , surface of revolution, tabulated cylinder.
Synthetic Surfaces: Cubic and Bezier surfaces.
Solid modeling: C – rep and B – rep approaches
Design Applications: Mass property calculations, mechanical tolerancing, finite element analysis.
2 D Transformations: Translation, scaling and rotation about arbitrary point, shear and reflection, homogenous representation, concatenation

UNIT-III: CAD Database and Data Exchange:
CAD database and structure, IGES, STEP and STL format

Numerical Control of Machine Tools:
Features and elements of NC, Types of NC systems: PTP, Straight Cut and Contouring
Introduction to CNC , Typical configurations, Definition of axes, Definition of interpolation, post-processor, preparatory and miscellaneous functions, canned cycles, tool length and cutter radius compensation. Manual and computer aided part programming (APT) for simple components. Programming with MACROS..

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UNIT-IV: DNC:
Typical configurations ,CNC vs DNC, Adaptive control systems, Machining centers. Introduction to FANUC, SINUMERIC controllers.
Industrial robots:
Robot anatomy, configurations, controls, drivers, programming methods and applications.

UNIT-V: GT:
Part families, layout, part classification and coding system- OPITZ, MICLASS .
CAPP: Variant and generative process planning.
FMS and CIM: F.M.S equipment, FMS layouts, benefits of FMS.. Elements of CIM.
Computer Aided Inspection and QC:
Automated inspection- Off-line, On-line, contact (Co-ordinate measuring machine), Non-contact inspection (Machine Vision, Scanning LASER Beam, Photogrammetry)
CAD/CAM integration, Turnkey CAD/CAM systems, Introduction to rapid prototyping technique.

Text Books:

1. Ibrahim Zeid, CAD/ CAM "theory and practice" , McGraw Hill Inc , New York, 2011
2. Grover MP and Zimmers EW "CAD/CAM" Prentice Hall of India, 1989
3. Rao PN "CAD/CAM : Principles and applications" 2nd edition, Tata McGraw Hill, New Delhi, 2004

Suggested Reading:

1. Arvid R Eide , Roland D Jenison, Lane H Mashaw, Larry L Northup, "Introduction to Engineering Design" McGraw Hill 1998
2. Yoramkoren, "Computer Control of Manufacturing Systems" McGraw Hill Int, New York, 1994
3. Elanchezhian C Sunder Selwyn , T Shanmuga Sunder G" Computer Aided manufacturing" , Laxmi Publications P) Ltd, 2nd edition, New Delhi 2007

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16PE C06

MACHINE TOOL ENGINEERING

Instruction	3	Hours per week
Duration of Semester End Examination	3	Hours
Semester End Examination	70	Marks
Continuous Internal Evaluation	30	Marks
Credits	3	

Course Objectives: Student will learn the

1. To provide the basic understanding of cutting tools, geometry in machining process
2. To make students familiar with cutting forces in turning drilling, milling operations.
3. To make the students to understand various machine tools, like lathe, drilling, milling shaper, planner
4. To make a knowledge of Thread manufacturing and gear manufacturing

Course Outcomes: Students are able to

1. Select tool geometry for various materials
2. Calculate forces in turning, drilling and milling processes
3. Identify the machine tools for manufacturing various components
4. Understand thread cutting and gear cutting operations
5. Select grinding wheel and Automats
6. Work on shaper, planner and grinding machines

UNIT-I: Orthogonal and Oblique Cutting:
Cutting forces in turning, drilling milling and grinding, Merchant's analysis, Shear angle, friction angles. Experimental methods for estimation of shear angle, cutting forces and power, types of chips. Built up edge phenomena and its effects. Chip breakers. Sources of heat, its distribution and measurement. Different types of cutting fluids.

UNIT-II: Tool Wear and Tool Life:
Criteria for tool wear, flank and crater wear theories, criteria for tool life in roughing and finishing, Measurement of tool wear, Taylor's tool life equation, factors effecting tool life, Machiniability. Single point cutting tool design; Geometry, tool nomenclature, American, DIN, max. rake system. Interrelation between normal rake and orthogonal rake, tool signature, effect of basic tool angles on its performance. Selection of size and angles of S.I. Tools, from tools. Design feature of multipoint cutting tools.

UNIT-III: Lathe:
Types constructional features, size of lathe, various operations that can be performed on lathes types of lathes, capstan and turret lathes, bar work and chuck work and tool holding devices. Taper turning methods. Thread cutting and accessories of lathe

Automats:
Single spindle and multiple spindle automats, Swiss type of automats, constructions and features of these machines.

UNIT-IV: Drilling Machines:
Types and constructional features and applications, Radial drilling machine, drilling operations

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Milling Machines:
Classifications and types various operations on milling machines, Up and down milling, Types of milling cutters and bars. Dividing head, plain, compound and differential indexing.
Boring machines: Horizontal, Vertical and Jig boring machines and constructional features.
Thread production: Thread rolling, thread chasing , thread milling and thread grinding

UNIT-V : Shaping, Planing & Slotting Machines:
Types, Constructional features, Types of work done on it. Quick return motion, manipulation of cutting speeds and feeds, work and tool holding devices, comparison of these machines.

Gear Cutting Machines:
Methods of gear cutting, types and classification of gear hobbing, gear shaping machines Bevel gear cutting

Grinding Machines:
Types, Classification Abrasives and bonds used for grinding wheel, Selection of grinding wheel, cylindrical grinding and center less grinding

Text Books:

1. B.L. JuneJa and Shekon, *"Fundamentals of Metal Cutting & Machines Tools"*, Wiley Eastern Ltd. 1987.
2. P.N. Rao, *"Manufacturing Technology – Metal Culling & Machine Tools"*, Vol. 2, Tata McGraw Hill Education Pvt. Ltd, 2010.
3. M.C. Shaw, "Metal Cutting Principles", Clarendon Press, Oxford 1984

Suggested Reading:

1. Hazra Choudary, "Workshop Technology", Vol. II, Media Pub., New Delhi.
2. Kibbe Richand R, Meyer, R.D, Neely etal, 'Machine Tool Practices, 9th Edition, PHI, 2014.
3. Jain & Chitale, Text Book of Production Engineering, 2nd Edition, PHI, 2014

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16PE C07

ADDITIVE MANUFACTURING (Professional Elective-III)

Instruction	3	Hours per week
Duration of Semester End Examination	3	Hours
Semester End Examination	70	Marks
Continuous Internal Evaluation	30	Marks
Credits	3	

Course Objectives:

1. To make students understand the basic concepts of various rapid prototyping technologies.
2. To understand and apply criterion for selecting appropriate RPT technique for any given application.
3. To competently use tools to explore digital manufacturing techniques and CAD modeling software
4. To understand the stl file generation and manipulations
5. Explain and summarize the principles and key characteristics of RP technologies and commonly used RP systems.
6. To make students understand typical rapid tooling processes for quick batch production of plastic and metal parts

Course Outcomes: After completion of course, the student will able to

1. Explain the process chain of Additive manufacturing and other rapid manufacturing Processes and their classification, advantages and disadvantages.
2. Critically explore technologies used for Additive manufacturing in terms of their parameters, application, limitations, materials, equipment, outcomes and implications and their comparison.
3. Compare different Additive manufacturing processes and select a subtractive or an AM process for a particular application for product development of engineering components.
4. Describe various CAD issues for rapid prototyping and related operations for STL model manipulation, formulate and solve typical problems on reverse engineering.
5. Identify different post processing techniques involved after rapid prototyping
6. Explore the applications of Additive manufacturing in different industries

UNIT-I: Introduction to rapid manufacturing:

Customization and mass customization, types of mass customization. Classification of fundamental fabrication processes (additive/subtractive/formative), Difference between AM and CNC. Process chain for Additive Manufacturing(AM) processes. Classification of additive (layered) Manufacturing processes. Advantages and Limitations of AM.

UNIT-II: Extruder Deposition System:

Laminated object manufacturing, shaped deposition manufacturing and modular configuration. Photo polymerization, Stereo lithography apparatus & Solid ground curing -Working principles and their applications, advantages and disadvantages. Laser sintering based technologies and their related details. Direct metal laser Sintering process.

UNIT-III: Pre-processing in AM:

Pre-processing of CAD model- STL conversion, STL error diagnostics, STL file Repairs: Generic Solution. Newly Proposed Formats.

Support generation, transformations, slicing, surface preparation of materials, pre-heating of powders.

Rapid Prototyping Software's: Features of various RP software's like Magics, Mimics, Solid View, Rhino, STL View 3 Data Expert and 3 D doctor.

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UNIT-IV: Post processing in AM:
Post processing equipment – support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern,
Property enhancements using non–thermal and thermal techniques.
Rapid Tooling:
Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Rapid Tooling Classification: **Indirect Rapid Tooling Methods**: Arc Spray Metal Deposition, Investment Casting, 3D Keltool process. Direct Rapid Tooling: Direct AIM , LOM Tools, EOS Direct Tool Process

UNIT-V: AM Applications:
Application in Design, Engineering, Analysis & Planning. Application in Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture.
RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Forensic Science.

Text Books:

1. Gibson I, Rosen DW and Stucker B; Additive manufacturing methodologies : Rapid prototyping to direct digital manufacturing , Springer , 2010
2. Chee Kai Chua, Kah Fai Leong , 3D printing and additive manufacturing : principles and application: fourth edition of rapid prototyping
3. Venuvinod, PK; Ma, W; Rapid prototyping – Laser based and other technologies, Kluwer , 2004

Suggested Reading:

1 Rapid tooling : Technologies and industrial applications by Jacob, Paul F
2 Andreas Gebhanrdt, Understanding Additive Manufacturing,Hanses,2012
3 Alain Brnard, Georges Talliander,Additive Manufacturing,Wiley,2014

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16ME C29

MACHINE DESIGN

Instruction	4 Theory Periods per week
Duration of Semester End Examination	3 Hours
Semester End examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	4

Course Objectives:

1. To learn design criteria of machine components, selection of materials and manufacturing process.
2. To learn application of principles to design helical coiled and leaf springs, gears, curved beams, sliding contact and rolling element bearings and IC engine components.
3. To provide the design concepts of helical and leaf springs.
4. To provide the students the knowledge of design of IC engine parts.

Course Outcomes:

1. Graduates demonstrate the ability to design helical, leaf springs for static and fluctuating loads.
2. Graduates expected to have an ability to design gears for power transmission considering beam strength, dynamic factors and wear life.
3. Graduates demonstrate the ability in designing sliding contact bearings, considering power lost in friction, heat dissipation.
4. Graduates are expected to have the ability of selection of rolling contact bearings based on load-life relationship.
5. Graduates demonstrate the ability of designing IC engine parts such as piston, connecting rod and crank shaft considering gaseous impulse and thermal aspects.
6. Graduate demonstrate the ability of designing curved beams like C-clamp, crane hooks etc.

UNIT-I: Mechanical Springs:

Introduction, types of springs, Materials used for springs.

Helical Springs:

Whal's factor, calculation of stresses, deflection and energy stored in spring. Design for static and fluctuating loads.

Leaf Springs:

Stresses and deflection, nipping of Leaf springs. Design for static loads.

UNIT-II: Gears:

Introduction to gear drives, types of gears, materials used for gears. Standards and specification of gears. Design of Spur, Helical, Bevel and Worm gears: Lewis beam strength equation. Dynamic loads on gear tooth. Wear load and design for wear strength.

UNIT-III: Bearings:

Introduction, classification of bearings, materials used for bearings, properties and types of lubricants.

Design of Sliding Contact Bearings:

Hydrostatic and Hydrodynamic bearings.

Selection of Rolling Contact Bearings: Types of rolling elements and their constructional details. Static and dynamic load carrying capacity. Load-life relationship, selection of bearing, for cyclic loads and speeds.

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UNIT-IV: **I.C. Engine Parts**: Introduction. Materials used. Design of piston, connecting rod and crank shaft.

UNIT-V: **Design of Curved Beams**: Introduction, stresses in curved beams, expression for radius of curvature of neutral axis for rectangular, circular and trapezoidal sections. Design of C-clamp and crane Hook. Design of chain drives: Power rating of roller chains. Strength of roller chains.

Text Books:

1.Bhandari V.B. Machine Design, Tata Mc Graw Hill Publications, 2010.
2.J.E. Shigley , C.R. Misckhe, Mechanical Engineering Design, Tata Mc Graw Hill Publication, 2010.
3.P. Kannaiah, Machine Design, Science-Tech Publications, 2010

Suggested Reading:

1. M.F. Spotts, Design of Machine Elements, Prentice Hall, 2013.
2. Robert L. Norton, Machine Design: An Integrated Approach, 2/e Pearson Education, 2013.
3. Siraj Ahmed, 'Mechanical Engineering Design, PHI, 2014.

Machine Design Data Books:

1. Design Data book by PSG College –2012
2. Mahadevn .K, Balaveera Reddy. K, 'Design Data Hand Book, 4th Edn., CBS Publishers & Distributors, 2013.
4. Machine Design Data Book, by V.B. Bhandari McGraw hill education, 201

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16PE E06

WORK SYSTEM DESIGN (Professional Elective – III)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives: Student will

1. Understand work system design concepts
2. Learn method study techniques
3. Conceptualize work measurement tools and techniques
4. Learn job evaluation and merit rating
5. Understand principles of ergonomics
6. Learn the concepts of production planning & control

Course Outcomes: At the end of the course, the student is able to

1. Use work study techniques to improve productivity
2. Apply method study recording techniques
3. Implement work measurement and time study tools
4. Execute job evaluation and merit rating techniques
5. Apply ergonomical principles in product design
6. Use concepts of production planning & control in industry

UNIT-I :Work Study:
Introduction, Basic Concepts, importance, Scope, procedure and benefits.
Productivity, Basic Concept and principles, Production Vs productivity, Productivity improvement techniques.

UNIT-II: Method Study:
Introduction, Steps involved in method study
Recording Techniques-Outline Process Chart, Flow process charts, Two handed process chart, Multiple activity chart, SIMO chart. flow diagram, string diagram, Travel chart, Cycle graph and Chronocycle graph, Therbligs. Principle of Motion Economy

UNIT-III: Work Measurement:
Introduction, Techniques of work, Measurement, Time study, Standard data, analytical estimation. Time study-objectives and uses of Time study. Time Study Equipments, Procedure for Time study, Allowances and types, Calculation of standard time.

UNIT-IV: Methods of Job and Performance Evaluation:
Job evaluation and Merit rating, various methods of job evaluation, performance Appraisal system, Wage Incentive systems.
Line balancing: Line balancing in production and assembly lines-Heuristic and other methods of line balancing.

UNIT-V: Ergonomics and economics: Ergonomic design, Ergonomic evaluation methods, cognitive ergonomics, participative ergonomics. Social sustainability for work systems.
Production planning & Control: Objectives of production planning and control- functions of production planning and control. Types of production – continuous and intermittent, job shop, batch and mass production systems.

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Text Books:

1. O.P. Khanna, Industrial Engineering and Management, Dhanpat Rai Pub.,
2. M.S. Mahajan Industrial Organization & Management, Nirali Prakashan Pub.
3. Gerald Nadler 'Work System Design: The ideals concept by McGraw Hill Publisher
4. Mikell P. Groover, 'Work system and The Methods Measurement and Management of Work', Pearson Prentice Hall, 2007

Suggested Readings:

1. Industrial Management, Deepak Kumar Bhattacharya, Vikas Pub., 2011.
2. Industrial Engineering & Management by S. Chand
3. Introduction to work study, ILO Publication

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16ME E06

COMPUTATIONAL FLUID DYNAMICS (Professional Elective – III)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives:

1. Understanding of governing equations of fluid flow.
2. Student understand finite difference and finite volume methods to solve fluid flow equations.
3. Issues that arise in the solution of such equations.
4. Various methods to overcome those issues and modern trends in CFD.
5. Get exposure to grid generation.
6. Various boundary conditions and their implementation.

Course Outcomes: At the end of the course, the students were able to

1. Classify basic equations of fluid flow
2. Choose appropriate boundary conditions
3. Choose proper numerical technique to solve equations.
4. Critically analyze different mathematical models and computational methods for flow simulations
5. Interpret computational results.
6. Acquire the required knowledge to take advanced courses in CFD.

UNIT-I: Basic Equations:
Continuity, momentum and energy equations, navier-stokes equations, Heat transfer conduction equations for steady and unsteady flows, steady convection-diffusion equation.

UNIT-II: Models:
Reynolds and Favre averaged N-S equations, Mixing length model, k-epsilon turbulence model
Classifications of Partial Differential Equations:
Elliptic, parabolic and hyperbolic equations, Initial and boundary value problems

UNIT-III: Finite Difference Method:
Forward, backward and central difference
Parabolic partial differential equations:
Euler, implicit and crank Nicholson methods, ADI models, Errors, consistency, stability analysis, Vonnumen analysis, Convergence criteria.

UNIT-IV: Elliptic Partial Differential Equations:
Jacobi, Gauss seidel methods, Viscous incompressible flow, Stream-function-vorticity method
Introduction to grid generation- types of grids O, H, C

UNIT – V: Finite Volume Method:
Finite volume formulation for diffusion equation, convection diffusion equation, Solution algorithm for pressure velocity coupling in steady flows, staggered grid, SIMPLE algorithm.

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Text Books:

1. P.S. Ghoshdastidat, Computational Fluid Dynamics & Heat Transfer, Cengage Pub.,
2. J.D. Anderson, Jr., *Computational Fluid Dynamics: The Basic with Applications* McGraw Hill, Inc., 2012
3. H. Versteeg and W. Malalasekra, *An Introduction to Computational Fluid Dynamics*: The Finite Volume Method, Pearson,2nd edn. 2011

Suggested Reading:

1. John F. Wendt (Editor), *Computational Fluid Dynamics - An Introduction*, Springer – Verlag, Berlin, 1992
2. Charles Hirsch, *Numerical Computation of Internal and External Flows*, Vols. I and II. John Wiley & Sons, New York, 1988
3. Anil W.Date, Introduction to Computational Fluid Dynamics, Cambridge

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CBIT(A)
16ME E07

with effect from the academic year 2018-19

AUTOMOBILE ENGINEERING (Professional Elective – III)

Instruction	4 Hours per week
Duration of Semester End Examination	3 Hours
Semester End examination	70 Marks
Continuous Internal Evaluation	20 Marks
Credits	3

Course Objectives: The student will learn

1. The anatomy of the automobile in general
2. The location and importance of each part
3. The functioning of the engine and its accessories, gear box, clutch, brakes, steering, axles and wheels
4. Suspension, frame, springs and other connections
5. Ignition, controls, electrical systems and ventilation
6. Emissions, pollution regulations, EURO and BHARATH stages

Course Outcomes: At the end of the course, the student will be able to

1. Identify the different parts of the automobile
2. Explain the working of various parts like engine, transmission, clutch, brakes
3. Describe how the steering and the suspension systems operate.
4. Understand the environmental implications of automobile emissions
5. Develop a strong base for understanding future developments in the automobile industry
6. Formation of pollutants in I.C Engines & Their remedial methods to control them

UNIT I: Types of automobiles:
Normal, Hybrid and Hydrogen Fuel vehicles. Engine location and its components, chassis layout; crank shaft proportion, firing order, piston and piston rings, cylinder liners, valves and operation mechanism, inlet and exhaust manifolds, carburetion and fuel injection system, Mechanical Fuel Injection system.

UNIT II: Lubricating Systems:
Wet sump, dry sump and petroil systems - Cooling systems: Water pumps, radiators, thermostat control anti freezing compounds - Types of Ignition Systems, Modern Ignition systems, Types of Batteries and charging systems, starting motors, lighting and electrical accessories, automobile air-conditioning.

UNIT III: Steering systems:
Linkage arrangements and its components modified Ackerman linkage, wheel alignment, caster and camber. Rack and pinion assembly, recent trends, Wheel and tyres: Tyre construction, specification. Tyre wear and causes, wheel balancing, wheel alignment, Types of Suspension systems, Independent suspension, coil and leaf springs, torsion bar, shock absorbers.

UNIT IV: Power Train:
Clutches, gear and gearbox manual, semi-automatic and automatic gearboxes. Torque converter, propeller shaft, universal coupling differential, four-wheel drive system
Brakes Systems: Description and operation of hydraulic brake, leading and trailing shoe layout, disc brakes, master cylinder and hand brake linkage, Recent Trends

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UNIT V: Maintenance:
Pollution control, trouble shooting and servicing procedure overhauling, engine tune up, tools and equipment for repair and overhaul testing equipment, pollution control technologies used for petrol and diesel engines. Types and study of catalytic converters, Euro norms 2 & 3 and Bharat Norms – Recent Trends.

Text Books:

1. *Crouse & Anglin, Automotive Mechanics*, TataMcGraw Hill. Publishing Co. Ltd., New Delhi, Tenth Edition – 2004
2. Kirpal singh., *Automobile Engineering Vol. I & II* Standard Publishers, Delhi.
3. R.K. Rajput, *A Textbook of Automobile Engineering*, Laxmi Publications, New Delhi, 2012

Suggested Reading:

1. Joseph Heitner, *Automotive Mechanics*, Affiliated East West Pvt. Ltd.
2. C.P Nakra, *Basic Automobile Engineering*, Dhanpat Rai Publishing Co(P) Ltd., New Delhi, 2003.
3. G.B.S. Narang, *Automobile Engineering*, Khanna Publishers, New Delhi, 2014

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16PE E07

QUALITY AND RELIABILITY ENGINEERING (Elective – III)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives: Student will understand the

1. Concepts of quality and associated techniques
2. process control for variables and attributes
3. Conceptualization of design for quality
4. Experimental design & quality techniques
5. Reliability and its influence in engineering
6. Conceptualization of the design for reliability & maintainability

Course Outcomes: At the end of the course, the student is able to

1. Apply quality improvement techniques
2. Use control charts for variables and attributes
3. Implement designing for quality
4. Apply experimental design and Taguchi methods
5. Use techniques of reliability engineering
6. Implement reliability & maintainability in industry

UNIT-I: Introduction: Introduction, definition of quality, basic concept of quality, definition of SQC, benefits and limitation of SQC, Quality assurance, Quality cost, Quality improvement process through Bar Chart, cause and effect diagram, parato analysis, scatter diagram etc,.

UNIT-II Process Control for Variables and Attributes: Causes of Variation, Control Charts for Variables (Mean and Range) Xchart and R chart, Control Chart Patterns and Corrective Actions, Control Charts for Attributes (p-chart, c-chart,) acceptance Sampling Plans, Producer's Simple and Consumer's risk, types of Sampling Plans and their demerits, operating Characteristic Curve, Average Outgoing Quality Curve), Errors in Making Inferences from Control Charts (Type I and II errors)

UNIT-III: Designing for Quality: Introduction to Concurrent Engineering, Quality Function Deployment (QFD) and Failure Mode and Effect Analysis (FMEA) - Concept, methodology and Application Experimental Design and Taguchi method: Fundamentals – factorial experiments – Taguchi method – Loss function – experiments – S/N ratio and performance measure- Orthogonal arrays.

UNIT-IV

Reliability Engineering: Reliability function, Failures rate, Mean Time Between Failures (MTBF), Mean Time To Failure (MTTF), mortality curve, availability, maintainability, system effectiveness. Introduction to probability distributions.

Time to failure distributions: Reliability evaluation of two-state device networks-series, parallel, Standby redundant systems, Reliability evaluation.

UNIT-V

Design For Reliability and Maintainability: Reliability design process, system effectiveness, economic analysis and life cycle cost, reliability allocation, design methods, parts and material selection, failure analysis, determination of causes, assessments of effects, computation of criticality index, corrective action, system analysis of down-time, reliability under preventive

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maintenance, repair vs replacement, replacement models, proactive, preventive, predictive maintenance, optimization techniques for system reliability with redundancy, heuristic methods applied to optimal system reliability.

Text Books:

1. Quality Assurance and Total Quality Management, by K C Jain and A K Chitale, Publisher: Khanna Publishers
2. Statistical *Quality* Control, by M. Mahajan, Publisher: Dhanpat Rai & Co. (P) ltd.
3. Statistical Methods for Quality, Reliability and Maintainability by K. Muralidharan and A. Syamsunder, PH Publications

Text Books:

1. Quality Control & Application, by B. L. Hanson & P. M. Ghare, Publisher: Prentice Hall of India
2. Reliability Engineering, by Srinath L. S., Publisher :Affiliated East West Press.
3. Statistical *Quality* Control, by Eugene L. Grant and Richard S. Leavenworth, Publisher :Tata McGraw-Hill Publishing Company ltd.
4. Quality and Reliability Engineering by Tirupathi R. Chandraputla, Cambridge Univ. Press, New Delhi

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16ME E10

TURBO MACHINES (Professional Elective-IV)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives: Student will

1. Learn the fundamentals of turbo machinery and its importance
2. Learn principles and equations of turbo machinery
3. Know about velocity triangle and power developed by steam turbines
4. Familiarize the working principles of axial flow compressor
5. Understand the working principle of Centrifugal compressor and its performance
6. Learn the power required for Rotary compressors and power developed by Gas turbines

Course Outcomes: Students are able understand

1. The principle of turbo machinery
2. Apply gas dynamics equations depending upon applications
3. Estimate the power developed by steam turbines
4. Find efficiency, pressure rise and degree of reaction of axial flow compressor
5. Analyze the slip factor and performance of centrifugal compressor
6. Understand cycles and improve the cycle efficiency in gas turbines

UNIT -I Introduction:
Definition and parts of turbo machines and its classifications, Comparison with positive displacement machines, Efficiencies of turbomachines, Static and Stagnation states,overall isotropic efficiency, stage efficiency (their comparison) and poly tropic efficiency for both compression and expansion processes.

UNIT – II Energy Exchange in Turbo Machines:
Euler's turbine equation, Alternate form of Euler's turbine equation, Components of energy transfer, Degree of Reaction, General Analysis of Turbo machines: Radial flow compressors – general analysis and Expression for degree of reaction, Problems.

UNIT-3 Steam Turbines:
Introduction to steam nozzles, design for throat area. Classification of steam turbines, Impulse turbine, compounding of steam turbines, Pressure velocity variations across different compounding turbines, blade efficiency and work done by impulse turbine ,degree of reaction of reaction turbine, blade efficiency and work done by reaction turbine, stage efficiency and nozzle efficiency and simple problems on impulse and reaction turbines

UNIT-4 Rotodynamic Compressors:
Introduction and general classification, Comparison of Reciprocating and Rotary compressors, Positive displacement Rotary compressors, Flow through rotary compressors. Static and total head quantities. Thermodynamic cycles and work done, calculation of various efficiencies. Velocity diagrams and pre-whirl. Euler equation for energy transfer between fluid and rotor, Analysis of Centrifugal compressors and analysis of axial flow compressors, Chocking, Surging and Stalling.

UNIT -5 Gas Turbines :
Application and classification of Gas turbine, Thermal efficiency of joule cycle, Maximum pressure ration in terms of temperature ratio, optimum pressure ratio for maximum work output with or without considering machine efficiencies .Improvements of gas turbine plant performance-Inter cooling, Reheating and regeneration. Simple problems on joule cycle.

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Air Craft Propulsion:
Aircraft engine types, Turbo jet engines, ram jet and Pulse jet engines.
Rocket Propulsion:
Types of Propellants, Types of Rocket engines, Rocket propulsion theory-Rocket applications

Text Books:

1. V. Kadambi and Manohar Prasad, An Introduction to Energy Conversion, Volume III, Turbo machinery, , New Age International Publishers, reprint 2008.
2. S. M. Yahya, Turbines, Compressors & Fans, Tata McGraw HillCo. Ltd., 2nd edition, 2002
3. S. L.Dixon,Fluid Mechanics & Thermodynamics of Turbo machines, Elsevier (2005).

Suggested Reading:

1. D. G. Shepherd Principals of Turbo machines, the Macmillan Company.
2. B.K. Venkanna, Turbo machine,. PHI, New Delhi 2009
3. M. S. Govindgouda and A. M.Nagaraj,Text Book of Turbo machines, M. M. Publications, 4Th Ed, 2008

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16ME E09

Object Oriented Programming through C++ (Professional Elective-IV)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives:

1. To teach difference between OOP and structured programming
2. To teach how to use different features of C++.
3. To write programs for simple applications.
4. To understand capability of OOP.
5. To use operator overloading
6. To create templates and usage of exception handling

Course Outcomes: Be able to understand

1. The difference between object oriented programming and Structured programming and data types in C++.
2. To program using C++ features such as classes and objects.
3. The write C++ programs for simple applications in mechanical engineering.
4. The overload operators
5. The use inheritance and polymorphism
6. Capability to use effectively templates and exception handling.

UNIT-I: Principles of Object Oriented Programming:

Procedure Vs Object Oriented, Paradigm, Basic concepts, benefits, Applications and Object Oriented Languages.

Introduction:

Program structure, Creating, Compiling and Linking of C++ program.

Token, Expression and Control Structures:

Tokens, Keywords, Identifiers and Constants, Data Types, Operators, Precedence, Type Compatibility, Control Structures, New Features of C++.

Functions:

Function Prototype and Parameter Passing, Inline Functions, Default, Constant Arguments, Recursion, Function Overloading.

UNIT-II: Classes and Objects:

Defining classes and Member functions, creating objects, objects and arrays, objects and functions, const with classes, friends to a class, nesting static members of a class,

Constructors and Destructors:

Type of Constructors, Dynamic Initialization of Objects, Destructors.

UNIT –III: C++ Operator Overloading and Type Conversions:

Fundamentals, restrictions, overloading unary / binary operators, overloading ++ and --, overloading special operators, overloading by member functions and friend functions, type conversions.

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UNIT-IV: C++ Inheritance:
Defining derived classes, Types of Inheritance, Virtual Base class Abstract Class, function overriding and containership.
Pointers and Polymorphism:
Pointers and Generic pointer, Pointer to Objects and Derived Classes, this pointer, Virtual Functions, Virtual Destructors.

UNIT-V: C++ Templates:
ntroduction, function templates and class templates
C++ Exception Handling:
Conventional error handling mechanism, C++ error handling mechanism, Try, throw, catch, exception handling in classes.

Text Books:

1. RohitKhurana "Object oriented programming with C++", Vikas publications. 2nd edition
2. Ashok Kamtani 'Object Oriented Programming with ANSI and Turbo C++", Pearson Education, 2014.
3. Somshekara & others, Object Oriented Programming with C++, Eastern Economy Edition, 2nd edition.

Suggested Reading:

1. E. Balagurusamy "Object Oriented Programming with C++" ,McGraw-Hill Education (India), 6th Edition 2013
2. Bjarne Stroustrup "The C++ Programming Language",Pearson Education 5th Edition (2013)
3. Robert Lafore "Object-Oriented Programming in C++ "Fourth Edition Sams Publishing,2002
4. John Hubbard, Atul Khate, Schaum's Series, 'Programming with C++' 3rd Edition

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16PE E08

MODERN MACHINING AND FORMING PROCESSES (Professional Elective-IV)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives: Student will learn

1. The importance of non-conventional machining processes
2. Various non-conventional machining processes and their process parameters
3. The relative merits, limitations and applications of various non-conventional machining processes
4. The knowledge regarding working media and its functions of non-conventional machining processes
5. The concepts of non-conventional forming processes such as rubber pad forming, hydro forming, stretch forming, etc.,
6. The concepts of HERF and to provide the description of HERF process

Course Outcomes: At the end of the course, the students are able to

1. Select the non-conventional machining process for a particular application
2. Demonstrate the capability of comparison of various non-conventional machining methods
3. Describe the various non-conventional machining processes
4. Exhibit the proficiency of selecting working media for various non-conventional machining processes
5. Exhibit the basic understanding of non-conventional forming processes
6. Compare various non-conventional forming processes based on their merits, limitations and applicability

UNIT-I: Mechanical Energy Processes:

Ultrasonic Machining (USM): Introduction, Process description, abrasive slurry, Abrasive materials and their characteristics, Functions of liquid medium in slurry, Types of transducers, effect of process parameters, applications and limitations

Abrasive Jet Machining (AJM):

Principle of operation, process details, process variables and their effect on MRR and accuracy, advantages, disadvantages and applications

Water Jet Machining (WJM):

Schematic diagram, equipment used, advantages and applications

Abrasive Water Jet Machining (AWJM):

Process, advantages, limitations and applications

UNIT-II: Thermal Processes:

Electro Discharge Machining (EDM):

Process description with schematic diagram, process parameters, functions and characteristics of dielectric medium, dielectric fluids, flushing, mechanism of metal removal, types of power supply circuits, mathematical analysis of metal removal rate (MRR), equations for surface finish, characteristics of spark eroded surfaces, advantages, disadvantages and applications

Wire EDM:

Process description and applications

LASER Beam Machining (LBM):

Principle of LASER beam production, materials used, process parameters, advantages, limitations and applications,

Plasma Arc Machining (PAM):

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Introduction, equipment used, process description and parameters, types of plasma arc: transferred arc and non transferred arc and process applications,

Electron Beam Machining (EBM): Schematic of the process, process parameters, principle of production of electron beam, equipment used, advantages, disadvantages and applications,

UNIT-III: Chemical and Other Machining Processes:

Electro-chemical machining (ECM): Schematic of process parameters, function and characteristics of electrolyte, MRR for pure metal and alloys, electrode feed rate (EFR), advantages, limitations and applications

Chemical Machining: Chemical blanking and chemical milling, advantages, limitations and applications

ION Etching: Process description, merits, limitations and applications.

UNIT-IV: High Energy Rate Forming Processes (HERF):

Introduction, applications, advantages, **Explosive Forming:**

Principles, explosive materials, Equipment, types of explosive forming, standoff operation and contact operation.

Electro-Hydraulic Forming (EHF): Schematic of process, description and its applications, **Electro-Magnetic Forming (EMF):** Process description, merits, limitations and applications

UNIT-V: Other Forming Processes:

Rubber Pad Forming: Principle of the process, process details and its types, Guerin, wheelon, Mar forming and Hydro forming processes and applications,

Stretch Forming: Introduction, types of stretch forming, stretch draw forming, rotary stretch forming or stretch wrapping, compression forming, radial draw forming.

Tube spinning: introduction, methods of tube spinning, backward spinning, forward spinning.

Text Books:

1. P.C. Pandey and H.S. Shah, *Modern Machining Process* Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1980
2. J Paulo Davim, *Modern Machining Technology, A Practical Guide*, 1st Edition, Woodhead Publishing in Mechanical Engineering
3. Hassan Abdel-Gawad El-Hofy, *Advanced Machining Processes, Nontraditional and Hybrid Machining Processes*, McGraw Hill Publishing Co. Ltd.,

Suggested Reading:

1. Davies and Austin, *Developments in High Speed Metal Forming*, The Machinery Publishing Co. Ltd., 1985
2. Production Technology, HMT
3. A. Bhattacharya, *New Technology*, The Institution of Engineers (India), 1984

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16PE E09

SURFACE ENGINEERING (Elective-IV)

Instruction	3 Hours per week
Duration of End Examination	3 Hours
Semester End examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Objectives:

1. To impart knowledge on surface engineering and surface modification methods that will come in handy to solve the industrial problems.
2. This will also serve as a precursor for future research in the same field.
3. Student will understand the basic principles of corrosion and know the methods to reduce the corrosion on mechanical components.
4. Student will understand the role of wear and wear measurement techniques on Engineering components.

Outcomes: Students will

1. demonstrate basic understanding of friction, and be familiar with adhesion theories and the effect of adhesion on friction.
2. demonstrate basic understanding of wear processes, and able to describe wear mechanisms on engineering components.
3. demonstrate basic understanding of corrosion and know the methods to reduce the corrosion on engineering components.
4. be able to design a tribological system for optimal performance, and Justify, critical analysis on surface engineering techniques and surface design for relevant applications.
5. Apply surface engineering principles and methods to modify and improve the properties of surfaces for structural and functional applications.
6. Identify suitable surface processing method from various methods to create surface engineering solutions for specific materials, specific environments and specific applications in modern engineering practice.

UNIT I: Friction

Topography of Surfaces – Surface features – Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction – Rolling Friction – Friction properties of metallic and non metallic materials – Friction in extreme conditions – Thermal considerations in sliding contact.

UNIT II: Wear

Introduction – Abrasive wear, Erosive, Cavitation, Adhesion, Fatigue wear and Fretting Wear- Laws of wear – Theoretical wear models – Wear of metals and non metals - International standards in friction and wear measurements

UNIT III: Corrosion

Introduction – Principle of corrosion – Classification of corrosion – Types of corrosion – Factors influencing corrosion – Testing of corrosion – In-service monitoring, Simulated service, Laboratory testing – Evaluation of corrosion – Prevention of Corrosion – Material selection, Alteration of environment, Design, Cathodic and Anodic Protection, Corrosion inhibitors.

UNIT IV: Surface Treatments

Introduction – Surface properties, Superficial layer – Changing surface metallurgy – Wear resistant coatings and Surface treatments – Techniques – PVD – CVD – Physical CVD – Ion implantation – Surface welding – Thermal spraying – Laser surface hardening and alloying, Applications of coatings and surface treatments in wear and friction control – Characteristics of Wear resistant coatings – New trends in coating technology – DLC – CNC – Thick coatings – Nano-engineered coatings – Other coatings, Corrosion resistant coatings.

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UNIT V: Engineering Materials

Introduction – Advanced alloys – Super alloys, Titanium alloys, Magnesium alloys, Aluminium alloys, and Nickel based alloys – Ceramics – Polymers – Biomaterials – Applications – Bio Tribology, Nano Tribology.

Text Books:

1. G.W.Stachowiak & A.W .Batchelor , "Engineering Tribology", Butterworth-Heinemann, UK, 2005
2. Rabinowicz.E, "Friction and Wear of materials", John Willey & Sons ,UK,1995
3. Halling, J. (Editor) – "Principles of Tribology ", Macmillian – 1984

Suggested Readings

1. Williams J.A. "Engineering Tribology", Oxford Univ. Press, 1994.
2. S.K.Basu, S.N.Sengupta & B.B.Ahuja ,"Fundamentals of Tribology", Prentice –Hall of India Pvt Ltd , New Delhi, 2005
3. Fontana G., "Corrosion Engineering", McGraw Hill, 1985

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16ME C30

CAD AND CAM LAB

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
Continuous Internal Evluation	30 Marks
Credits	2

Course Objectives:

1. 3D Part modeling – protrusion, cut, sweep, draft, loft, blend, rib , Editing – Move, Pattern, Mirror, Round, Chamfer
2. Assembly (Coupling, Screw jack) – creating assembly from parts – assembly constraints
3. Conversion of 3D solid model to 2D drawing - different views, sections, isometric view and dimensioning , mass property calculations
4. To learn and develop the skill in creating a component by utilizing the Automated Machines.

Course Outcomes:

1. Draw complex geometries of parts in sketcher mode.
2. Generate freeform shapes in part mode to visualize parts.
3. Create complex engineering assemblies using appropriate assembly constraints.
4. Develop various machine components and generate their orthographic view modeling software
5. Have a fundamental knowledge of Computer Numerical Control machines.
6. Write part programs using G and M codes for lathe and milling operations

Detailed Syllabus:

1. Introduction to Solid Works Package, Working with sketch mode and features of Solid Works and applying on various part models
2. Part modeling of cotter, Knuckle Joints and Couplings
3. Generating, editing and modifying drawings in SolidWorks.

4-8 Assembly modeling of the following

(a) Stuffing Box (b) Screw Jack (c) CrossHead (d) Eccentric

9. Specifying tolerances for part and assembly Drawings
10. Contouring on CNC Milling Machine
11. Facing on CNC Milling Machine
12. Rectangular Pocketing on CNC Milling Machine
13. Circular pocketing on CNC Milling Machine
14. Step Turning, Taper Turning and Multiple Turning On CNC Lathe Machine
15. Use of CAM software for various Machining Operations

Text Books:

1. Ibrahim Zeid, CAD/ CAM "theory and practice", McGraw Hill Inc , New York, 2011
2. Rao PN "CAD/CAM : Principles and applications" 2nd edition, Tata McGraw Hill, New Delhi, 2004

Note: Any 12 experiments need to be conducted

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16PE C08

MACHINE TOOL ENGINEERING LAB

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
Continuous Internal Evluationa	30 Marks
Credits	2

Course Objectives: Students will learn

1. To grind single point cutting tool using HSS as cutting tool
2. to do various operations like plain turning, step turning, knurling
3. have work shop practice on lathe drilling and milling machines
4. the gear cutting and to cut gear on milling machine
5. measure cutting forces during machining on Lathe machine, milling
6. unconventional machining operations like EDM & ECM

Course Outcomes: Student is able to

1. grind single point cutting tool with various angles
2. perform taper turning and knurling on lathe
3. perform drilling and thread cutting operations
4. to manufacture a gear using milling machine
5. do operation on shaper
6. exposed to various unconventional processes

Experiments:

1. Introduction to Machine Tools, like Lathe, Drilling, Milling and Shaper.
2. Plain and step turning operations on Lathe
3. Step turning and Knurling on Lathe machine
4. Taper turning on Lathe
5. Drilling and Boring on Lathe
6. Thread Cutting on Lathe
7. Grinding of Single Point Cutting Tool
8. Gear Cutting using (a) Plain Indexing (b) Compound Indexing
9. Measurement of Cutting forces during machining on Lathe machine and Milling machine
10. Finding Shear angle experimentally in turning operation
11. Step turning and facing on CNC Lathe
12. Taper turning on CNC Lathe
13. Multiple turning in ball shape on CNC Lathe
14. Contouring on CNC milling machine
15. Pocketing (rectangular and circular)
16. Drilling Cycles on Milling machine

Text Books:

1. B.L. JuneJa and Shekon, "Fundamentals of Metal Cutting & Machines Tools", Wiley Eastern Ltd. 1987.
2. P.N. Rao, "Manufacturing Technology – Metal Culling & Machine Tools", Vol. 2, Tata McGraw Hill Education Pvt. Ltd, 2010.

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16PE C09

ADDITIVE MANUFACTURING LAB

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
Continuous Internal Evaluation	30 Marks
Credits	2

Course objectives:

1. Use commercial software for digitizing free-form geometry.
2. Capture digital data from a difficult to design object and make a manufactured model.

Course outcomes: The intended outcomes of the course are:

1. Select and use correct CAD formats in the manufacture of a 3D printed part.
2. Set up and fabricate a 3D part using an additive manufacturing machine.
3. Ability to understand and use modern rapid prototyping systems;
4. Capacity to select the processing parameters best suited to the production of prototype quality
5. Identify, characterize and select the ideal materials for a given Rapid Prototyping system.
6. Gain confidence to operate the 3d printing machine

List of Experiments:

1. Introduction to RP machine , Machine Specifications, Materials
2. Review of modeling of resin and metal parts in cad software.
3. Stl file Generation (stitching, orientation, scaling, etc.,) in magics/Idea maker software.
4. Slicing of stl files
5. Obtaining the tool path data and sending it to RP Machines
6. 3d printing of jigs, fixtures and other manufacturing tools
7. Demonstration of rapid tooling using fused deposition modeling
8. Prototyping of petrol engine Connecting rod
9. Fabrication of Components of Screw jack and assembling them
10. Removing the supports & post processing (cleaning the surfaces)
11. Post curing of fabricated resin parts
12. Reverse engineering: from scanner to model validation (solid works)

Text Books:

1. Gibson I, Rosen DW and Stucker B; Additive manufacturing methodologies : Rapid prototyping to direct digital manufacturing , Springer , 2010
2. Chee Kai Chua, Kah Fai Leong , 3D printing and additive manufacturing : principles and application: fourth edition of rapid prototyping

Note: Any 10 experiments need to be conducted

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With Effect from the Academic Year 2016 - 2017

PE 411

Production Drawing Practice

Instruction	1 Lecture + 3 Drawing Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student will understand

1. The need and the importance of production drawing
2. How to make part drawing from given assembly drawings.
3. Indication of size, form and positional tolerances on the drawing sheets
4. Surface finish and heat treatment process on the drawing sheets.
5. Writing process sheets
6. Notations, symbols and abbreviations on production drawings

Outcomes: On completion of the course the students will develop abilities to

1. Draw part drawings from given assembly drawings of machine parts.
2. Indicate tolerance values on the parts drawn on sheet as per alpha numeric codes for given assembly drawings
3. Indicate form tolerances and position tolerances on the parts drawn on the sheet as per universally accepted norms for a given assembly drawing
4. Indicate values of surface finished and heat treatment process on the parts drawn for a given assembly drawings.
5. Write process sheet for every part that is drawn from given assembly drawings
6. Interpret a production drawing and process sheet.

UNIT-I

Introduction to Production Drawing: Types of Drawings and their uses, Format of drawing sheet, title block - Machine tools elements, methods of indicating notes on drawing

UNIT-II

Limits and Fits: Basic definition of terms, alpha numeric designation of limits/fits, calculation of limits and tolerances - Types of fits, interchangeability and selective assembly - Exercises involving selection/interpretation of fits and calculation of limits.

UNIT-III

Production Drawing: Conventional practices of indicating tolerances on size and geometrical form, Position - Surface finish, surface treatments

UNIT-IV

Part drawings: Part drawings from assembled drawings (10 No's - out of which student should draw a minimum of 8 drawings) – (Specification and indication of the above features on the drawings) - Stuffing box, Screw jack, I.C engine connecting rod, Revolving center, Square tool post, Single tool post, Steam engine cross head, Drill jig (plate type), Non return valve, Blow off cock

UNIT-V

Writing Process sheets, tolerances and surface finish for different components such as Bevel Gear, Flange & Pinion shaft.

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Text Books:

1. K.L. Narayana, P. Kannaiah and K. Venkat Reddy, *Production Drawing*, New Age Intl., (P) Ltd., Revised Edition, 1997.
2. P. Narasimha Reddy, T.A. Janardhan Reddy and C. Srinivasa Rao, *Production Drawing Practice*, Hitech Publishers, 2001

Suggested Reading:

1. R.L. Murthy, *Precision Engineering in Manufacturing*, New Age International Private Ltd., 1996
2. R.K. Jain, *Engineering Metrology*, Khanna Publishers, 8th edition, 1985
3. IC Gupta, *Engineering Metrology*, Dhanpat Rai Pub., New Delhi, 1984.
4. Rega Rajendra, *Principles of Engineering Metrology*, Jaico Publishing House, Mumbai, 2008.
5. Doeblin, *Measurement Systems Application and Design*, TMH, 5 th Edn., 2004.

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ME 412

Metrology and Instrumentation

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives:

1. Student will understand the need for measurement and fundamental concepts of measurement.
2. Student will get familiarize with limits, Fits& tolerances and the instruments used to measure these limits.
3. Student will able to have knowledge of various precision linear and angular measuring instruments.
4. Student will learn the importance of Geometric form and how to measure form errors.
5. Equip the student to have knowledge in the concepts of classification of instrument errors and their characteristics.
6. Student will enable to understand the working principles of various instruments used for the measurement of strain, forces, pressure, and temperature.

Outcomes: At the end of the course, students are able to

1. Learn and understand the need for measurement and fundamental concepts of measurement.
2. Demonstrate sound knowledge in gauges design and gauge selection for inspection.
3. Acquire the knowledge about fundamentals of linear and angular measurements and various instruments used for measuring the different parameters.
4. Demonstrate an ability to select and use the appropriate measuring instruments to measure surface roughness and other geometric form errors.
5. Recognize the concepts of errors, classification and instrument characteristics.
6. Apply the skills in measuring various quantities like strain, force, pressure & temperature.

UNIT-I

Limits, Fits and Tolerances: Types of fits, Selective assembly and interchangeability, Taylor's Principle for plain limit gauges, Use of Plug, Ring and Snap gauges, Introduction to Linear and Angular measurements, Slip gauges and End bars, Gauge material and manufacturing methods, Different types of Micrometers, Height gauges, Tomlinson gauges, Sine bar.

UNIT-II

Comparators: Dial indicator, Sigma Mechanical comparator, Back pressure type Pneumatic comparator. Optical projector and its Principle and Applications, Tool maker's Microscope and its Principle and applications, measurement of straightness and flatness, Auto collimator, Roundness measurement with bench centers and talyround, Coordinate Measuring Machine.

UNIT-III

Surface Roughness Measurements: Profilometer, Taylor Hobson Talysurf, Application of screw Thread metrology - 2 wire and 3 wire methods, Best wire size, Spur Gear nomenclature, Gear tooth thickness measurement by gear tooth vernier, Parkinson gear tester.
Introduction to Interferometry and its applications, The N.P.L. flatness Interferometer.

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UNIT-IV

Elements of instrumentation system: Static and Dynamic characteristics of instruments, Types of errors, Strain measurement, Wire and foil type resistance strain gauges, Rosette Gauges, Bonding procedure, Strain Gauge Factor, Application of strain gauges, Strain gauge load cells, measurement of axial load and torsion by strain gauges, Piezo electric load cell.

UNIT-V

Introduction to Transducers: Displacement and acceleration measurement, L.V.D.T, Pressure measurement by Bourdon pressure gauge, Bulk modulus pressure gauge and Pirani gauge, Temperature measurement by thermo couples, Laws of thermo electricity, Types of materials used in thermocouples, Series and parallel circuits.

Text Books:

1. R.K. Jain, *Engineering Metrology*, Khanna Publications, 1996.
2. Doeblin, *Measurement Systems Application and Design*, TMH, 5th Edn., 2004.
3. Anand Bewoore & Vinay Kulkarni, *Metrology & Management*, McGrawhill Education India, 2014.
4. I B.C. Nakra & K.K. Chaudhary , *Instrumentation Measurement and Analysis* , 3rd Edn., McGrawhill, 2014

Suggested Reading:

1. IC Gupta., *Engineering Metrology*, Dhanpat Rai Pub. New Delhi, 1984.
2. Rega Rajendra, *Principles of Engineering Metrology*, Jaico Publishing House, Mumbai, 2008.

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With Effect from the Academic Year 2016 - 2017

ME 414

Operations Research
(for Mech, Prod and I.T)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives:

1. Students will understand the significance of Operations Research concept and techniques
2. Students will come to know the formulation of LPP models
3. Students will understand the Algorithms of Graphical and Simplex Methods
4. Students will understand the Transportation and Assignment techniques
5. Students will come to know the procedure of Project Management along with CPM and PERT techniques
6. Students will understand the concepts of sequencing and queuing theory

Outcomes: At the end of the course, the students were able to

1. Recognize the importance and value of Operations Research and mathematical formulation in solving practical problems in industry;
2. Formulate a managerial decision problem into a mathematical model;
3. Apply Operations Research models to real time industry problems;
4. Build and solve Transportation Models and Assignment Models.
5. Apply project management techniques like CPM and PERT to plan and execute project successfully
6. Apply sequencing and queuing theory concepts in industry applications

UNIT-I

Introduction: Definition and Scope of Operations Research.

Linear Programming: Introduction, Formulation of linear programming problems, graphical method of solving LP problem, simplex method, Degeneracy in Simplex, Duality in Simplex.

UNIT-II

Transportation Models: Finding an initial feasible solution - North West Corner Method, Least Cost Method, Vogel's Approximation Method, Finding the optimal solution, Special cases in Transportation problems - Unbalanced Transportation problem, Degeneracy in Transportation, Profit Maximization in Transportation.

UNIT-III

Assignment Techniques: Introduction, Hungarian technique of Assignment techniques, unbalanced problems, problems with restrictions, Maximization in Assignment problems, Travelling salesman problems

UNIT-IV

Project Management: Definition, Procedure and Objectives of Project Management, Differences between PERT and CPM, Rules for drawing Network diagram, Scheduling the activities, Fulkerson's rule, Earliest and Latest times, Determination of ES and EF times in forward path, LS & LF times in backward path, Determination of critical path, duration of the project, Free float, Independent float and Total float, Crashing of network.

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UNIT-V

Sequencing Models: Introduction, General assumptions, processing 'n' jobs through two machines, processing 'n' jobs through three machines.

Queuing Theory: Introduction, Kendal's Notation, single channel - poisson arrivals - exponential service times

Text Books:

1. Hamdy, A. Taha, *Operations Research-An Introduction*, Sixth Edition, Prentice Hall of India Pvt. Ltd., 1997.
2. S.D. Sharma, *Operations Research*, Kedarnath, Ramnath & Co., Meerut,2009
3. V.K. Kapoor, *Operations Research*, S. Chand Publishers, New Delhi, 2004

Suggested Reading:

1. Harvey M. Wagner, *Principles of Operations Research*, Second Edition, Prentice Hall of India Ltd., 1980.
2. R. Paneer Selvam, *Operations Research*, Second Edition, PHI Learning Pvt. Ltd., New Delhi, 2008.
3. Nita H. Shah, Ravi M. Gor, Hardik Soni, *Operations Research*, PHI Learning Private Limited, 2013

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PE 412

Modern Machining and Forming Methods

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student will learn

1. The importance of non-conventional machining processes
2. Various non-conventional machining processes and their process parameters
3. The relative merits, limitations and applications of various non-conventional machining processes
4. The knowledge regarding working media and its functions of non-conventional machining processes
5. The concepts of non-conventional forming processes such as rubber pad forming, hydro forming, stretch forming, etc.,
6. The concepts of HERF and to provide the description of HERF process

Outcomes: At the end of the course, the students are able to

1. Select the non-conventional machining process for a particular application
2. Demonstrate the capability of comparison of various non-conventional machining methods
3. Describe the various non-conventional machining processes
4. Exhibit the proficiency of selecting working media for various non-conventional machining processes
5. Exhibit the basic understanding of non-conventional forming processes
6. Compare various non-conventional forming processes based on their merits, limitations and applicability

UNIT-I

Mechanical Energy Methods:

Ultrasonic Machining (USM): Introduction, Process description, abrasive slurry, Abrasive materials and their characteristics, Functions of liquid medium in slurry, Types of transducers, effect of process parameters, applications and limitations

Abrasive Jet Machining (AJM): Principle of operation, process details, process variables and their effect on MRR and accuracy, equation for MRR, advantages, disadvantages and applications

Water Jet Machining (WJM): Schematic diagram, equipment used, advantages and applications

Abrasive Water Jet Machining (AWJM): Process, advantages, limitations and applications

UNIT-II

Thermal methods: Electro Discharge Machining (EDM): Process description with schematic diagram, process parameters, functions and characteristics of dielectric medium, dielectric fluids, over cut and side taper, flushing, mechanism of metal removal, crater volume, types of power supply circuits, mathematical analysis of metal removal rate (MRR), equations for surface finish, characteristics of spark eroded surfaces, advantages, disadvantages and applications

Wire EDM: Process description and applications

LASER Beam Machining (LBM): Principle of LASER beam production, materials used, process parameters, advantages, limitations and applications,

Plasma Arc Machining (PAM): Introduction, equipment used, process description and parameters, types of plasma arc: transferred arc and non transferred arc and process applications, **Electron Beam Machining (EBM):** Schematic of the process, process parameters, principle of production of electron beam, equipment used, advantages, disadvantages and applications,

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UNIT-III

Electro chemical, Chemical and other machining processes: Electro-chemical machining (ECM): Schematic of process parameters, function and characteristics of electrolyte, chemistry of the process, MRR for pure metal and alloys, electrode feed rate (EFR), advantages, limitations and applications

Chemical Machining: Chemical blanking and chemical milling, advantages, limitations and applications

ION Etching: Process description, merits, limitations and applications, hot machining, high speed machining, process parameters, advantages and applications

UNIT-IV

High Energy Rate Forming Processes (HERF): Introduction, applications, advantages, **Explosive Forming:** Principles, explosive materials, Equipment, types of explosive forming, standoff operation and contact operation, the pressure pulse, gas bubble and the process applications

Electro-Hydraulic Forming (EHF): Schematic of process, description and its applications,

Electro-Magnetic Forming (EMF): Process description, merits, limitations and applications

UNIT-V

Other Forming Processes:

Rubber Pad Forming: Principle of the process, process details and its types, Guerin, wheelon, Mar forming and Hydro forming processes and applications,

Stretch Forming: Introduction, types of stretch forming, stretch draw forming, rotary stretch forming or stretch wrapping, compression forming, radial draw forming.

Tube spinning: introduction, methods of tube spinning, backward spinning, forward spinning, machines and tools used, machine variables, speeds and feeds, effect of tube spinning on work metal properties and applications.

Text Books:

1. P.C. Pandey and H.S. Shah, *Modern Machining Process* Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1980
2. J Paulo Davim, *Modern Machining Technology, A Practical Guide*, 1st Edition, Woodhead Publishing in Mechanical Engineering

Suggested Reading:

1. Hassan Abdel-Gawad El-Hofy, *Advanced Machining Processes, Nontraditional and Hybrid Machining Processes*, McGraw Hill Publishing Co. Ltd.,
2. Davies and Austin, *Developments in High Speed Metal Forming*, The Machinery Publishing Co. Ltd., 1985
3. *Production Technology*, HMT
4. A. Bhattacharya, *New Technology*, The Institution of Engineers (India), 1984

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PE 461

Robotics (Elective – II)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Students will understand

1. The configuration, work envelop and motion controls and applications
2. Familiarities with the kinematics of robots.
3. Robot end effectors and their design.
4. Familiarities with the dynamics of robots.
5. Robot Programming methods & Languages of robot.
6. Various Sensors and drives and their applications in robots

Outcomes: At the end of the course, the students will be

1. Equipped with robot anatomy, work volume and robot applications
2. Familiarized with the kinematic motions of robot
3. Having good knowledge about robot end effectors and their design concepts
4. Familiarized with the robot dynamics
5. Equipped with the Programming methods & drives used in robots
6. Equipped with the principles of various Sensors and their applications in robots.

Unit I

Robots: History and evolution of robots, Laws of Robotics, basic configuration, degree of freedom, work envelope, motion control methods, Application in industry, material handling, loading & unloading, processing, welding & painting applications, assembly and inspection, Robot specification requirements

Unit II

Rotation matrix: Homogenous transformation matrix, Denavit-Hartenberg convention, Euler angles, RPY represnsation, Direct and inverse kinematics for industrial robots for position and orientation, Redundancy

Unit III

Manipulator Jacobian: Joint, End effector velocity, direct and inverse velocity nalysis, Trajectory Planning, interpolation, cubic polynomial, linear segments with with parabolic blending, static force and moment transformation, solvability, stiffness, singularities

Unit IV

Robot dynamics: Lagrangian formulation, link inertia tensor and manipulator inertia tensor, Newton-Euler formulation for RR & RP manipulators, Control: Individual joint, computed torque

Unit V

End effectors: position and velocity measurement, Sensors: Proximity and range, tactile, force and torque, Drives for Robots: Electrical, Hydraulic and Pneumatic, Robot vision: Introduction to technique, image acquisition and processing, introduction to robot programming languages

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Text Books:

1. Spong and Vidyasagar, *Robot Dynamics and Control*, John Wile and Sons, 1990
2. R.K. Mittal, I.J. Nagrath, *Robotics and control*, Tata Mcgraw-Hill Publishing Company Ltd. 2003
3. Groover, *Industrial Robotics*, Mcgraw-Hill Publishing Company Ltd. 2003

Suggested Reading:

1. Asada and Siotine, *Robot analysis and Intelligence*, Wiley Interscience, 1986
2. K.S. Fu Gon ZalezRC., IEEc.S.G., *Robotics, Control Sensing Vision and Intelligence*, McGraw Hill, Int. Ed., 1987
3. Richard S. Paul, *Robot Manipulators: Mathematics, Programming, and Control*, MIT Press (MA)

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With Effect from the Academic Year 2016 - 2017

ME 461

Renewable Energy Sources (Elective – II)

Instruction	4	Periods per week
Duration of End Examination	3	Hours
End examination	75	Marks
Sessionals	25	Marks
Credits	3	

Objectives: Student will learn the

1. Need and importance of non-conventional energy resources
2. Extent of solar energy which can be utilized as energy resource
3. Concept of wind energy and its merits and demerits
4. Operating principles of ocean and geothermal energy
5. Advantages and disadvantages of bio-energy over conventional energy
6. Merits and demerits of tidal energy, wave energy and OTEC

Outcomes: At the end of the course, the students are able to

1. Understand the depletion and of environmental impact conventional sources of energy and will suggest suitable and alternative renewable energies in place of fossil energies
2. Know the absorption, conversion and utilization of solar energy
3. Understand the problems associated with utilizing the wind energy
4. Describe the physics of geothermal resources and describe how biomass is currently used as a source of energy
5. Explain the physical principles of wave energy, the generation of tides and how to harness their power
6. Understand the environmental impact of OTEC plants

Unit-I

Statistics on conventional energy sources and supply in developing countries, Definition-Concepts of RES, Limitations of RES, Classification of NCES-Solar, Wind, Geothermal, Bio-mass, Ocean Energy Sources, comparison of these energy sources.

Unit-II

Solar Energy- Solar Radiation – Energy available from Sun, Solar Thermal Collectors – Flat Plate and Concentrating Collectors –Solar Applications, Solar engines-Stirling, Brayton engines, fundamentals of photo Voltaic Conversion – p-n junction – PV solar cells and its materials-solar satellite system

Unit-III

Wind energy- merits and demerits-Wind power plant-site selection-classification of wind power plants-Windmill rotors- Horizontal axis and vertical axis rotors-.working principle-New developments.

Unit-IV

Geothermal energy- Layers in earth-Definition and classification of resources.

Biomass energy-Biomass- Source, Composition, Conversion technologies – Direct combustion-Pyrolysis–Gasification, Biomass gasifier –float and fixed dome types

Unit V

Wave, Tidal and OTEC energy- Difference between tidal and wave power generation-single basin and double basin tidal plants-progressive wave.

OTEC power plants- Open and closed OTEC Cycles- Environmental impacts of OTEC.

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Text Books:

1. S. Hasan Saeed and D.K. Sharma, *Non Conventional Energy Resources*, S.K. Kataria & Sons, New Delhi, 2014
2. Dr. R.K. Singal, *Non Conventional Energy Resources*, S.K. Kataria & Sons, New Delhi, 2005
3. G.D. Rai, *Non Conventional Energy Sources*, Khanna Publishers, New Delhi, 2011

Suggested Reading:

1. Mittal K M, *Non-Conventional Energy Systems*,Wheeler Publishing Co. Ltd, New Delhi, 2003.
2. Ramesh R & Kumar K U, *Renewable Energy Technologies*, Narosa Publishing House, New Delhi, 2004
3. Shali Habibulla, *Non-Conventional Energy Sources*, State Institute of Vocational Education, Hyderabad, 2005
4. Ashok V Desai, *Non-Conventional Energy*, Wiley Eastern Ltd, New Delhi, 2003
5. R.K. Hegde, *Power Plant Engineering*, Pearson Education India, 2015

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With Effect from the Academic Year 2016 - 2017

ME 462

Computational Fluid Dynamics (Elective – II)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives:

1. Understanding of governing equations of fluid flow.
2. Student understand finite difference and finite volume methods to solve fluid flow equations.
3. Issues that arise in the solution of such equations.
4. Various methods to overcome those issues and modern trends in CFD.
5. Get exposure to grid generation.
6. Various boundary conditions and their implementation.

Outcomes: At the end of the course, the students were able to

1. Classify basic equations of fluid flow
2. Choose appropriate boundary conditions
3. Choose proper numerical technique to solve equations.
4. Critically analyze different mathematical models and computational methods for flow simulations
5. Interpret computational results.
6. Acquire the required knowledge to take advanced courses in CFD.

UNIT-I

Basic Equations: Continuity, momentum and energy equations, navier-stokes equations, Heat transfer conduction equations for steady and unsteady flows, steady convection-diffusion equation.

UNIT-II

Models: Reynolds and Favre averaged N-S equations, Mixing length model, k-epsilon turbulence model

Classifications of partial differential equations: Elliptic, parabolic and hyperbolic equations, Initial and boundary value problems

UNIT-III

Finite Difference Method: Forward, backward and central difference

Parabolic partial differential equations: Euler, implicit and crank Nicholson methods, ADI models, Errors, consistency, stability analysis, Vonnumen analysis, Convergence criteria.

UNIT-IV

Elliptic partial differential equations - Jacobi, Gauss seidel methods, Viscous incompressible flow, Stream-function-vorticity method

Introduction to grid generation- types of grids O, H, C

UNIT – V

Finite Volume Method: Finite volume formulation for diffusion equation, convection diffusion equation, Solution algorithm for pressure velocity coupling in steady flows, staggered grid, SIMPLE algorithm.

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Text Books:

1. J.D. Anderson, Jr., *Computational Fluid Dynamics: The Basic with Applications* McGraw Hill, Inc., 2012
2. H. Versteeg and W. Malalasekra, *An Introduction to Computational Fluid Dynamics*: The Finite Volume Method, Pearson,2nd edn. 2011

Suggested Reading:

1. John F. Wendt (Editor), *Computational Fluid Dynamics - An Introduction*, Springer – Verlag, Berlin, 1992
2. Charles Hirsch, *Numerical Computation of Internal and External Flows*, Vols. I and II. John Wiley & Sons, New York, 1988.
3. K. Muralidhar and T. Sundarajan.. *Computational Fluid Flow and Heat Transfer*, Narosa Publishing House. 2008
4. C.J.Date , *Introduction to CFD*, Dorling Kindersley Pvt Ltd, 2007

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ME 463

Automobile Engineering (Elective – II)

Instruction	4	Periods per week
Duration of End Examination	3	Hours
End examination	75	Marks
Sessionals	25	Marks
Credits	3	

Objectives: The student will learn

1. The anatomy of the automobile in general
2. The location and importance of each part
3. The functioning of the engine and its accessories, gear box, clutch, brakes, steering, axles and wheels
4. Suspension, frame, springs and other connections
5. ignition, controls, electrical systems and ventilation
6. Emissions, pollution regulations, EURO and BHARATH stages

Outcomes: At the end of the course, the student will be able to

1. Identify the different parts of the automobile
2. Explain the working of various parts like engine, transmission, clutch, brakes
3. Describe how the steering and the suspension systems operate.
4. Understand the environmental implications of automobile emissions
5. Develop a strong base for understanding future developments in the automobile industry

Unit I

Types of automobiles: Normal, Hybrid and Hydrogen Fuel vehicles. Engine location and its components, chassis layout; crank shaft proportion, firing order, piston and piston rings, cylinder liners, valves and operation mechanism, inlet and exhaust manifolds, carburetion and fuel injection system, Mechanical Fuel Injection system & Electronic Fuel Injection System.

Unit II

Lubricating Systems: Wet sump, dry sump and petroil systems - Cooling systems: Water pumps, radiators, thermostat control anti freezing compounds - Types of Ignition Systems, Modern Ignition systems, Types of Batteries and charging systems, starting motors, lighting and electrical accessories, automobile air-conditioning.

Unit III

Steering systems: Linkage arrangements and its components modified Ackerman linkage, wheel alignment, caster and camber. Rack and pinion assembly, recent trends, Wheel and tyres: Tyre construction, specification. Tyre wear and causes, wheel balancing, Types q/' Suspension system, Independent suspension, coil and leaf springs, torsion bar, shock absorbers.

Unit IV

Power Train: Clutches, gear and gearbox manual, semi-automatic and automatic gearboxes. Torque converter, propeller shaft, universal coupling differential, four-wheel drive system
Brakes Systems: Description and operation of hydraulic brake, leading and trailing shoe layout, disc brakes, master cylinder and hand brake linkage, Recent Trends.

Unit V

Maintenance: Pollution control, trouble shooting and servicing procedure overhauling, engine tune up, tools and equipment for repair and overhaul testing equipment, pollution control technologies used for petrol and diesel engines. Types and study of catalytic converters, Euro norms 2 & 3 and Bharat Norms – Recent Trends.

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JNTUH B.Tech 4-1 PROD

Text Books:

1. *Crouse & Anglin, Automotive Mechanics*, TataMcGraw Hill. Publishing Co. Ltd., New Delhi, Tenth Edition – 2004
2. Kirpal singh., *Automobile Engineering Vol. I & II* Standard Publishers, Delhi.

Suggested Reading:

1. Joseph Heitner, *Automotive Mechanics*, Affiliated East West Pvt. Ltd.
2. C.P Nakra, *Basic Automobile Engineering*, Dhanpat Rai Publishing Co(P) Ltd., New Delhi, 2003.
3. G.B.S. Narang, *Automobile Engineering*, Khanna Publishers, New Delhi, 2014
4. R.K. Rajput, *A Textbook of Automobile Engineering*, Laxmi Publications, New Delhi, 2012

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ME 464

Entrepreneurship (Elective – II)
(for Mech, Prod, Civil, EEE, ECE, I.T, Chemical, BioTech and CSE)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student will understand

1. The essence of Entrepreneurship
2. The environment of industry and related opportunities and challenges
3. Concept a procedure of idea generation
4. Elements of business plan and its procedure
5. Project management and its techniques
6. Behavioral issues and Time management

Outcomes: After completing this course, students will be able to:

1. Apply the entrepreneurial process
2. Analyze the feasibility of a new business plan and preparation of Business plan
3. Evaluate entrepreneurial tendency and attitude
4. Brainstorm ideas for new and innovative products or services
5. Use project management techniques like PERT and CPM
6. Analyze behavioural aspects and use time management matrix

UNIT-I

Indian Industrial Environment: Competence, Opportunities and Challenges, Entrepreneurship and Economic growth, Small Scale Industry in India, Objectives, Linkage among small, medium and heavy industries, Types of enterprises, Corporate Social Responsibility.

UNIT-II

Identification and characteristics of entrepreneurs: First generation entrepreneurs, environmental influence and women entrepreneurs, Conception and evaluation of ideas and their sources, Selection of Technology, Collaborative interaction for Technology development.

UNIT-III

Business plan: Introduction, Elements of Business Plan and its salient features, Technical Analysis, Profitability and Financial Analysis, Marketing Analysis, Feasibility studies, Executive Summary.

UNIT-IV

Project Management: During construction phase, project organization, project planning and control using CPM, PERT techniques, Human aspects of project management, Assessment of tax burden

UNIT-V

Behavioral aspects of entrepreneurs: Personality, determinants, attributes and models, Leadership concepts and models, Values and attitudes, Motivation aspects, Change behavior

Time Management: Approaches of time management, their strengths and weaknesses. Time management matrix and the urgency addiction

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Text Books:

1. Vasant Desai, *Dynamics of Entrepreneurial Development and Management*, Himalaya Publishing House, 1997.
2. Prasanna Chandra, *Project-Planning, Analysis, Selection, Implementation and Review*, Tata Mcgraw-Hill Publishing Company Ltd. 1995.
3. S.S. Khanka, *Entrepreneurial Development*, S. Chand & Co. Pvt. Ltd., New Delhi

Suggested Reading:

1. Robert D. Hisrich, Michael P. Peters, *Entrepreneurship*, Tata Me Graw Hill Publishing Company Ltd., 5lh Ed., 2005
2. Stephen R. Covey and A. Roger Merrill, *First Things First*, Simon and Schuster Publication, 1994.
3. Sudha G.S., *Organizational Behavior*, National Publishing House, 1996.

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CE 461

Disaster Mitigation and Management (Elective – II)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives: Students will understand

1. The basic knowledge of hazards, disasters, risks and vulnerabilities including natural, climatic and human induced factors and associated impacts.
2. The nature, mechanism causes, consequences and mitigation measures of the various natural disasters including hydro metrological and geological based disasters.
3. Risks, vulnerabilities and human errors associated with human induced disasters including chemical, biological and nuclear warfare agents.
4. The knowledge of various chronological phases in the disaster management cycle.
5. The disaster management framework and legislations in the context of national and global conventions.
6. The applications of geospatial technologies like remote sensing and geographical information systems in disaster management.

Course Outcomes:

1. Ability to analyse and critically examine existing programs in disaster management regarding vulnerability, risk and capacity at local level
2. Ability to choose the appropriate activities and tools and set up priorities to build a coherent and adapted disaster management plan.
3. Ability to understand various mechanisms and consequences of natural and human induced disasters for the participatory role of engineers in disaster management.
4. Develop an awareness of the chronological phases of disaster preparedness, response and relief operations for formulating effective disaster management plans
5. Ability to understand various participatory approaches/strategies and their application in disaster management
6. Ability to understand the concepts of remote sensing and geographical information systems for their effective application in disaster management.

UNIT-I:

Introduction to Natural, human induced and human made disasters – Meaning, nature, types and effects; International decade of natural disaster reduction (IDNDR); International strategy of natural disaster reduction (ISDR)

UNIT-II:

Natural Disasters– Hydro meteorological disasters: Causes, impacts, Early warning systems, structural and non-structural measures for floods, drought and cyclones; Tropical cyclones: Overview, cyclogenesis, drought monitoring and management.; Geographical based disasters: Earthquakes and Tsunami- Overview, causes, impacts, zoning, structural and non-structural mitigation measures; Tsunami generation; Landslides and avalanches: Overview, causes, impacts, zoning and mitigation measures. Case studies related to various hydro meteorological and geographical based disasters.

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UNIT III:

Human induced hazards: Risks and control measures in a chemical industry, Causes, impacts and mitigation measures for chemical accidents, chemical disaster management, current status and perspectives; Case studies related to various chemical industrial hazards eg: Bhopal gas tragedy; Management of chemical terrorism disasters and biological disasters; Radiological Emergencies and case studies; Case studies related to major power break downs, fire accidents and traffic accidents .

UNIT IV:

Use of remote sensing and GIS in disaster mitigation and management; Scope of application of ICST (Information, communication and space technologies in disaster management, Critical applications& Infrastructure; Potential application of Remote sensing and GIS in disaster management and in various disastrous conditions like earthquakes, drought, Floods, landslides etc.

UNIT V:

Concept of Disaster Management: Introduction to disaster management, Relationship between Risk, vulnerability and a disaster, Disaster management cycle, Principles of disaster mitigation: Hazard identification and vulnerability analysis, Early warning systems and forecasting; Infrastructure and development in disaster management; Disaster management in India: National disaster management framework at central, state, district and local levels. Community based disaster management.

Text Books :

1. Rajib, S and Krishna Murthy, R.R, *Disaster Management Global Challenges and Local Solutions,* Universities Press Hyderabad, 2012
2. *Notes / Reading material published by National Disaster Management Institute*, Ministry of Home Affairs, Govt. of India.

Suggested Reading:

1. Navele, P & Raja, C.K., *Earth and Atmospheric Disasters Management, Natural and Manmade*. B.S. Publications, Hyderabad, 2009
2. Fearn-Banks, K, *Crises computations approach: A case book approach*. Route ledge Publishers, Special Indian Education, New York & London, 2011
3. Battacharya, T., *Disaster Science and Management*. Tata McGraw Hill Company, New Delhi., 2012

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PE 413

Computer Aided Production Drawing Lab

Instruction	3 Periods per week
Duration of End Examination	3 Hours
End examination	50 Marks
Sessionals	25 Marks
Credits	2

Objectives: Students will learn

1. Construct production drawings to meet final design requirements.
2. Creation drawings for visualization using Modeling Packages Solid works, CATIA
3. The Fits, limits and Tolerances of parts
4. The Conventions like surface finish, roughness, concentricity
5. Preparation of Bill of materials for assembly
6. The process sheet in industrial terminology

Outcomes: At the end of the course, students will be able to

1. Read the working drawing of various components
2. Identify the different parts of the object with dimensional tolerances
3. Create the various part drawings using solid modeling package
4. Use the various functions of modeling soft ware: annotations, sheet making
5. Define the bill of materials with mass properties
6. Understand and read the industrial blueprint readings

Part Drawings:

Prepare the Part Drawings with production drawing details of the following assemblies using modeling softwares, like, solid works/solid edge/CATIA/ProE/Auto CAD-MDT/ Nx

Exercise No: 1	Stuffing box
Exercise No: 2	Screw jack
Exercise No: 3	I.C engine connecting rod
Exercise No: 4	Revolving center
Exercise No: 5	Square tool post
Exercise No: 6	Single tool post
Exercise No: 7	Universal coupling
Exercise No: 8	Flange coupling
Exercise No: 9	Steam Engine Cross Head
Exercise No: 10	Drill Jig (Plate Type)
Exercise No: 11	Non Return Valve
Exercise No: 12	Blow off Cock

Note: Student should prepare a minimum of 10 production drawings

Suggested Reading:

1. K.L. Narayana, P. Kannaiah and K. Venkat Reddy, *Production Drawing*, New Age Intl., (P) Ltd., Revised Edition, 1997.
2. P. Narasimha Reddy, T.A. Janardhan Reddy and C. Srinivasa Rao, *Production Drawing Practice*, Hitech Publishers, 2001

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ME 416

Metrology and Instrumentation Lab

Instruction	3 Periods per week
Duration of End Examination	3 Hours
End examination	50 Marks
Sessionals	25 Marks
Credits	2

Objectives:

1. Student will choose the proper measuring instrument for the precise measurement of Length, Height and diameter
2. Student will able to select the proper measuring instrument for the angular measurement.
3. Student will indentify gear & screw thread parameters using optical projector and tool makers microscope.
4. Student will get familiarize with limits & fits, gauge selection and design.
5. Student will enable to understand the working principles in the measurement of Flatness, Roundness and Surface roughness.
6. Student will equip with various aspects regarding displacement.

Outcomes: At the end of the course, the students were able to

1. Identify methods and devices for measurement of length, height and diameter.
2. Acquire the knowledge about angular measurement and various measuring instruments.
3. Recognize & measure the gear and screw thread parameters using profile projector and tool maker microscope.
4. Demonstrate the sound knowledge in gauges selection and design.
5. Acquire adequate knowledge in the measurement of flatness, roundness and surface roughness.
6. Demonstrate the measurement of displacement.

Experiments:

1. Measurement with inside, outside and depth micrometers.
2. Measurement with height gauges, height masters, etc.
3. Measurement of Linear and Angular dimensions with Tool Maker's Microscope – Diameter of a thin wire and single point cutting tool angle.
4. Measurement with Dial Indicator and its calibration.
5. Measurement of angles with Sine bar and Bevel protractor.
6. Measurement of roundness errors with bench centers.
7. Measurement of flatness errors (surface plate) with precision level.
8. Measurement with optical projector.
9. Checking machined components with plug gauges and adjustable snap gauges.
10. Surface roughness measurement by Taylor Hobson -Talysurf.
11. Measurement of Gear tooth thickness.
12. Displacement measurement with LVDT.

Note: Student should complete a minimum of 10 experiments.

Suggested Reading:

1. IC Gupta, *Engineering Metrology*, Dhanpat Rai Pub., New Delhi, 1984.
2. B.C. Nakra & K.K. Chaudhary , *Instrumentation Measurement and Analysis*, , 3rd Edn. McGrawhill, 2014

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PE 414

Manufacturing Engineering Lab

Instruction	3	Periods per week
Duration of End Examination	3	Hours
End examination	50	Marks
Sessionals	25	Marks
Credits	2	

Objectives: Students will learn

1. Various concepts of Manufacturing Processes
2. The process of choosing right manufacturing process and materials
3. The concepts of process sheets
4. Various CAD packages
5. The Bill of Materials and MRP concepts
6. Limits, tolerances and fits in manufacturing

Outcomes: Students able to

1. Apply right manufacturing techniques
2. Choose the right material
3. Operate different machine tools
4. Prepare process sheets and Bill of Material
5. Apply limits, fits and tolerances while manufacturing components
6. Prepare CAD drawings

Part-1: **Manufacturing Mini Product**: Study of all manufacturing facilities available in various manufacturing related laboratories, manufacturing canon.

Part-2: **Manufacturing Major Product:** One/two of the following items have to be manufactured by a group of maximum two members using all the production facilities and processes as far possible and assembly techniques with fits and tolerances using CAD system, various exercises have to be allotted to different groups of students by the lab faculty

1. V block with U clamp
2. Dia test indicator stand
3. Simple Jig
4. Simple fixture
5. Simple die set
6. Simple tail stock mechanism
7. Lathe tool post
8. Milling Machine Arbor
9. Pipe vice
10. Paper Punch (double punch)
11. Hydraulic Cylinder
12. Gear box (Spur, Helical or Worm)

Suggested Reading:

1. P.N. Rao, *Manufacturing Technology – Metal Culling & Machine Tool*, Vol. 2, Tata McGraw Hill Education Pvt. Ltd, 2010.
2. Jain K.C Chitale, A.K., *Production Engineering*, 2nd Edn., PHI, 2014.

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PE 415

Project Seminar

Instruction	3 Periods per week
Sessionals	25 Marks
Credits	1

The objective of the project seminar is to actively involve the student in the initial work required to undertake the final year project. Dealing with a real time problem should be the focus of the under graduate project.

It may comprise of

- Problem definition and specifications.
- A broad understanding of the available techniques to solve a problem of interest.
- Presentation (Oral & written) of the project.

The department should appoint a project coordinator who will coordinate the following.

- Grouping of students as project batch(a maximum of 3 in group)
- Allotment of projects and project guides
- Project monitoring at regular intervals.

Each project group/batch is required to

1. Submit a one page synopsis of the seminar to be delivered for display on notice board.
2. Give a 30-40 minutes presentation followed by 10 minutes discussion.
3. Submit a technical write up on the talk delivered.

Three (3) teachers will be associated with the evaluation of the project seminar for the award of the sessional marks which should be on the basis of performance on all the three items stated above.

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ME 421

Production and Operations Management

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives:

1. Understand plant layout design to facilitate material flow and processing of a product in the most efficient manner
2. Understand work study methods to improve the performance of workers
3. Gain some ability to recognize situations in a production system environment that suggests the use of certain quantitative methods to assist in decision making on operations management and strategy.
4. Understand how Materials Requirement Planning and MRPII systems are used in managing operations
5. Recognize the importance of Inventory control to ensure their availability with minimum capital lock up.
6. Evaluate the quality processes in manufacturing and service sector to improve the operational performance

Outcomes: At the end of the course, the student will be able to

1. Identify and evaluate the processes, tools and principles of production and operations management to better understand the logistics and supply chain operations
2. Demonstrate the ability to apply mathematical forecasting techniques
3. Identify future challenges and directions that relate to production and operations management to effectively and efficiently respond to market changes
4. Apply the tasks, tools and underlying principles of operations management in the manufacturing an d service sectors to improve organizational performance
5. Explain and evaluate the quality process in manufacturing and service sector to improve the operational performance

UNIT-I

Production & Operations Management: Introduction: Types of Production Systems, job shop, batch, flow shop

Plant location and layout: Factors affecting plant location, plant layout objectives, types of layouts, merits and demerits.

Work Study: Introduction to method study and work measurement, standard time calculations, methods of rating, work sampling, wages and incentives, types of incentive plans.

UNIT-II

Forecasting: Introduction, forecasting objectives and uses, demand patterns, qualitative models, market survey, Delphi, quantitative models, moving average, weighted moving average, simple exponential smoothing, trend adjusted exponential smoothing, least square method, simple regression, multiple regression.

Forecast Errors: Mean Absolute Deviation (MAD), Mean Square Error (MSE), Mean Forecast Error (MFE), Mean Absolute Percentage Error (MAPE)

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UNIT-III

Aggregate planning and master scheduling: Introduction, objectives of aggregate planning, cost in aggregate planning, strategies in aggregate planning, master production scheduling

Materials Requirement Planning (MRP): Importance of MRP, MRP system inputs and outputs, MRP calculations, bill of materials.

UNIT-IV

Inventory Control: Importance of inventory control, types of inventory models, inventory costs deterministic inventory models, basic EOQ model, production model without shortages, purchase model with instantaneous replenishment and with shortages, production model with shortages, inventory model with price breaks, fixed order quality system, periodic review system and inventory model with probabilistic demand.

UNIT-V

Quality Control: Introduction, history and early contributions by quality gurus, quality tools, process capability, quality control by control charts, control charts for variables and attributes, sampling plans, operating characteristic curves, introduction to total quality management

Text Books:

1. Stevenson, *Production operation Management*, Mc-Graw Hill International
2. Joseph Monks, *Operations Management*, TMH Publishers, New Delhi, 2004.
3. Buffa Elwood S, *Modern Production /Operations Management* , John Wiley Publishers, Singapore, 2002

Suggested Reading:

1. Everrete E. Adama & Ronald J. Ebert, *Production & Operations Management*, Prentice Hall of India, 5th Edition, 2005
2. Panneer Selvam R, *Production and Operations Management*, Second Edition, PHI Learning Pvt. Ltd., New Delhi, 2006.
3. S.D. Sharma, *Operations Research*, Kedarnath, Ramnath & Co., Meerut,2009
4. S.N. Chary, *Production and Operations Management*, Tata McGraw Hill, 3rd Edition, 2006.

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PE 421

Tool Engineering

Instruction	4	Periods per week
Duration of End Examination	3	Hours
End examination	75	Marks
Sessionals	25	Marks
Credits	3	

Objectives: Students will understand

1. The fundamentals of Tool Design that apply to different areas of manufacturing.
2. How to design simple tools independently as required by the industry
3. Various tool materials available including new materials like plastics
4. Significant technological advancement in this field
5. The fundamental concepts of Jigs and fixtures along with design principles
6. Common tools used in manufacturing practices

Outcomes: At the end of the course, the students will be able to

1. Understand the definition of tool design, its importance and application in various fields.
2. Suggest appropriate tool geometry, tool material, locating and clamping methods and manufacturing process for various tools.
3. Design simple tools independently
4. Design jigs and fixtures based on requirements.
5. Understand importance of plastics as tooling material
6. Design the tools for various operations like blanking, piercing, drawing, broaching, milling etc.

Unit-I

Introduction to Tool Engineering: Role and importance of tool engineering in industries, tool engineering functions, duties of a tool engineer.

Tools : Types, classification, features and applications, Properties of Cutting tool materials, types of cutting tool material -- Major constituents , relative characteristics and their applications, ISO classification and coding of carbide tools, coated tools, modern cutting tool materials and their applications, cutting tools for machining composites. Introduction to plastics, their properties and commonly used plastics as tooling materials and their applications.

Unit-II

Design of tools: Design of single point cutting tools, Design of flat and circular form tools, Design elements of a milling cutter, types of milling cutters, forces and power estimation, grinding of milling cutters, Design of milling cutters.

Introduction to broaching operation: Types of broaches - pull, push broach, geometry of broach, and design of broaching tool and manufacturing of broaches.

Unit-III

Twist drill geometry: Design and manufacturing of twist drill, effect of variation of angles on torque and thrust forces and sharpening of twist drills.

Reamers: Types of reamers, geometry of a reamer, reaming allowance, tolerance disposition, design and manufacture of reamers

Taps and Dies: Types, geometry, calculation of tapping drill diameters, design and manufacturing of taps and dies.

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Unit-IV

Introduction to press tools and various sheet metal forming operations: Design of die set for blanking and piercing operations, design of bending dies, design of die set for deep drawing operation, design of die set for forging operation, design of dies for metal spinning operation.

Unit-V

Jigs & Fixtures: Design principles and construction features, locating methods associated with flat, cylindrical, internal and external surfaces, type of locating pins, requirements and choice of locating systems, redundant location, fool proofing, setting blocks, types of clamping devices and their basic elements, quick action clamps and nuts, equalizing and multiple clamping pneumatics, hydraulic, magnetic, electrical and vacuum clamping, types of drill jigs and their classification, drilling bushings, indexing jigs, design of fixtures for turning, grinding, welding and milling, economic analysis of jigs and fixtures.

Text Books:

1. Cyril Donaldson, George H LeCain, V C Goold and Joyjeet Ghose, *Tool Design*, 4th edition, Tata Me Graw Hill Education Private Limited, New Delhi, 2012
2. David Spitler, Jeff Lantrip, John Nee and David A Smith, *Fundamentals of Tool Design*, 5th edition, Society of Manufacturing Engineers, 2003

Suggested Reading:

1. P.C Sharma, *A Textbook of Machine Tools and Tool Design*, S.Chand (G/L) & Company Ltd, 2005
2. AmitabhaBattacharya and Inyong Ham, *Design of Cutting Tools Use of Metal Cutting Theory*, ASTME Pub., Michigan, USA
3. Surender Keshav & Umesh Chandra, *Production Engineering Design (Tool Design)*, Satya Prakashan, New Delhi-1994.
4. P.C Sharma, *Production Engineering*, New Age India Pub.,

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ME 471

Power Plant Engineering (Elective – III)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student will learn

1. Different types of power plants and their site selection criteria
2. Operation of thermal power plant
3. About hydraulic power plant, dams and spillways
4. Different types of nuclear power plants including Pressurized water reactor, Boiling water reactor, Liquid metal fast breeder reactor and Gas cooled reactor
5. The power plant economics
6. The environmental and safety aspects of power plant operation.

Outcomes: At the end of the course, the student will be able to

1. Select the suitability of site for a power plant.
2. Propose ash handling, coal handling method in a thermal power plant
3. Understand the flow-sheet of hydro-power plant
4. Explain working principle of different types of nuclear power plant.
5. Know the various factors of plant load and economy
6. Indicate safety aspects of power plants

Unit - I

Introduction: Power plant, classification of power plants, conventional and non-conventional power plants

Steam power plant: Plant Layout, types of coals, coal handling equipment, Ash handling systems

UNIT II

Steam power plant: Combustion Process - Overfeed and Underfeed stokers-traveling grate stokers, spreader stokers, retort stokers- Pulverized fuel burning system-cyclone furnace-Fluidized bed combustion (FBC).

UNIT III

Hydro electric power plant: Hydrological cycle, flow measurement, Hydrographs - drainage area characteristics, Types of hydroelectric power plants- storage and pondage - classification of dams and spill ways.

UNIT - IV

Nuclear power plant: Nuclear fuel - breeding and fertile materials - types of reactors: Pressurized water reactor, Boiling water reactor, sodium-graphite reactor, fast Breeder Reactor, Gas cooled Reactor-Radioactive waste disposal.

UNIT - V

Power plant economics and environmental considerations:

Definitions of connected load, Maximum demand, demand factor, average load, load factor, diversity factor - related exercises-Fixed cost and variable cost-methods to find depreciation cost, Effluents from power plants and Impact on environment – pollutants - Pollution control.

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Text Books:

1. R.K. Rajput, *A Text Book of Power Plant Engineering* 4th edition, Laxmi Publications (P) Ltd., New Delhi, 2015
2. P.K. Nag, *Power Plant Engineering* 4th edition, McGraHill Education(India) Private Limited, New Delhi, 2014
3. S.C. Arora and S. Domukundwar, *A Course in Power Plant Engineering*, Dhanpat Rai & Sons, New Delhi, 2005

Suggested Reading:

1. R. Yadav, *Fundamentals of Power Plant Engineering*, Central Publishing House, Allahabad, 2012
2. R.K. Hegde, *Power Plant Engineering*, Pearson Education India, 2015
3. P.C. Sharma, *A Text Book of Power Plant Engineering*, S.K. Kataria & sons, New Delhi, 2016

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ME 472

Intellectual Property Rights (Elective – III)

(for Mech, Prod, Civil, ECE, EEE, CSE, IT)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student will learn

1. Fundamental aspects of IP
2. Aspects of IPR acts.
3. Awareness of multi disciplinary audience
4. Awareness for innovation and its importance
5. The changes in IPR culture
6. About techno-business aspects of IPR

Outcomes: At the end of the course, a student

1. Will respect intellectual property of others
2. Learn the art of understanding IPR
3. Develop the capability of searching the stage of innovations.
4. Capable of filing a patent document independently.
5. Completely understand the techno-legal business angle of IP. .
6. Capable of converting creativity into IP and effectively protect it.

UNIT-I

Overview of Intellectual Property: Introduction and the need for intellectual property right (IPR), IPR in India – Genesis and Development, IPR abroad, Some important examples of IPR. Importance of WTO, TRIPS agreement, International Conventions and PCT

Patents: Macro economic impact of the patent system, Patent and kind of inventions protected by a patent, Patent document, How to protect your inventions. Granting of patent, Rights of a patent, how extensive is patent protection. Why protect inventions by patents. Searching a patent, Drafting of a patent, Filing of a patent, the different layers of the international patent system, (national, regional and international options), compulsory licensing and licensers of right & revocation, Utility models, Differences between a utility model and a patent. Trade secrets and know-how agreements

UNIT-II

Industrial Designs: What is an industrial design. How can industrial designs be protected? What kind of protection is provided by industrial designs? How long does the protection last? Why protect industrial designs?

UNIT-III

Trademarks: What is a trademark, Rights of trademark? What kind of signs can be used as trademarks. Types of trademark, function does a trademark perform, How is a trademark protected? How is a trademark registered. How long is a registered trademark protected for? How extensive is trademark protection. What are well-known marks and how are they protected? Domain name and how does it relate to trademarks? Trademark infringement and passing off.

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UNIT-IV

Copyright: What is copyright. What is covered by copyright. How long does copyright last? Why protect copyright? Related Rights: what are related rights. Distinction between related rights and copyright. Rights covered by copyright? Copy rights in computer programming.

UNIT-V

Enforcement of Intellectual Property Rights: Infringement of intellectual property rights Enforcement Measures Emerging issues in Intellectual property protection. Case studies of patents and IP Protection.

Unfair Competition: What is unfair competition. Relationship between unfair competition and intellectual property laws.

Text Books:

1. Ajit Parulekar and Sarita D' Souza, *Indian Patents Law – Legal & Business Implications*; Macmillan India ltd , 2006
2. B. L.Wadehra; *Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications*; Universal law Publishing Pvt. Ltd., India 2000
3. P. Narayanan; *Law of Copyright and Industrial Designs*; Eastern law House, Delhi 2010

Suggested Reading:

1. Cronish W.R1 *Intellectual Property; Patents, copyright, Trad and Allied rights*, Sweet & Maxwell, 1993.
2. P. Narayanan, *Intellectual Property Law*, Eastern Law Edn., 1997.
3. Robin Jacob and Daniel Alexander, *A Guide Book to Intellectual Property Patents, Trademarks, Copy rights and designs*, Sweet, Maxwell 4th Edition.

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ME 473

Mechatronics (ELECTIVE - III)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student will understand

1. How to identify, formulate, and solve engineering problems
2. The design a system, component, or process to meet desired needs within realistic constraints
3. The how to use the techniques, skills, and modern engineering tools necessary for engineering practice
4. The use of drive mechanisms and fluid power systems
5. The use of industrial electronic devices
6. The demonstrate the design of modern CNC machines, and Mechatronics elements

Outcomes: At the end of the course, the students will be able to

1. Model and analyze electrical and mechanical systems and their interconnection
2. Integrate mechanical, electronics, control and computer engineering in the design of mechatronics systems
3. Do the complete design, building, interfacing and actuation of a mechatronics system for a set of specifications
4. Be proficient in the use of fluid power systems in various mechatronics applications
5. Demonstrate the use of industrial electronic devices
6. Demonstrate the design of modern CNC machines, and mechatronics elements

UNIT-I

Introduction to mechanization & automation: Need of interface of electrical & electronic devices with mechanical elements, the concept of Mechatronics, Flow chart of Mechatronics system, elements of Mechatronics system, drive mechanisms, actuators, feedback devices and control system, application in industries and systems development

UNIT-II

Drive mechanisms: Feeding and indexing, orientation, escapement and sorting devices, conveyor systems

Introduction to electrical actuators: A.C. servomotors, D.C. servomotors, stepper motors

UNIT-III

Introduction to fluid power systems: Industrial Pneumatics and hydraulics, merits of fluid power, pneumatic & hydraulic elements symbols, study of hydraulic control valves, pumps & accessories, hydraulic circuits & mechanical servo control circuits, Electro-hydraulic and Hydro-pneumatic circuits

UNIT-IV

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Introduction to industrial electronic devices: Diodes, Transistors, Silicon Controlled Rectifiers (SCR), Integrated Circuits (IC), Digital Circuits, Measurement systems & Data acquisition systems: sensors, digital to analog and analog-to-digital conversion, signal processing using operational amplifiers, introduction to micro processor & micro controller, Temperature measurement interface and LVDT interface, Systems response

UNIT-V

Design of modern CNC machines and Mechatronics elements: machine structures, guide ways, spindles, tool monitoring systems, adaptive control systems, Flexible manufacturing systems, Multipurpose control machines, PLC programming

Text Books:

1. William Bolton, *Mechatronics*: *Electronic control systems in mechanical and electrical engineering*, 6th edition, Pearson Education
2. HMT Ltd, *Mechatronics*, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1998

Suggested Reading:

1. Michaels Histand & David G, Alciatore, *Introduction to Mechatronics and Measurement Systems*, Tata McGraw-Hill International Edition
2. Devdas Shetty, Richard A. Kolk, *Mechatronics System Design*, Cengage Learning
3. S.R. Majumdar, *Oil Hydraulic Systems – Principles & Maintenance*, McGraw-Hill Publishing Company Limited, New Delhi
4. Godfrey Onwubolu, *Mechatronics: Principles and Applications*, Butterworth-Heinemann

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ME 474

Mechanics of Composite Materials (ELECTIVE - III)

Instruction week	4 Periods per
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student will understand the

1. Properties of fiber and matrix materials used in commercial composites, as well as some common manufacturing techniques.
2. How to predict the elastic properties of long fiber composites based on the constituent properties. An ability to rotate stress, strain and stiffness tensors using ideas from matrix algebra.
3. Linear elasticity with emphasis on the difference between isotropic and anisotropic material behavior. An ability to analyze a laminated plate in bending using classical lamination theory.
4. How to predict the failure strength of a laminated composite plate. A knowledge of issues in fracture of composites.
5. Exposure to recent developments in composites, including metal and ceramic matrix composites.
6. How to use the ideas developed in the analysis of composites towards using in industrial application.

Outcomes: At the end of the course, a student should be able to

1. Understand the various fabrication methods of composite materials.
2. Understand the specifics of mechanical behavior of layered composites compared to isotropic materials.
3. Determine stresses and strains in composites.
4. Apply constitutive equations of composite materials and understand mechanical behavior at micro and macro level.
5. Understand the failure of composites including fracture.
6. Understand the theory of plate and shell; understand the bending analysis of composite beams.

Unit-I

Introduction: Fibers, matrix materials, interfaces, polymer matrix composites, metal matrix composites, ceramic matrix composites and carbon composites.

Unit-II

Micromechanics of lamina and mechanical properties: Prediction of elastic constants, micromechanical approach, Halpin-Tsai equations, thermal properties, hygro properties, mechanics of load transfer from matrix to fibre.

Unit-III

Macro-mechanics of lamina: Elastic constants of a lamina, relations between engineering constants and reduced stiffness and compliances, variation of lamina properties with orientation, analysis of laminated composites, stresses and strains with orientation, inter-laminar stresses and edge effects, simplified composite beam solutions, bending of laminated beams.

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Unit-IV

Strength, fracture, fatigue and design: Tensile and compressive strength of unidirectional fibre composites, fracture modes in composites: single and multiple fractures, de-bonding, fibre pullout and de-lamination.

Strength of an orthotropic lamina: Max stress theory, max strain criteria, maximum work (Tsai-Hill) criterion, quadratic interaction criteria, designing with composite materials

Unit-V

Manufacturing processes: Hand lay-up, prepregs, bag molding, autoclave processing, RTM, pultrusion, filament winding, gel time test for resins, curing cycle,

Measurement of basic composite properties: Fiber and matrix tests, tensile test, compressive test, in-plane shear test, inter-laminar shear test, flexure test.

Text Books:

1. Jones, R.M., *Mechanics of Composite Materials*, Mc Graw Hill Co., 1967
2. B.D. Agarwal et.al, *Analysis and performance of fiber composites*, 3rd edition, Wiley sons., 2013
3. P.K. Mallick, *Fiber Reinforced Composites Materials*, Manufacturing, and Design, Taylor & Francis, Third Edition 2007 ,

Suggested Reading:

1. Ever J Barbero, *Introduction to composite materials design*, Taylor &Francis, 1999.
2. Hyer, M.W., *Stress Analysis of Fibre Reinforced Composite Materials*, McGraw Hill Co., 1998.
3. Carl. T. Herakovich, *Mechanics of Fibrous Composites*, John Wiley Sons Inc., 1998.

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ME 475

Supply Chain Management (Elective – III)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student will understand

1. The significance of supply chain management in engineering.
2. The awareness about transportation and warehouse management systems.
3. The designing supply chain networks.
4. The concept of demand and supply and integrating it with supply chain management.
5. The acquainted with planning and managing inventories.
6. The pricing and revenue management

Outcomes: At the end of the course, the student is able to

1. Apply supply chain management concepts in engineering applications
2. Plan an effective transportation and warehouse management systems
3. Design an effective supply chain networks
4. Integrate and optimize demand and supply gaps
5. Apply inventory management techniques
6. Understand and design a pricing and revenue management systems

UNIT-I

Concept of SCM, Concept of Logistics Management, Supply Chain, Types of supply chain, functions in SCM, Transportation Management, Warehousing Management, Warehouse management systems.

UNIT-II

Designing the supply chain Network, Designing the distribution network, Network Design, Network Design in an uncertain environment.

UNIT-III

Planning and Demand:Planning demand & supply in a supply chain, demand forecasting, aggregate planning, planning supply & demand.

UNIT-IV

Planning & managing inventories in a supply chain, managing economies of scale, cycle inventory, and managing uncertainty safety inventory optimal level of product availability

UNIT-V

Sourcing, Transporting & Pricing Products, sourcing decisions, transportation, pricing & revenue management. Coordination & technology in the supply chains, coordination in supply chain, information technology and supply chain.

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Text Books:

1. N. J. Kumar & Mukesh Bhatia, *Supply Chain Management*, Neha publishers & Distributors,2010
2. Michael H. Hugos, *Essentials of Supply Chain Management*, 3rd edition, John Wiley & Sons, Inc, Hoboken, New Jersy,2011
3. Sunil Chopra & Peter Meindl, *Supply Chain Management* – Strategy, Planning and Operation, Pearson Education, Inc., Upper Saddle River, New Jersey, 2003

Suggested Reading:

1. Martin Christopher, *Logistics & Supply Chain Management*, 5th edition, Financial Times Series,2010
2. Dobler Donald. W, David.N.Burt, *Purchasing & supply Management Text & Cases*. McGraw-Hill, 1996
3. Chitale A.K. Gupta R.C, *Materials Management-Text and Cases*, Prentice-Hall Of India Pvt. Limited, 2007

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PE 471

Manufacturing Systems and Simulation (Elective – III)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student will understand

1. The systems, subsystems for manufacturing techniques
2. The information technologies relevant to manufacturing systems
3. The discrete and continuous systems
4. The system simulation and associated concepts
5. The queuing theory concepts applied to system simulation
6. The awareness about programming with GPSS and SIMSCRIPT

Outcomes:

1. Student is able to have overall view of various manufacturing processes
2. Capable of applying information systems and automation to manufacturing
3. Ability to build various models suitable for appropriate manufacturing facility
4. Able to understand and conceptualize systems simulations
5. Ability to simulate discrete and continuous systems
6. Capable of programming with GPSS and SIMSCRIPT

UNIT-I

Manufacturing Systems: Definition of systems, basic concepts and problems concerning systems, systems design, decision making procedures, Structural, transformational and procedural aspects of manufacturing, modes of production, process systems for manufacturing, logistic systems, material flow & technological information flow, management & information systems for manufacturing, managerial information flow in manufacturing systems

UNIT-II

Information Systems: Fundamentals of information technology, information systems, information networking, parts oriented production information systems and computerized production scheduling, online production control systems, Computer based production management systems, Automation systems for manufacturing, Industrial automation, Kinds of automation, principles of CIM, effectiveness of CIM, factory automation, automatic machine tools for mass production, NC machine tools, computer controlled manufacturing systems, FMS, automated assembly, automatic material handling, automatic inspection & testing, computer integrated automation systems- unmanned factory

UNIT-III

System Models: Concepts, continuous and discrete systems, systems modeling, type of models, subsystems, corporate model and system study

System simulation: Techniques, comparison of simulation and analytical methods, types of simulation, distributed log model, cobweb models

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UNIT-IV

Continuous system Simulation: Numerical solution of differential equation, analog computers, hybrid computers, continuous system simulation languages CSMP, system dynamic growth models, logistic curves

Discrete systems simulation: Events generation of arrival patterns, simulation programming tasks, analysis of simulation output

Queuing theory: Arrival pattern distribution, service times, queuing disciplines and measure of queues

UNIT-V

GPSS and SIMSCRIPT: General description of GPSS and SIMSCRIPT, programming in GPSS simulation programming techniques: Data structures, implementation of activities, event and queues, event scanning, simulation algorithms in GPSS and SIMSCRIPT

Text Books:

1. Geofery Gordan, *Systems Simulation*, Prentice Hall, 1980
2. Allan Carrie, *Simulation of Manufacturing Systems*, John Wiley & Sons Ltd,1998

Suggested Reading:

1. Adelaide Marzano, *Manufacturing system simulation*, VDM Verlag
2. Davi Bedworth & James Bailey, *Integrated Production Control system Management, analysis & design*, 2nd edition, John Wiley & Sons Ltd.,2010
3. Ronald Zskin & Charles Standridge, *Modeling and Analysis of Manufacturing Systems*, John Wiley & Sons Ltd.,2011
4. Deo. N., *'ystem simulation with Digital Computers*, Prentice Hall, 1980

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PE 481

Micro Manufacturing (ELECTIVE - IV)

Instruction	4 Periods per
week	
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student will understand

1. The importance of micromachining, Nano polishing, Micro forming and Micro welding.
2. Micromachining processes
3. The Nano polishing methods
4. The micro forming processes
5. The concepts of micro welding to the students
6. The recent trends and applications of micro manufacturing

Outcomes: At the end of the course, the students are able to

1. Suggest suitable micromachining process to a particular application.
2. Select the process parameters of particular micro machining process
3. Describe the various micro, machining, welding and forming processes
4. Compare various micro machining / forming/ welding processes based on relative merits and demerits.
5. Demonstrate the understanding of various nano machining operations.
6. Exhibit the knowledge regarding the recent trends in micro-manufacturing processes

UNIT I

Micro Machining I: Introduction, scaling laws, mechanical micro machining, ultra sonic micro machining, abrasive jet micro machining, water jet micro machining, abrasive water jet micro machining, micro turning, chemical and electro chemical micro machining, electric discharge micro machining, electro discharge grinding.

UNIT II

Micro Machining II: Beam energy based micro machining, electron beam micro machining, laser beam micro machining, ion beam micro machining, plasma beam micro machining, hybrid micro machining, electro chemical spark micro machining, electrolytic in process dressing.

UNIT III

Nano Polishing: Abrasive flow finishing, magnetic abrasive finishing, magneto rheological finishing, magneto rheological abrasive flow finishing, magnetic float polishing, elastic emission machining, chemo-mechanical polishing

UNIT IV

Micro Forming and Welding: Micro extrusion, micro and nano structured surface development by nano plastic forming and roller imprinting, micro bending with laser, laser micro welding, electron beam for micro welding.

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UNIT V

Recent Trends and Applications: Metrology for micro machined components, ductile regime machining, AE based tool wear compensation, machining of micro gear, micro nozzle, micro pins and applications.

Text Books:

1. Jain V. K., *Micro Manufacturing Processes*, CRC Press, Taylor & Francis Group, 2012
2. Janocha H., *Actuators – Basics and applications*, Springer publishers, 2012
3. Jain V.K., Introduction to Micro machining, Narosa Publishing House, 2011

Suggested Reading:

1. Bharat Bhushan, *Handbook of nanotechnology*, springer, Germany, 2010.
2. Bandyopadhyay. A.K., *Nano Materials*, New age international publishers, New Delhi, 2008, ISBN:8122422578.
3. Jain V.K., *Advanced Machining Processes*, Allied Publishers, Delhi, 2002
4. Mcgeoug.J.A., *Micromachining of Engineering Materials*, CRC press 2001, ISBN-10:0824706447.

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PE 482

Non - Destructive Testing and Evaluation (ELECTIVE - IV)

Instruction	4 Periods per
week	
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student has to understand the

1. Need, basic concepts and technologies of Non Destructive Testing (NDT)
2. Security precautions from Radiography, protection from radiation and measurement of radiation received by personnel.
3. Technology of acoustic emission (AE), the associated instrumentation and applications
4. Technologies like neutron radiography; laser induced ultrasonics, surface analysis and thermography
5. Merits and demerits of the different NDT Technologies
6. Latest research and developments in NDT

Outcomes: At the end of the course, the students will be able to demonstrate

1. the knowledge of different NDT techniques.
2. clear understanding of liquid penetrant inspection and magnetic particle inspection.
3. view and interpret radiographs, utilize the various principles of radiography for different components of different shapes.
4. the knowledge of acoustic emission for NDT and the instrumentation used for NDT.
5. the ability to analyze and prepare a technical report.
6. the knowledge of latest research, developments and trends in NDT.

UNIT-I

Liquid penetrate inspection: Principles of penetrate inspection, characteristics of a penetrate, water washable system, post emulsification system , solvent removable system, surface preparation and cleaning, penetrate application, development, advantages limitations, and applications.

Magnetic particle instruction: Principle, magnetization methods, continuous and residual methods, sensitivities, demagnetization, magnetic particles, applications advantages and limitations.

UNIT-II

Eddy current testing: Principle, lift-off factor, and edge effect, skin effect, inspection frequency, coil arrangements, inspection probes, types of circuit, reference pieces, phase analysis, display methods and applications.

UNIT-III

Ultrasonic testing: Generation of ultra sound, characteristics of an ultrasonic beam, sound waves at interfaces, sound attenuation, display systems, probe construction, type of display, inspection techniques, identification of defects, Immersion testing , sensitivity and calibration. Reference standards. Surface condition, Applications.

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UNIT-IV

Radiography: Principle and uses of radiography, limitation principle, radiation sources, production of X-Rays, x-ray spectra, attenuation of radiation, radiographic equivalence, shadow formation enlargement and distortion, radio graphic film and paper, Xeroradiography, fluoroscopy, exposure factors, radiographic screens, identification markers and image quality indicators, inspection of simple shapes, inspection of complex shapes, viewing and interpretation of radiographs, radiation hazard, protection against radiation, measurement of radiation received by personnel.

UNIT-V

Acoustic Emission: Physical Principles, Sources of emission, instrumentation and applications, Other NDT Techniques: Neuron radiography, Laser induced ultrasonics, surface analysis, and thermography.

Text Books:

1. Barry Hull & Vernon John, *Non Destructive Testing*, 1988.
2. H J Frissell (Editorial Coordinator), Non-*Destructive Evaluation and quality control*, ASM handbook-International Publication USA, 1989..
3. Dove and Adams, *Experimental Stress analysis and Motion Measurement*, Prentice Hall of India, Delhi

Suggested Reading:

1. *Non-Destructive Examination and Quality Control*, ASM International, Vol.17, 9th edition (1989)
2. J. Prasad and C. G. K. Nair, *Non-Destructive Test and Evaluation of Materials*, Tata McGraw-Hill Education, 2nd edition (2011).
3. B. Raj, T. Jayakumar and M. Thavasimuthu, Practical *Non Destructive Testing*, Alpha Science International Limited, 3 rd edition (2002).
4. T. Rangachari, J. Prasad and B.N.S. Murthy, *Treatise on non-destructive testing and evaluation*, Navbharath Enterprises, Vol.3, (1983

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PE 483

Product Design and Process Planning (ELECTIVE – IV)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student will understand

1. The Product Design and Process Functions
2. The essence of innovation in product development
3. The Human Machine Interactions (ergonomics)
4. The various Intellectual Property Rights
5. The interaction between Design, Manufacturing, Quality and Marketing
6. The awareness about overall view of Process Planning

Outcomes: At the end of the course, the student is able to

1. Have overall view of Product Design and Process Planning
2. Apply creativity techniques in Product Development
3. Applying ergonomically enabled concepts in developing a new product
4. Have awareness and apply Intellectual Property Rights
5. Integrate various stages of developing a new product
6. Develop and execute an effective Process Plan

UNIT-I

Product Design and Process Design functions: selection of right product, systematic procedure of product innovation, factors contributing to successful technological innovation, need for creativity and innovation, techniques of innovation like brain storming and Delphi techniques

UNIT-II

Product Selection and Evaluation: Function of design, design with Human Machine Interaction (HMI) and collection of ideas and purpose of project, selection criteria, screening ideas for new products using evaluation techniques, principles of ergonomics.

UNIT-III

New Product Planning: Interaction between the functions of design, manufacture, quality, testing and marketing, design and material selection, steps for introducing new products after evaluation.

UNIT-IV

New Product Development: Research and new product development, patents, definitions, patent search, patent laws, international code for patents, Intellectual Property Rights (IPR).

UNIT-V

Process Selection and Planning: Process selection, process planning, process sheets, selection of manufacturing process, estimation of machining time in various cutting operations, estimation of costs for manufacture, value engineering in product design, group technology, concepts of concurrent engineering.

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Text Books:

1. Niebel BW & Draper AB, *Production Design & Process Engg*, McGraw Hill, Kogakusha, 1974
2. K. G. Swift & J. D. Booker, *Process Selection*: From Design to Manufacture", Butterworth-Heinemann Ltd; 2nd Revised edition, 2003
3. Bhaskaran Gopalakrishnan, *Product Design and Process Planning in CE (Design & Manufacturing*", Chapman and Hall publishers, 1994

Suggested Reading:

1. Harry Nystrom, *Creativity and Innovation*, John Wiley & Sons,
2. Brain Twiss, *Managing Technological Innovation*, Pittrnan Publications, 1992
3. Harry, B.Waton, *New Product Planning*, Prentice Hall Inc., 1992
4. Chitale, A. K. & Gupta RC., *Product Design & Manufacturing*, PHI, 1997

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With Effect from the Academic Year 2016 - 2017

PE 484

Nano Materials and Technology (Elective – IV)
(for Mech, Prod and Chemical)

Instruction	4	Periods per week
Duration of End Examination	3	Hours
End examination	75	Marks
Sessionals	25	Marks
Credits	3	

Objectives: Student will learn the

1. Nanotechnology approach and challenges
2. Materials of nanotechnology
3. Nano structures
4. Nano fabrication
5. Special nano materials
6. Bio materials

Outcomes: At the end of the course

1. Understand the developments and challenges in nano technology
2. Understand synthesis and properties of nanostructured materials
3. Analyze magnetic and electronic properties of nano materials
4. Analyze nano fabrication methods and their applications
5. Understand the characterization of nano and bio materials and their use
6. Analyze the synthesis and characterization of nano wires and tubes

Unit I

Introduction: Nanoscale, Properties at Nanoscale, advantages and disadvantages, importance of Nanotechnology, Bottom-up and Top-down approaches, challenges in nanotechnology, proximal probe technologies

Unit II

Materials of Nanotechnology: Introduction, Si-based materials, Ge-based materials, Ferroelectric materials, Polymer materials, GaAs& InP (HI-V) group materials, Nanotribology and materials, characterization using Scanning Probe Microscope, AFM, FFM

Unit III

Nano Structures: Zero dimensional Nanostructure (Nano particles), synthesis procedure, characterization techniques, properties and applications of Nano particles
One dimensional Nanostructures (Nano Wires, Nano Tubes), various Synthesis procedure, characterization procedure and principles involved, properties and applications of Nano Wires, Types of Nano Tubes, Synthesis procedure, characterization properties and applications of Nano Tubes

Unit IV

Nano Fabrication: Introduction, Basic fabrication techniques (Lithography, thin film deposition, and doping), MEMS fabrication techniques, Nano fabrication techniques (E-beam Nano-imprint fabrication, Epitaxy and strain engineering, Scanned probe techniques)

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Unit V

Special Nano Materials: Nano Composites: Introduction, Synthesis procedures, various systems (metal-polymer, metal-ceramics and Polymer-ceramics), Characterization procedures, applications,

Nano Biomaterials: Introduction, Biocompatibility, anti-bacterial activity, principles involved, applications

Text Books:

1. A.K. Banopadyay, *Nano Materials*, New Age Publications
2. T. Pradeep, *Textbook of Nanoscience and Nanotechnology*, McGraw Hill Education (India) Private Limited, New Delhi
3. Dieter Vollath, *Nanomaterials: An Introduction to Synthesis, Properties and Applications*, Wiley, 2013

Suggested Reading:

1. Carl C. Koch, *Nano Materials Synthesis, Properties and Applications*, Jaico Publishing House
2. Willia Tllsey Atkinson, *Nano Technology*, Jaico Publishing House
3. George W. Hanson, *Fundamentals of Nanoelectronics*, Pearson Education, 2009
4. T. Pradeep, *Nano: Essentials-understanding Nano Science and Technology*, TMH, 2007
5. Sabu Thomas, Nandakumar Kalarikkal, A. Manuel Stephan, B. Raneesh, *Advanced Nano-materials*: Synthesis, Properties, and Applications, Apple Academic Press

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PE 485

Total Quality Management (Elective – IV)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student will understand

1. The essence of total quality management in design and manufacturing a product
2. The various principles and concepts of total quality management
3. The functional requirement of quality
4. The various technical tools of quality like control charts and ANOVA etc
5. The quality information system
6. The awareness about measuring and satisfying customer needs

Outcomes: At the end of the course, the student is able to

1. Apply TQM techniques in engineering applications
2. Use various theories and principles related to TQM
3. Using functional requirements of quality
4. Use statistical techniques in TQM
5. Have awareness and use quality information system and innovative systems
6. Deal with customer grievances and satisfying the customers

UNIT-I

Strategic Quality Management: Quality policies, quality goals, obstacle to achieving successful strategic quality management, Organization for quality role of {Top, middle, work force team (Quality Circles)}, Developing a quality work culture, Maslow need theory, Herzberg two factor theory, Theory X, Y & Z methods to create and maintain awareness of quality, provide evidence of management leadership, types of self development and empowerment programmes, methods of participations means of inspiring action, recognition and rewards, Supplier quality rating plans (lot plot plan, OC curve, parent analysis), assignment of supplier capability, methods of evaluating supplier products, contract management (Joint economic plan, joint technological forecasting

UNIT-II

Design for quality: Basic functional requirements of quality, design for (reliability, safety, cost and product performance), concurrent engineering (DFMA) value engineering, support for quality improvement processes (block diagram, brain storming, cause effect analysis, pareto analysis), quality function deployment, reliability analysis, failure rate, failure pattern of complex products (bath tub curve), weibull distribution relationship between part and the system, exponential reliability, availability, FMEA (Fracture Mode and Effect Analysis), Design for experiments: Factorial experiments, construction fractional designs

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UNIT-III

Technical tools for Quality: Analysis of variance (ANOVA), 4 factor ANOVA experiment, 2 levels, analysis of means, Techniques for online quality: data collection plan, variable and attribute charts, interpreting the control charts, Techniques for offline quality control: background to Taguchi method (quality loss and loss function, controllable factor, and non controllable factors in parameter performance, tolerance design

Taguchi analysis techniques: net variation and contribution ratio, estimation of process performance, accumulating analysis, performance measures, Taguchi tolerance design and tolerance (re) design

UNIT-IV

Quality Information System: Scope of Quality Information System, differences between QIS and MIS, creating new software (steps, types, defects) reports on quality (operational and executive reports), features of QIS software, software for inspection

Inspection System: Operational sorting and correlation sorting, AQL, LTPD, AOQL, Nondestructive test, Audit systems: (quality improvement planning and implementation, describing quality function, process control system, control of measurement system, material identification and control, drawing and specification control, process corrective action), the concept of POKAYOKE

UNIT-V

Measure of customer needs: The need to measure customer satisfaction, importance of proper packaging, customer processing and installation of product, dealing with customer complaints, using weibull analysis, field feedback, parameter to measure customer (dis)satisfaction, problems with the customer satisfaction system

Beyond TOM: Difficulties in implementing TOM system, rating your quality system, JIT system, the people side of TOM system, system integration, Kansei engineering and flexibility in manufacturing

Text Books:

1. L. Suganthi, Aanand A. Samuel, *Total Quality Management*, PHI Learning Pvt. Ltd., 2004
2. H.G. Menon, *TQM in view Production Manufacturing*, McGraw Hill Publishers

Suggested Reading:

1. Joel E. Ross & Susan Perry, *Total Quality Management*: *Text, Cases, and Readings*, 3rd edition, CRC Press, 1999
2. John S Oakland, *Total Quality Management*: *The route to improving performance*, A Butterworth-Heinemann Title, 2nd edition, 1994
3. Jankiraman, *Total Quality Management*: *Text and Cases*, PHI Learning Private Limited-New Delhi; 1 edition (2006)

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CSE 481

Information Security (Elective – IV)

Instruction	4 Periods per week
Duration of End Examination	3 Hours
End examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives: Student will understand the

1. Information assurance as practiced in computer operating systems, distributed systems, networks and representative applications.
2. Several ethical issues in information system
3. Principal concepts, major issues, technologies, and basic approaches in information security.
4. Prevalent network and distributed system attacks, defenses against them, and forensics to investigate the aftermath.
5. Cryptography, how it has evolved, and some key encryption techniques used today.
6. Security policies (such as authentication, integrity and confidentiality), as well as protocols to implement such policies in the form of message exchanges.

Outcomes: At the end of the course, the students are able to understand the

1. Basic concepts and goals of Information security such as Confidentiality, Integrity, Authentication, Non-Repudiation, Authorization, and Availability and their relevance in various Contexts.
2. Classical cryptosystems and techniques used to break them.
3. Ideas of public key cryptosystems and digital signature schemes
4. Different network issues as well as database security issues and the solutions for them through firewall, intrusion detection system
5. Critical evaluation of a range of access control and authentication mechanisms
6. Legal privacy and ethical issues in computer security

Unit I

Introduction: History, critical characteristics of information, NSTISSC SECURITY MODEL, Components of an information system, securing the components, balancing security and access, The SDLC, The Security SDLC

Need for security: Business needs, Threats, Attacks-secure software development

Unit II

Legal, Ethical and Professional Issues: Law and Ethics information security, relevant U.S. laws, international laws and legal bodies, Ethics and information security

Risk Management: Overview, Risk Identification, risk assessment, Risk Control Strategies, selecting a risk control strategy, Quantitative versus qualitative risk control practices, Risk Management discuss points, recommended risk control practices

Unit III

Planning for security: Security policy, standards and practices, security blue print, security education, continuity strategies, Security technology

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Firewalls and VONs: Physical design, firewalls, protecting remote connections

Unit IV

Security Technology: Intrusion detection, access control and other security tools, Intrusion detection and prevention systems, scanning and analysis tools, access control devices

Cryptography: Foundations of cryptology, cipher methods, crypryptographic algorithms, cryptographic tools, protocols for secure communications, attacks on cryptosystems

Unit V

Implementing Information Security: Information security project management, technical topics of implementation, Non-technical aspects of implementation, security certification and accreditation,

Security and personnel: Positioning and staffing security function, Employment policies and practices, internal control strategies

Information Security Maintenance: Security management models, the maintenance model, digital forensics

Text Books:

1. Michael E. Whitman and Hebert J. Mattord, *Principles of Information Security*, 4th edition, Ed. Cengage Learning, 2011
2. Thomas R. Peltier, Justing Peltier, John Blackley, *Information Security Fundamentals*, Auerbacj Publications, 2010

Suggested Reading:

1. Detmar W Straub, Seymor Goodman, Richard L Baskerville, *Information Security Policy Processes and Practices*, PHI, 2008
2. Marks Merkow and Jim Breithaupt, *Information Security, Principle and Practices'*, Pearson Education, 2007
3. Mark Rhodes-Ousley, *Information Security, The Complete Reference* McGraw-Hill Education, New York, 2013
4. Alberts, Christopher and Dorofee, Audrey, *Managing Information Security Risks*: *The OCTAVE Approach* Addision-Wesley Publications, 2003

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With Effect from the Academic Year 2016 - 2017

PE 422

Seminar

Instruction	3 Periods per week
Sessionals	25 Marks
Credits	1

Oral presentation is an important aspect of engineering education. The objective of the seminar is to prepare the student for a systematic and independent study of state of the art topics in a broad area of his /her specialization.

Seminar topics may be chosen by the students with advice from the faculty members. Students are to be exposed to following aspects of seminar presentations.

- Literature survey
- Consolidation of available information
- Power point Preparation
- Technical writing

Each student is required to:

1. Submit a one page synopsis of the seminar talk for display on the notice board.

2. Give twenty(20) minutes presentation through OHP/ PPT/ Slide Projector followed by Ten(10) minutes discussion

3. Submit a report on the seminar topic with list of references and hard copy of the slides.

Seminars are to be scheduled from 3rd week to the last week of the semester and any change in schedule should be discouraged.

For the award of sessional marks students are judged by three (3) faculty members and are based on oral and written presentations as well as their involvement in the discussions during the oral presentation.

Note: Topic of the seminar should be from any peer reviewed recent journal publications.

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PE 901

Project

Instruction	6 Periods per week
Duration of End Examination	Viva Voce
End Examination	100 Marks
Sessionals	50 Marks
Credits	9

Dealing with a real time problem should be the focus of under graduate project.

All projects will be monitored at least four times in the II-semester through individual presentations (Project batch wise).

Every student should maintain a project dairy, wherein he/she needs to record the progress of his/her work and get it signed at least once in a week by the guide(s). If working outside and college campus, both the external and internal guides should sign the same.

Sessional marks should be based on the marks, awarded by a project monitoring committee of faculty members as well as the marks given by the guide.

Common norms are established for final documentation of the project report, the students are directed to download from the website regarding the guidelines for preparing the project report and the project report format.

The project report shall be evaluated for 100 Marks by the External Examiner.

If the project work found inadequate in the end examination, the candidate should repeat the project work with a new problem or improve the quality of work and report it again.

Break up for 100 Marks in the end examination:

1. Power point presentation 30 Marks
2. Thesis/Report preparation 20 Marks
3. Viva-voce 30 Marks

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
16MEC 101	**AUTOMATION**	3	1	0	4	70	30	100

Objective (s)	Student will 1. To learn & understand basic concepts of automation & its significance in manufacturing industries 2. To understand Detroit type automation & flow lines. 3. To conceptualize & design assembly line balancing 4. To learn about automated material handling systems 5. To understand different automated storage/retrieval system 6. To design effective and appropriate testing & inspection systems
Outcome (s)	1. Ability to conceptualize and design automated flow lines 2. Ability to implement line balancing concepts in production and assembly lines 3. Ability to understand and develop automated material handling system suitable for plant operations 4. Ability to design, implement and use and appropriate automated inspection facility 5. Ability to understand and develop automated material handling system suitable for plant operations 6. Ability to design, implement and use and appropriate automated inspection facility

1.	Total Hrs	9

Introduction: Definition of automation, Types of production, Functions of Manufacturing, Organization and Information Processing in Manufacturing, Production concepts and Mathematical Models, Automation Strategies, Production Economics: Methods of Evaluating Investment Alternatives, Costs in Manufacturing, Break-Even Analysis, Unit cost of production, Cost of Manufacturing Lead time and Work-in-process.

2.	Total Hrs	9

Detroit-Type Automation: Automated Flow lines, Methods of Workpart Transport, Transfer Mechanism, Buffer Storage, Control Functions, Automation for Machining Operations, Design and Fabrication Considerations. *Analysis of Automated Flow Lines*: General Terminology and Analysis, Analysis of Transfer Lines Without Storage, Partial Automation, Automated Flow Lines with Storage Buffers, Computer Simulation of Automated Flow Lines

3.	Total Hrs	9

Assembly Systems and Line Balancing: The Assembly Process, Assembly Systems, Manual Assembly Lines, The Line Balancing Problem, Methods of Line Balancing, Computerized Line Balancing Methods, Other ways to improve the Line Balancing, Flexible Manual Assembly Lines. *Automated Assembly Systems:* Design for Automated Assembly, Types of Automated Assembly Systems, Part Feeding Devices, Analysis of Multi-station Assembly Machines, Analysis of a Single Station Assembly Machine

4.	Total Hrs	9

Automated Materials Handling: The material handling function, Types of Material Handling Equipment, Analysis for Material Handling Systems, Design of the System, Conveyor Systems, Automated Guided Vehicle Systems. *Automated Storage Systems:* Storage System Performance, Automated Storage/Retrieval Systems, Carousel Storage Systems, Work-in-process Storage, Interfacing Handling and Storage with Manufacturing

5.	Total Hrs	9

Automated Inspection and Testing: Inspection and testing, Statistical Quality Control, Automated Inspection Principles and Methods, Sensor Technologies for Automated Inspection, Coordinate Measuring Machines, Other Contact Inspection Methods, Machine Vision, Other optical Inspection Methods. *Modeling Automated Manufacturing Systems:* Role of Performance Modeling, Performance Measures, Performance Modeling Tools: Simulation Models, Analytical Models. *The Future Automated Factory:* Trends in Manufacturing, The Future Automated Factory, Human Workers in the Future Automated Factory, The social impact

	Total hours to be taught	45

Text book (s)

1. Mikell P.Grover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson Education Asia,
2. C.Ray Asfahl, Robots and manufacturing Automation, John Wiley and Sons New York.

References:

1. N.Viswanadham and Y.Narahari, Performance Modeling of Automated Manufacturing Systems, Printice Hall India Pvt. Ltd.,
2. Stephen J. Derby, Design of Automatic Machinary, Special Indian Edition, Marcel Decker, New York Yesdee publishing Pvt. Ltd, Chennai.

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
16MEC 102	**COMPUTER AIDED MODELING AND DESIGN**	3	1	0	4	70	30	100

Objective (s)	Student will Understand the 1. Understand the basics of computer aided design 2. To impart knowledge on design process 3. Recognize and explain the uses of wireframe and surface entities 4. Understand and apply various Geometric transformations 5. Understand various advanced modeling concepts
Outcome (s)	Students are able to 1. apply design concepts in design , analysis and can visualize the models through the graphics standards 2. implement Various transformations on geometric models for manipulation 3. recognize various wireframe entities and model them 4. apply surface modeling techniques for the generating various parts and implement 5. differentiate various solid modeling techniques 6. apply various advanced modeling concepts and calculate the interference between mating objects

1. Criteria for selection of cad workstations, Shigle design process, Design criteria, Geometric modeling , Entities, 2d and 3d primitives, Computer Aided Design , Iterative Design ,CAD process Geometric Transformations: 2d Translation, Scaling, Rotation, Reflection and shearing, Homogeneous Coordinates , Rotation and Scaling about arbitrary points , 3D transformations Windowing - View ports -Clipping transformations Graphics standards: GKS , IGES , PDES and their relevance	**Total Hrs**	9
2. Analytic curves : Lines, Circles, Ellipse, Conics. Synthetic curves – Cubic, Bezier, B-Splines, NURBS. Curve Manipulations Wireframe Modeling and its advantages and Limitations	**Total Hrs**	9
3. Analytic Surfaces: Plane Surface, Ruled Surface, Surface of Revolution, Tabulated Cylinder. Synthetic Surface - Cubic, Bezier, B-spline, Coons ,Surface Manipulations , Surface Modeling Techniques	**Total Hrs**	9
4. Boundary Representation (B-rep) & Constructive Solid Geometry (CSG) Modeling Graph Based Model, Boolean Models, Instances, Cell Decomposition & Spatial – Occupancy Enumeration	**Total Hrs**	9
5. Feature Based Modeling, Assembly Modeling, Conceptual Design and Top down design, Parametric and Variational Modeling Feature recognition, Design by Features Computer Aided Design of mechanical parts and Interference Detection by Motion analysis		
	Total hours to be taught	45

Text book (s)

1. Ibrahim Zeid, —CAD/CAM, Theory and Practicell, Mc Graw Hill, 1998
2. Foley, Van Dam, Feiner and Hughes, —Computer Graphics Principles and Practicell, 2nd Ed., Addison Wesley, 2000

Reference (s)

1. E. Micheal, —Geometric Modellingll, John Wiley & Sons, 1995
2. Hill Jr, F.S., —Computer Graphics using open GLll, Pearson Education, 2003

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEC 103	**COMPUTER INTEGRATED MANUFACTURING**	L	T	P	C	E	I	Total
		3	1	0	4	70	30	100

Objective (s)	1. To identify the main elements in computer integrated manufacturing systems 2. To use computer in the area of manufacturing to reduce manual processing and linking computers to all the manufacturing machines and increase the productivity, reduce the unnecessary costs. 3. To study about computer aided planning, artificial intelligence and expert systems 4. To obtain an overview of computer technologies including computers, database and data collection, networks, machine control, as they apply to factory management and factory floor operation 5. To describe the integration of manufacturing activities into a complete system
Outcome (s)	Student are able to understand 1. the basic of CIM, Concurrent engineering, communication matrix, product development cycle, collaborative product development 2. to create the manufacturing database and store and retrieve data from database 3. the product design, design for manufacturability and design for assembly concepts, types of computer aided process planning 4. the CIM technologies such as cellular manufacturing, shop-floor control and flexible manufacturing systems 5. the importance of principles of networking, topology, network devices, selection of network technology, different models of CIM 6. to apply the concepts of lean manufacturing, agile & web based manufacturing to product life cycle and process plan during the development of a product.

1.	Total Hrs	9
The meaning of Manufacturing Types of Manufacturing: Basic Concepts of CIM: CIM Definition, Elements of CIM, CIM wheel, concept or technology, Evolution of CIM, Benefits of CIM, Needs of CIM: Hardware and software. Fundamentals of Communication: Communications Matrix. Product Development Cycle, Concurrent Engineering: Definition, Sequential Engineering Versus Concurrent Engineering, Benefits of Concurrent Engineering, Characteristics of concurrent Engineering, Framework for integration of Life-cycle phases in CE, Concurrent Engineering Techniques, Integrated Product Development(IPD), Product Life-Cycle Management (PLM), Collaborative Product Development		

2.	Total Hrs	9
Introduction, Manufacturing Data: Types, sources; Database Terminology, Database requirements, Database models, Database Management System, DBMS Architecture, Query Language, Structural Query Language (SQL): Basic structure, Data definition Language (Create, Alter, Drop, Truncate, View), Data Manipulation Language (store, retrieve, update, delete). Illustration of Creating and Manipulating a Manufacturing Database. SQL as a Knowledge Base Query Language. Features of commercial DBMS: Oracle, MySQL, SQL Access, Sybase, DB2. Product Data Management (PDM), Advantages of PDM.		

3.	Total Hrs	9
Product Design: Needs of the market, Design and Engineering, The design Process, Design for Manufacturability (DFM): Component Design, Design for Assembly. Computer-Aided Process Planning: Basic Steps in developing a process plan, Variant and Generative Process Planning, Feature Recognition in Computer-Aided Process Planning. Material Requirements Planning (MRP), Manufacturing Resource Planning (MRP –II), Cellular Manufacturing: Design of Cellular Manufacturing Systems, Cell Formation Approaches: Machine–Component Group Analysis, Similarity Coefficients-Based Approaches. Evaluation of Cell Design. Shop-floor Control: Data Logging and Acquisition, Automated Data Collection, Programmable Logic Controllers, Sensor Technology. Flexible Manufacturing Systems: Physical Components of an FMS. Types of Flexibility, Layout Considerations: Linear Single Machine Layout, Circular Machine Layout, Cluster Machine Layout, Loop Layout; Operational Problems of FMS. FMS benefits		

4.	Total Hrs	9
Introduction to Networking, Principles of Networking, Network Terminology, Types of Networks: LAN, MAN, WAN; Selection of Network Technology: Communication medium, Network Topology, Medium access control Methods, Signaling methods; Network Architectures and Protocols: OSI Model, MAP & TOP, TCP/IP, Network Interconnection and Devices, Network Performance. Framework for Enterprise-wide Integration. CIM Models: ESPRIT-CIM OSA Model, NIST-AMRF Model, Siemens Model of CIM, Digital Equipment Corporation Model, IBM Concept of CIM		

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5.	Total Hrs	9
Lean Manufacturing: Definition, Principles of Lean Manufacturing, Characteristics of Lean Manufacturing, Value of Product, Continuous Improvement, Focus on Waste, Relationship of Waste to Profit, Four Functions of Lean Production, Performance Measures, The Supply Chain, Benefits of Lean Manufacturing. Introduction to Agile and Web Based Manufacturing systems.		
Total hours to be taught		45
Text book (s) 1. S.Kant Vajpayee: Principles of Computer Integrated Manufacturing, Printice-Hall India 2. Singh: Systems Approach to Computer Integrated Design and Manufacturing- John Wiley		
Reference (s) 1. P.Radhakrishnan, S.Subramanyam: CAD/CAM/CIM, New Age International 2. Alavudeen, Venkateshwaran: Computer Integrated Manufacturing, Printice-Hall India		

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BIT	Autonomous Regulation	Semester-1			AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name			M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks	
		L	T	P	C	E	I	Total
16MEE101	**FAILURE ANALYSIS AND DESIGN**	3	1	0	4	70	30	100

Objective (s)	1. To understand importance of design and its morphology 2. To understand buckling phenomenon due to combined external pressure and axial loading
Outcome (s)	Graduate will be able to understand 1. design methodology and various aspects involved in design process 2. different creative and inventive problem solving techniques 3. different types of design process, concepts of reliable and safe design 4. concept of buckling of cylinders under various loading conditions 5. the fundamentals of fracture, fracture types and concepts of fatigue crack growth, fatigue life prediction and various stress theories of failure vessels 6. basic crack propagation concept, concepts of crack propagation under combined loading, fracture toughness of weld metals.

1.	Importance of design- The design process-Considerations of Good Design – Morphology of Design – Organization for design– Computer Aided Engineering –Concurrent Engineering – Product and process cycles –Market Identification – Competition Bench marking. Identification of customer needs- customer requirements- Product Design Specifications- Human Factors in Design – Ergonomics and Aesthetics	**Total Hrs 10**
2.	Creativity and Problem Solving –Creativity methods-Theory of Inventive Problem Solving(TRIZ)– Conceptual decomposition-Generating design concepts-Axiomatic Design – Evaluation methods-Embodiment Design-Product Architecture-Configuration Design- Parametric Design. Role of models in design-Mathematical Modeling – Simulation – Design for Reliability –Introduction to Robust Design-Failure mode Effect Analysis	**Total Hrs 10**
3.	Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure – collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading	**Total Hrs 10**
4.	Failure analysis and determination of stress patterns from plastic Flow observations – Dynamic loading– Fracture types in tension—Fatigue crack growth– Fatigue life prediction- Cumulative fatigue damage-Stress theory of failure vessels-Thermal stress fatigue	**Total Hrs 10**
5.	Introduction –Through cracks emanating from holes – Corner cracks at holes – Cracks approaching holes-Combined loading-Fatigue crack growth binder- Mixed mode loading-Fracture toughness of weld metals-Service failure analysis	**Total Hrs 10**
		Total hours to be taught

Text book (s)

1. Dieter, George E., —Engineering Design - A Materials and Processing Approachll, McGraw Hill, International Editions, Singapore, 2000.
2. Pahl, G, and Beitz, W.,ll Engineering Designll, Springer – Verlag, NY. 1984

References:

1. David Broek, llElementary Engineering Fracture Mechanics —, Fifthoff and Noerdhoff International Publisher, 1978
2. Preshant Kumar, —Elements of Fracture Mechanicsll, Wheeler Publishing, 1999
3. John F. Harvey, Theory and Design of Pressure Vessels, CBS Publishers and Distributors, 1987
4. Henry H. Bedner, —Pressure Vessels, Design Hand Book, CBS publishers and Distributors, , 1987

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CBIT	*Autonomous Regulation*						
Department	Mechanical Engineering	Programme Code & Name			M.E. CAD/CAM & Thermal Engineering		
	Semester-I						
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks	
		L	T	P	C	E	I	Total
16MEE 107	**ENGINEERING RESEARCH METHODOLOGY**	3	0	0	3	70	30	100

Objective (s)	1. To motivate the students to choose research as career. 2. To make the students to formulate the research problem. 3. To identify various sources for literature review and data collection. 4. To prepare the research design 5. To equip the students with good methods to analyze the collected data 6. To write a report and interpret the results
Outcome (s)	Students will be able to 1. define research problem 2. review and asses the quality of literature from various sources. 3. understand and develop various research designs. 4. collect the data by various methods: observation, interview, questionnaires. 5. analyze problem by statistical techniques: ANOVA, F-test, Chi-square 6. improve the style and format of writing a report for technical paper/ Journal report

1	**Research Methodology:**	**Total Hrs**	**9**

Research Methodology: Objectives and Motivation of Research, Types of Research, Research Approaches, Significance of Research, Research Methods verses Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general.
Defining the Research Problem: Selection of Research Problem, Necessity of Defining the Problem, Technique involved in Defining a Problem

2	**Literature Survey:**	**Total Hrs**	**9**

Literature Survey: Importance and purpose of Literature Survey. Sources of Information, Assessment of Quality of Journals and Articles, Information through Internet.
Literature Review: Need of Review, Guidelines for Review, Record of Research Review

3	**Research Design:**	**Total Hrs**	**9**

Research Design: Meaning of Research Design, Need of Research Design, Feature of a Good Design, Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Steps in sample design, types of sample designs.

4	**Data Collection:**	**Total Hrs**	**9**

Data Collection: Methods of data collection, importance of Parametric test, testing of proportions, testing of variance of two normal population, and Non Parametric test, relation between Spearman's r's and Kendall's W
Data Analysis: Tests for significance: Chi-square, ANOVA, F-test.

5	**Interpretation and report writing:**	**Total Hrs**	**9**

Interpretation and report writing: Meaning of interpretation, layout of research report, Types of reports, Mechanics of writing a report.
Research Proposal Preparation: Writing a Research Proposal and Research Report, Writing Research Grant Proposal

Text Book (s):

1. C.R Kothari, Research Methodology, Methods & Technique; New Age International Publishers, 2004
2. R. Ganesan, Research Methodology for Engineers, MJP Publishers, 2011

References:

3. Y.P. Agarwal, Statistical Methods: Concepts, Application and Computation, Sterling Publs., Pvt., Ltd., New Delhi, 2004
4. Vijay Upagade and Aravind Shende, Research Methodology, S. Chand & Company Ltd., New Delhi, 2009
5. P. Ramdass and A. Wilson Aruni, Research and Writing across the Disciplines, MJP Publishers

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEE 111	**THEORY OF ELASTICITY AND PLASTICITY**	L	T	P	C	E	I	Total
		3	0	0	3	70	30	100

Objective (s)	Students should able to 1. solve the problems selected to stress-strain tensors and an constitutive relations 2. apply suitable plasticity relations to solve the problems in various metal forming operations
Outcome (s)	Students can 1. demonstrate the understanding of fundamentals stress and its concepts. 2. understanding of concepts of strain 3. solve the problems related to stress & strain and also their relations in isotropic materials 4. to apply the constitutive equations, compatibility equation and equilibrium equations for problem solving 5. apply plasticity relations for simple problems 6. can choose and apply plasticity analysis methods

1.	Basic Concepts of Stress : Definition, State of Stress at a point, Stress tensor, invariants of stress tensor, principle stresses, stress ellipsoid, derivation for maximum shear stress and planes of maximum shear stress, octahedral shear stress, Deviatoric and Hydrostatic components of stress, Invariance of Deviatoric stress tensor, plane stress	**Total Hrs** 9
2.	Basic concepts of Strain : Deformation tensor, Strain tensor and rotation tensor; invariants of strain tensor, principle strains, derivation for maximum shear strain and planes of maximum shear strain, octahedral shear strain, Deviatoric and Hydrostatic components of strain tensor, Invariance of Deviatoric strain tensor, plane strain.	**Total Hrs** 9
3.	Generalized Hooke's Law : Stress-strain relationships for an isotropic body for three dimensional stress space, for plane stress and plane strain conditions, differential equations of equilibrium, compatibility equations, Material (D) matrix for Orthotropic Materials	**Total Hrs** 9
4.	True stress and true strain, von-Mise's and Tresca yield criteria, Haigh–Westergard stress space representation of von - Mise's and Tresca yield criteria, effective stress and effective strain, St. Venants theory of plastic flow, Prandtle–Reuss and Levy–Mise's constitutive equations of plastic flow, Strain hardening and work hardening theories, work of plastic deformation.	**Total Hrs** 9
5.	Analysis methods: Slab method, Slip line field method, uniform deformation energy method, upper and lower bound solutions. Application of Slab method to forging, wire drawing, extrusion and rolling processes	**Total Hrs** 9
	Total hours to be taught	**Total Hrs** 45

Text book (s)

1. Timoshenko and Goodieer, *Theory of Elasticity*, Mcgraw Hill Publications 3rd Edition
2. Madleson, *Theory of Plasticity*

Reference(s)

1. J. Chakrabarty, *Theory of Plasticity*, 2nd edition, McGraw Hill Publications 1998
2. George E Dieter, *Mechanical Metallurgy*, McGraw Hill Publications 1988

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Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
16MEE 102	**INTEGRATED MECHANICAL DESIGN**	3	0	0	3	70	30	100

Objective (s)	1. To know the importance of limits, fits and tolerances in design of machine and mechanical components 2. To learn design criteria of machine components according to standards and Theories of failures 3. To learn application of principles to design different gears and gear boxes. 4. To provide the design concepts of machine tools, automobiles and mechanical handling equipments for dynamics and thermal aspects. 5. To provide the students the knowledge of design of Mechanical handling equipments like power plants and Construction fields
Outcome (s)	1. Be able to know the importance of limits ,fits and tolerances and Testing standards for design and manufacturing 2. Be able to do the complete design and analysis of shafts, bearings and casings by considering design and machining allowances according to standards and requirements. 3. Be able to do the design and analysis of Different gears and gear boxes. 4. Be able to do the design of brakes of machine tools, automobiles and mechanical handling equipments for dynamics and thermal aspects. 5. Be able to design of Mechanical handling equipments.

1. Phases of design – Standardization and interchangeability of machine elements - Process and Function Tolerances – Individual and group tolerances – Selection of fits for different design situations – Design for assembly and modular constructions – Concepts of integration –BIS, ISO, DIN, BS, ASTM Standards. Oblique stresses – Transformation Matrix – Principal stresses – Maximum shear stress - Theories of Failure – Ductile vs. brittle component design - Analysis and Design of shafts for different applications – integrated design of shaft, bearing and casing – Design for rigidity.	**Total Hrs**	**9**
2. Principles of gear tooth action – Gear correction – Gear tooth failure modes – Stresses and loads – Component design of spur, helical, bevel and worm gears – Design for sub assembly – Integrated design of speed reducers and multi-speed gear boxes – application of software packages	**Total Hrs**	**9**
3. Dynamics and thermal aspects of vehicle braking – Integrated design of brakes for machine tools, automobiles and mechanical handling equipments	**Total Hrs**	**9**
4. Integrated Design of systems consisting of shaft, bearings, springs, motor, gears, belt, rope, chain, pulleys, Cam & Follower, flywheel etc. Example - Design of Elevators, Escalators, Gear Box, Valve gear Mechanisms, Machine Tools	**Total Hrs**	**9**
	Total hours to be taught	

Text book (s)

1. L. R., —Machine Design – An Integrated Approachl Pearson Education, 2005
2. Newcomb, T.P. and Spur, R.T., —Automobile Brakes and Braking Systemsl, Chapman and Hall, 2nd Edition,1975.
3. Maitra G.M., —Hand Book of Gear Designl, Tata McGraw Hill, 1985
4. Shigley, J.E., —Mechanical Engineering Designl, McGraw Hill, 1986
5. Prasad. L. V., —Machine Designl, Tata McGraw Hill, New Delhi, 1992
6. Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981
7. Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958

Approved Data Books:

1. .S.G. Tech., —Design Data Bookl, Kalaikathir Achchagam, Coimbatore, 2003.
2. Lingaiah. K. and Narayana Iyengar, —Machine Design Data Hand Bookl, Vol. 1 & 2, Suma 1983

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
16MEE 102	**ROBOTIC ENGINEERING**	3	0	0	3	70	30	100

Objective (s)	□ To be familiar with the brief history of robot and applications. □ To give the student familiarities with the kinematics of robots. □ To give knowledge about robot end effectors and their design. □ To give knowledge about various Sensors and their applications in robots.
Outcome (s)	1. Students will be equipped with the brief history of robot configuration , subsystems,applicatios. 2. Students will have good knowledge about robot end effectors and their design concepts. 3. Understand different orientations of robot 4. Students will be familiarized with the kinematic motions of robot and 5. Able to solve the static and dynamic analysis of Planar robots 6. Students will be equipped with the principles of various Sensors, their applications in robots and concept of robot vision

1.	Brief History, Types of robots, Overview of robot subsystems, resolution, repeatability and accuracy, Degrees of freedom of robots, Robot configurations and concept of workspace, Mechanisms and transmission, End effectors and Different types of grippers, vacuum and other methods of gripping. Pneumatic, hydraulic and electrical actuators, applications of robots, specifications of different industrial robots.	**Total Hrs** 9
2.	Rotation matrices, Euler angle and RPY representation, Homogeneous transformation matrices, Denavit-Hartenberg notation, representation of absolute position and orientation in terms of joint parameters, direct kinematics.	**Total Hrs** 9
3.	Inverse Kinematics, inverse orientation, inverse locations, Singularities, Jacobian, Trajectory Planning: joint interpolation, task space interpolation, executing user specified tasks, sensor based motion planning: The Bug Algorithm, The Tangent Bug Algorithm, The Incremental Voronoi Graph.	**Total Hrs** 9
4.	Static force analysis of RP type and RR type planar robots, Dynamic analysis using Lagrangean and Newton-Euler formulations of RR and RP type planar robots, , Independent joint control, PD and PID feedback, actuator models, nonlinearity of manipulator models, force feedback, hybrid control	**Total Hrs** 9
5.	Sensors and controllers: Internal and external sensors, position, velocity and acceleration sensors, proximity sensors, force sensors, laser range finder Robot vision: image processing fundamentals for robotic applications, image acquisition and preprocessing. Segmentation and region characterization object recognition by image matching and based on features	Total hours to be taught

Text book (s)

1. Nagrath and Mittal, —Robotics and Controll, Tata McGraw-Hill, 2003
2. Spong and Vidhyasagar, —Robot Dynamics and Controll, John Wiley and sons, 2008

References:

1. Fu. K.S, Gonzalez, R.C., Lee, C.S.G, Robotics, control, sensing, Vision and Intelligence, McGraw Hill International, 1987
2. Steve LaValle, —Planning Algorithmsll, Cambridge Univ. Press, New York, 2006
3. Howie Choset, Kevin Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki and Sebastian Thurn, —Principles of Robot Motion: Theory, Algorithms, and Implementationsll , Prentice Hall of India, 2005

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
16MEE 103	**PROGRAMMING METHODOLOGY AND DATA STRUCTURES**	3	0	0	3	70	30	100

Objective (s)	• To improve logical thinking of the students. • To encourage the student to use their own code to solve mechanical engineering Problems.
Outcome (s)	1. Different types of data storage and their structures 2. Implementing the concepts with programming in 'C' 3. Apply different sorting techniques in Mechanical engineering Applications 4. Classify the different Data Structures 5. differentiate between Linked lists,stacks and queues 6. Understand the concept of Trees and their traversals

1. **Programming Methodology:** Introduction, Algorithm, Data Flow Diagrams, Decision Tree, Decision Table and Life Cycles of Project Development.	**Total Hrs**	9
2. **Programming in 'C':** Data types & Memory size, Expressions, Statements, Operators, Control flows, Arrays, Pointers, Structures, Functions, Dynamic Memory Allocation and Simple programs in Mechanical Engineering.	**Total Hrs**	9
3. **Sorting and Searching Techniques:** Selection sort, Quick sort, Radix sort, Heap sort. Linear search, Binary search trees and Applications in Mechanical Engineering	**Total Hrs**	9
4. **Data Structures:** Classification of Data Structures, Definitions of Linked Lists, Double Linked Lists, Stacks and Queues. Operations and Implementations of Stack, Queues and Linked List. General and Mechanical Engineering Applications	**Total Hrs**	9
5. **Advanced Data Structures:** Tree, Basic Terminology, Binary Trees, Operations on Binary tree, Tree traversals, Graph, Graph representation Adjacency matrix, Adjacency Lists and Applications	**Total Hrs**	9
Total hours to be taught		

Text book (s)

1. G.Michael Schneider, Steven C.Bruell, —*Concepts in Data Structures and Software Development*", Jaico Publishing House,2002
2. Kernighan B.W, Ritchie D.M, —*The C Programming Language*", 2nd Edition, Prentice-Hall of India, 2003

References:

1. Kruse RL, Bruce RL, Cloris Lt, —*Data Structures and Program Design in C*", PHI, 1991
2. Hyer, M.W., *Stress Analysis of Fibre Reinforced Composite Materials*, Mc Graw Hill Co., 1998.
3. Trembly and Sorenson, —*An Introduction to Data Structures with application*", McGraw Hill, 1984

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
16MEE 104	**OPTIMIZATION TECHNIQUES**	3	1	0	4	70	30	100

Objective (s)	1. To Understand the need of the optimization methods. 2. To introduce the fundamental concepts of Optimization Techniques 3. To provide students with the modeling skills necessary to describe and formulate optimization problems 4. To make the learners aware of the importance of optimizations in real scenarios 5. To provide the concepts of various classical and modern methods of for constrained and unconstrained problems in both single and multivariable 6. Get a broad picture of the various applications of optimization methods used in engineering.
Outcome (s)	1. Formulate and solve Linear programming problem 2. Apply different techniques to solve Non Linear programming problem 3. Implement constrained optimization techniques 4. Analyze dynamic programming and integer programming problems 5. Develop schedule for projects and apply PERT/CPM techniques 6. Apply Queuing theory to real life situations

1. LINEAR AND TRASPORTATION PROBLEMS	**Total Hrs**	**9**
Statement of Optimization Problem, Linear Programming: Simplex Method, Revised Simplex Method, Sensitivity Analysis, Parametric Programming, and Transportation Problem		
2. NON-LINEAR PROBLEMS	**Total Hrs**	**9**
Nonlinear Programming: Approach, Convergence and Scaling of Design variables; Unconstrained Optimization Direct Search Methods: Random Search, Univariate, Simplex Method; Indirect Search Methods: Steepest Descent, Conjugate Gradient, Newton, Quasi Newton, DFP Methods;		
3. NON-LINEAR PROGRAMMING	**Total Hrs**	**9**
Constrained Optimization Direct Methods: Lagrange Multipliers, Kuhn-Tucker, conditions, Beal's method, Indirect Method: Penalty Function and Applications		
4. DYNAMIC PROGRAMMING	**Total Hrs**	**9**
Introduction to Dynamic Programming; Concept of Sub optimization and the principle of optimality; Linear and Continuous Dynamic Programming with Applications; Introduction to Integer Programming; Cutting Plane Method; Branch and Bound method; Introduction to Genetic Algorithms, particle swarm optimization		
5. PROJECT SCHEDULING	**Total Hrs**	**9**
Sequencing and Scheduling, Project Scheduling by PERT-CPM; Probability and cost consideration in Project scheduling; Queuing Theory, Single and multi server models; Queues with combined arrivals and departures; Queues with priorities for service		
Total hours to be taught	**Total Hrs**	**45**

Text book (s)

1. Rao,S.S. Engineering "Optimization Theory and Practice", New Age Int. Pub., 3rd Ed., 1996.
2. Haug,E.J.and Arora, J.S., "Applied Optimal Design", Wiley Inter Science Publication, NY, 1979.

Reference(s)

1. Douglas J. Willde, "Globally Optimal Design", Jhon Wiley & Sons, New York, 1978
2. Johnson Ray C., "Optimum Design of Mechanical Elements", John Wiley & Sons, 1981.
3. S.D. Sharma, S.D. "Operations Research", Khanna Publications, 2001.
4. David Goldberg, "Genetic Algorithms", pearson publications, 2006.
5. Maurice cleric, "Particle Swarm Optimization", ISTE Publications, 2006
6. Prem Kumar Gupta, "Operations Research", S Chand publications, 2008

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
16MEE105	**VIBRATION ANALYSIS AND CONDITION MONITORING**	3	0	0	3	70	30	100

Objective (s)	• To familiarization with the basics of vibration measurements • To apply the vibration principles for condition monitoring of machinery		
Outcome (s)	1. Understand the Causes of Vibration and its effect on structures 2. Understand Single degree and multi degree of freedom systems of steady state and transient characteristics of vibration, simple harmonic motion, periodic motion, peak to Peak,RMS and average values. 3. Vibration measuring instruments, display and recording to elements, frequency analysis and filters, Vibration limits and standards 4. Know and be able to explain the aim and the basics of CM; 5. Be aware of some methods and procedures applied for general CM; 6. Appreciate and understand the basic idea behind vibration-based structural health monitoring and vibration- based condition monitoring, know the general stages of CM;	**Total Hrs**	9
1.	Causes and effects of vibration. Vibrations of Single Degree, Two Degree and Multi Degree of freedom systems. Steady state and transient characteristics of vibration	**Total Hrs**	9
2.	Introduction to Condition Monitoring, Failure types, investigation and occurrences, Causes of failure, Characteristics of vibration – SHM, Periodic motion, Displacement, Velocity and acceleration Peak to peak & RMS, linear and logarithmic scales and phase angle	**Total Hrs**	9
3.	Vibration measuring instruments, vibration transducers, signal conditioning elements. Display and recording elements. Vibration meters and analyzers	**Total Hrs**	9
4.	Condition Monitoring through vibration analysis. Frequency analysis, Filters, Vibration signature of active systems, vibration limits and standards. Contaminant analysis, SOAP and other contaminant monitoring techniques	**Total Hrs**	9
5.	Special vibration measuring techniques - Change in sound method, Ultrasonic measurement method, Shock pulse measurement, Kurtosis, Acoustic emission monitoring, Cepstrum analysis, Modal analysis, critical speed analysis, Shaft –orbit & position analysis		
	Total hours to be taught	**Total Hrs**	45

Text book (s)

1. Collacott, R.A.,*Mechanical Fault Diagnosis and Condition Monitoring*, Chapman & Hall, London,1982
2. John S. Mitchell, *Introduction to Machinery Analysis and Monitoring*, Penn Well Books, Penn Well Publishing Company, Tulsa, Oklahoma, 1993.

Reference(s)

1. Nakra, B.C. Yadava, G.S. and Thuested, L.,*Vibration Measurement and Analysis, National Productivity Council, New Delhi, 1989*
2. Pox and Zenkins, *Time Series Analysis*
3. A.H. Search, *Vibration and Time Series Analysis*

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Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
16MEE 108	**TRIBOLOGY IN DESIGN**	3	0	0	3	70	30	100

Objective (s)	1. To impart knowledge in the friction , wear and lubrication aspects of machine components 2. To understand the material properties which influence the tribological characteristics of surfaces
Outcome (s)	After the completion of the course, student will be able to : 1. Have a knowledge of surface topography and can model a rough engineering surface 2. Understand friction and wear aspects of machine 3. decide upon lubricants and lubrication regimes for different operating conditions 4. Understand Hertz contact and rough surface contact 5. Ability to select material / surface properties based on the tribological requirements 6. Analysis ability of different types of bearings for given load/ speed conditions.

1. Topography of Surfaces – Surface features -Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction –Rolling Friction-Friction properties of metallic and non-metallic materials – friction in extreme conditions –Thermal considerations in sliding contact	**Total Hrs**	9
2. Types of wear – Mechanism of various types of wear – Laws of wear –Theoretical wear models-Wear of Metals and Non metals – Surface treatments – Surface modifications – surface coatings methods- Surface Topography measurements –Laser methods – instrumentation - International standards in friction and wear measurements.	**Total Hrs**	9
3. Lubricants and their physical properties- Viscosity and other properties of oils –Additives-and selection of Lubricants- Lubricants standards ISO,SAE,AGMA, BIS standards – Lubrication Regimes –Solid Lubrication-Dry and marginally lubricated contacts- Boundary Lubrication- Hydrodynamic lubrication — Elasto and plasto hydrodynamic - Magneto hydrodynamic lubrication – Hydro static lubrication – Gas lubrication	**Total Hrs**	9
4. Reynolds Equation,-Assumptions and limitations-One and two dimensional Reynolds Equation-Reynolds and Sommerfeld boundary conditions- Pressure wave, flow, load capacity and friction calculations in Hydrodynamic bearings-Long and short bearings-Pad bearings and Journal bearings- Squeeze film effects-Thermal considerations-Hydrostatic lubrication of Pad bearing-Pressure , flow , load and friction calculations-Stiffness considerations- Various types of flow restrictors in hydrostatic bearings	**Total Hrs**	9
5. Rolling contacts of Elastic solids- contact stresses – Hertzian stress equation- Spherical and cylindrical contacts-Contact Fatigue life- Oil film effects- Elasto Hydrodynamic lubrication Theory-Soft and hard EHL-Reynolds equation for elasto hydrodynamic lubrication- - Film shape within and outside contact zones-Film thickness and friction calculation- Rolling bearings- Stresses and deflections-Traction drives	**Total Hrs**	9
	Total hours to be taught **Total Hrs**	45

Text book (s)

Reference(s)

1. Rabinowicz.E, —Friction and Wear of materialsll, John Willey &Sons ,UK,1995
2. Cameron, A. —Basic Lubrication Theoryll, Ellis Herward Ltd., UK, 1981
3. Halling, J. (Editor) – —Principles of Tribology —, Macmillian – 1984
4. Williams J.A. — Engineering Tribologyll, Oxford Univ. Press, 1994
5. .K.Basu, S.N.Sengupta & B.B.Ahuja ,IFundamentals of Tribologyll, Prentice – Hall of India Pvt. Ltd., New Delhi, 2005
6. G.W.Stachowiak & A.W .Batchelor, Engineering Tribology, Butterworth-Heinemann,UK, 2005

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEE 109	**ADVANCED MECHANICS OF MATERIALS**	L	T	P	C	E	I	Total
		3	0	0	3	70	30	100

Objective (s)	1. To understand the various stresses and deflections in beams 2. To understand the stress-strain relations and failure theories
Outcome (s)	Students will be able to 1. understand the analysis and deformation, stress-strain relations, failure theories 2. analyze and design the columns 3. determine the stresses due to asymmetric bending 4. locate the shear centre of thin-walled sections. 5. Determine the stresses in curved beams 6. calculate the residual stresses in members under torsion/bending analyze the torsion of noncircular cross-sections.

1. Stress-Strain relations and general equations of elasticity in Cartesian, Polar and curvilinear coordinates, differential equations of equilibrium-compatibility-boundary conditions-representation of three-dimensional stress of a tension generalized hook's law - St. Venant's principle - plane stress - Airy's stress function. Energy methods	**Total Hrs**	**9**
2. Location of shear center for various thin sections - shear flows. Stresses and Deflections in beams subjected to unsymmetrical loading-kern of a section	**Total Hrs**	**9**
3. Circumference and radial stresses – deflections - curved beam with restrained ends - closed ring subjected to concentrated load and uniform load - chain links and crane hooks. Solution of rectangular	**Total Hrs**	**9**
4. Torsion of rectangular cross section - St.Venants theory - elastic membrane analogy - Prandtl's stress function - torsional stress in hollow thin walled tub	**Total Hrs**	**9**
5. Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness allowable speeds. Methods of computing contact stress deflection of bodies in point and line contact applications	**Total Hrs**	**9**
Total hours to be taught	**Total Hrs**	**45**

Text book (s)

Reference(s)

1. Arthur P Boresi, Richard J. Schmidt, —Advanced mechanics of materialsǁ,John Wiley, 2002
2. Timoshenko and Goodier, "Theory of Elasticity", McGraw Hill
3. Robert D. Cook, Warren C. Young, "Advanced Mechanics of Materials", Mc-millan pub. Co., 1985
4. Srinath. L.S., —Advanced Mechanics of solidsǁ, Tata McGraw Hill, 1992
5. G H Ryder Strength of Materials Macmillan, India Ltd, 2007
6. Allan F. Bower, —Applied Mechanics of Solidsǁ, CRC press – Special Indian Edition -2012, 2010
7. K. Baskar and T.K. Varadan, —Theory of Isotropic/Orthotropic Elasticityǁ, Ane Books Pvt. Ltd., New Delhi, 2009

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
16MEC 106	**CAD/CAM LABORATORY**	0	0	3	2		50	50

Objective(s):

1. To produce CAD drawings which communicate the appropriate manufacturing details, standards, and specifications..
2. To effectively communicate with others using oral, written, and graphical methods and procedures..
3. To function effectively on teams or on group projects and assume leadership roles when appropriate..
4. To introduce STUDENTS to the basic tools of computer-aided design (CAD) and computer-aided manufacturing (CAM)
5. To understand the basic analytical fundamentals that are used to create and manipulate geometric models in a computer program
6. To prepare the student to be an effective user of a CAD/CAM system.

Outcome(s): After the completion of the course, students will be able to

1. use parametric CAD software for geometric modeling of mechanical designs
2. visualize of machine components and assemblies before their actual fabrication through modeling, animation, shading, rendering, lighting and coloring
3. apply of CAD computational analysis tools to engineering design.
4. create a complete CAD documentation for an engineering design.
5. model complex shapes including freeform curves and surfacesExplain the basic concepts of CNC programming and machining
6. implement CNC programs for milling and turning machining operations

List of Exercises:

CAD

1. Understanding of various CAD commands and creating simple objects.
2. Understanding of holes, cuts and model tree relations.
3. Creation shafts, rounds, chamfers and slots.
4. Sketch Tools & Datum planes.
5. Creation of objects by revolved features, patterns and copies, sweeps and blends.
6. Creation of engineering drawing details such as dimensioning, sectional views, adding esthetics.
7. Assembling of part models using constraints with bill of materials.
8. Assembly operations - part modifications, adding another assembly features – display.
9. Mass properties and tolerance analysis.

CAM

1. Understanding of CNC Machines and CNC Programming and Creation of 2-D contour Pockets, Slots
2. Drills and Facing, 2-D high Speed blend
3. Surface Roughing for Bottle die
4. Surface finishing for Phone die
5. Manufacturing of Crane Hook
6. Manufacturing of Connecting Rod
7. Manufacturing of Turbine Blade
8. 3-D Machining using ball nose cutters

PROFESSOR & HEAD
Department of Mechanical Engineering
Chaitanya Bharathi Institute of Technology (A)
Gandipet, Hyderabad-500 075, Telangana

With effect from the academic year 2016- 2017

Scheme of Instruction & Examination
M.E. (CAD/CAM) – Mechanical Engineering - 4 Semesters (Full Time)

Semester - I

Sl. No	Subject	No. of Hrs. per week		Duration (Hrs)	Marks for		Total Marks	Credits
		Lecture	T/P/S		Internal Assessment	End Exam		
1.	Core	3	1	4	30	70	100	4
2.	Core	3	1	4	30	70	100	4
3.	Core	3	1	4	30	70	100	4
4.	Elective	3	--	3	30	70	100	3
5.	Elective	3	--	3	30	70	100	3
6.	Elective	3	--	3	30	70	100	3
7.	Laboratory	--	3	3	50	--	50	2
8.	Seminar - I	--	3	3	50	--	50	2
9.	Soft Skills	--	--	--	--	--	--	--
	Total	18	09		340	360	700	25

Semester - II

Sl. No	Subject	No. of Hrs. per week		Duration (Hrs)	Marks for		Total Marks	Credits
		Lecture	T/P/S		Internal Assessment	End Exam		
1.	Core	3	1		30	70	100	4
2.	Core	3	1		30	70	100	4
3.	Core	3	1		30	70	100	4
4.	Elective	3	--		30	70	100	3
5.	Elective	3	--		30	70	100	3
6.	Elective	3	--		30	70	100	3
7.	Laboratory - II	--	3		50	--	50	2
8.	Seminar - II	--	3		50	--	50	2
9.	Mini Project	--	2		50	--	50	1
	Total	18	11		390	360	750	26

Semester - III

Sl. No	Subject	Marks for		Total Marks	Credits
		Internal Assessment	End Exam		
1	Project Seminar* (i)Problem formulation and submission of synopsis within 8 weeks from the commencement of 3rd Semester. (50 Marks) (ii) Preliminary work on Project implementation. (50 Marks)	100	--	100	6
	Total	100		100	6

Semester - IV

Sl. No	Subject	Marks for		Total Marks	Credits
		Internal Assessment	End Exam		
1	Project Work	100	100	200	12

Note: Six core subjects, Six elective subjects, Two Laboratory Courses and Two Seminars, Mini Project and Soft Skills should normally be completed by the end of semester II.

* Project seminar presentation on the topic of Dissertation only, 50 marks awarded by the project guide and 50 marks by the internal committee

Credit requirements for the award of degree, lower limit and upper limit of credits for registration by a student in a semester Credit Requirement for the award of M.E/M. Tech. Degree is 69

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
16MEC 104	**COMPUTER AIDED MECHANICAL DESIGN AND ANALYSIS**	3	1	0	4	70	30	100

Objective (s)	1. To develop the necessary skills to understand and analyze problems in pressure vessels 2. To achieve fundamental understanding of the theory of bending of flat plates with various loading and boundary conditions 3. To Understand design principles of a component and structures using fracture mechanics approaches 4. To enable the importance of vibrations in mechanical design and to understand the basic concepts of matrix algebra 5. To understand the different mode extraction methods in vibrations 6. To understand the fundamental concepts various algorithms used for dynamic analysis
Outcome (s)	1. Ability to apply knowledge of mathematics, sciences and computations in solving the stresses & strains in pressure vessels 2. Demonstrate the ability to identify, formulate and solve problems for a given flat plate bending applications 3. An ability to design a system or a component to meet the desired needs of fracture mechanics 4. Students are able to understand and solve various Eigen value and Eigen vectors 5. Students will understand different mode extraction methods to calculate frequencies 6. Student will understand numerical methods in solving multi degree freedom dynamic analysis problems

1. Design of pressure Vessels: Introduction and constructional features of pressure vessels, stresses in pressure vessels, shrink fit stresses in built up cylinders, auto frettage of thick cylinders, thermal stresses and their significance.	**Total Hrs**	**9**
2. Stresses in flat plates: Introduction, Bending of plate in one direction, Bending of plate in two perpendicular directions, Thermal stresses in plates, Bending of circular plates of constant thickness, Bending of uniformly loaded plates of constant thickness	**Total Hrs**	**9**
3. Fracture Mechanics: Introduction, Modes of fracture failure Griffith Analysis, Energy release rate, Energy release rate of DCB specimen; Stress Intensity Factor: SIF's for edge and centre line crack, Fracture toughness, Elastic plastic analysis through J-integral method: Relevance and scope, Definition of J-integral, Path independence, stress strain relation, Strain Energy Release Rate Vs J-integral	**Total Hrs**	**9**
4. Eigen Value Problems: Properties of Eigen values and Eigen Vectors, Torsional, Longitudinal vibration, lateral vibration, Sturm sequence. Subspace iteration and Lanczo's method, Component mode synthesis, Eigen value problems applied to stepped beams and bars	**Total Hrs**	**9**
5. Dynamic Analysis: Direct integration method, Central difference method, Wilson-θ method, Newmark method, Mode superposition, Single degree of freedom system response, Multi degree of freedom system response, Rayleigh damping, Condition for stability. (Note: The related algorithms and codes to be practiced by students)		
	Total hours to be taught	**45**

Text book (s)

1. John, V. Harvey, Pressure Vessel Design: Nuclear and Chemical Applications, Affiliated East West Press Pvt. Ltd., 1969
2. Prasanth Kumar, Elements of Fracture Mechanics, Wheeler Publishing, New Delhi-1999

Reference (s)

1. Rammurti, Computer Aided Mechanical Design and Analysis, Tata Mc Graw Hill-1992
2. Bathe, J., Finite Element Procedures, Prentice Hall of India-1996.

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BIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM & Thermal Engineering		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
16MEC 105	**FINITE ELEMENT TECHNIQUES**	3	1	0	4	70	30	100

Objective (s)	1. Identify mathematical model for solution of common engineering problems 2. Enable the students to formulate the design problems into FEA 3. Enable the students to perform engineering simulations using Finite Element Analysis software
Outcome (s)	Students are able to 1. implement finite element formulations to axial and quadratic elements and solve problems with hand calculations numerically 2. formulate numerically the truss, beam and frame elements and solve for deflection, strains and stresses 3. formulate numerically the plane and axisymmetric triangular elements and quadrilateral elements then solve for deflections, strains and stresses in structural mechanics problems 4. apply FE formulations to heat transfer of 1D and 2D elements and solve for temperature and heat flux in slabs, walls and plates 5. apply FE formulations to dynamic analysis of 1D and 2D elements and solve for eigen values and eigen vectors in bars and beams 6. apply FE formulations to 3D solids, plates and for non linear problems

1. FIELD PROBLMES AND MODELING	**Total Hrs**	**9**
Introduction to Finite Element Method of solving field problems. Stress and Equilibrium. Boundary conditions. Strain-Displacement relations. Stress-strain relations. One Dimensional Problem: Finite element modeling. Local, natural and global coordinates and shape functions. Potential Energy approach: Assembly of Global stiffness matrix and load vector. Finite element equations, treatment of boundary conditions. Quadratic shape functions		
2. ANALYSIS OF TRUSSES AND FRAMES	**Total Hrs**	**9**
Analysis of plane truss with number of unknowns not exceeding two at each node. Analysis of Beams: Element stiffness matrix for two noded, two degrees of freedom per node for beam element. Analysis of frames with two translations and a rotational degree of freedom at each node		
3. TWO DIMENSIONAL STRESS ANALYSIS	**Total Hrs**	**9**
Finite element modeling of two dimensional stress analysis problems with constant strain triangles treatment of boundary conditions. Two dimensional four noded isoparametric elements treatment of boundary conditions. Two dimensional four noded isoparametric elements and numerical integration. Finite element modeling of Axisymmentric solids subjected of axisymmetric loading with triangular elements. Convergence requirements and geometric isotropy		
4. HEAT TRANSFER PROBLEMS AND DYNAMIC ANALYSIS	**Total Hrs**	**9**
Steady state heat transfer analysis: One dimensional analysis of a fin and two dimensional, conduction analysis of thin plate, Time dependent field problems: Application to one dimensional heat flow in a rod. Dynamic analysis: Formulation of finite element modeling of Eigen value problem for a stepped bar and beam. Evaluation of Eigen values and Eigen vectors, Analysis of a uniform shaft subjected to torsion using Finite Element Analysis.		
5. THREE DIMENSIONAL PROBLEMS IN SRESS ANALYSIS	**Total Hrs**	**9**
Finite element formulation of three dimensional problems in stress analysis, Bending of elastic plates: Thin and Thick plate formulations, Introduction to non-linear problems and Finite Element analysis software's		
	Total hours to be taught	

Text book (s)

1. Tirupathi R Chandrupatla and Ashok.D. Belegundu, Introduction of Finite Element in Engineering. Prentice Hall of India, 2004
2. Rao S.S.,The Finite Element Methods in Engineering, 2nd Edn Pergamon Press, 2001.
3. David.V.Hutton, " Fundamentals of Finite Element Analysis", Tata McGraw Hill,2003

References:

1. Robert Cook , "Concepts and applications of finite element analysis", 4e, John Wiley and sons,2009
2. Reddy J.N., An Introduction to Finite Element Methods ,Mc Graw Hill Company, 1984
3. K..J Bathe, Finite element procedures, 2nd Edn,Prentice Hall of India,2007
4. Logan, D. L. (2011). First course in finite element method, (5th Ed.). Mason, OH: SouthWestern, Cengage Learning.

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CBIT	Autonomous Regulation		
Department	Mechanical Engineering	Programme Code & Name	M.E. Thermal Engineering

Semester-I

Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
16MEC 205	**COMPUTATIONAL FLUID DYNAMICS**	3	1	0	4	70	30	100

Objective (s)	1. To understand the basic equations and concept of CFD. 2. To make the students to learn concept of PDEs and finite difference methods. 3. To study various types of grid generation and errors in numerical solution. 4. To learn the Crank-Nihcolson, Implicit and Explicit methods 5. To prepare the students with Jacobi, Gauss Seidel and ADI methods 6. To enkindle the students importance of FVM
Outcome (s)	Students will be able to 1. derive CFD governing equations and turbulence models. 2. apply elliptical, parabolic and hyperbolic PDEs and forward, backward and center difference methods . 3. understand errors, stability, consistency and develop O,H and C grid generated models. 4. evaluate the use of Crank-Nihcolson, Implicit and Explicit methods. 5. analyze problem by Jacobi, Gauss Seidel and ADI methods. 6. solve conduction and convection problems using FVM

1	**BASIC EQUATIONS IN FLUID DYNAMICS**	**Total Hrs**	9

Continuity, Momentum and Energy equations, Navier Stokes equations, Reynolds and Favre averaged N – S equations. Introduction to turbulence, Turbulence models-mixing length model, K-ε turbulence Model.

2	**CLASSIFICATION OF PDEs**	**Total Hrs**	9

Elliptic, parabolic and hyperbolic equations, Initial and boundary conditions.
Concepts of Finite difference methods – forward, backward and central difference.

3	**GRID GENERATION**	**Total Hrs**	9

Grid Generation- Types of grid O,H,C. Coordinate transformation, Unstructured grid generation, Errors, Consistency, Stability analysis by von Neumann. Convergence criteria.

4	**FINITE DIFFERENCE SOLUTIONS**	**Total Hrs**	9

Finite difference solutions-Parabolic PDEs – Euler, Crank Nicholson, Implicit methods, Elliptic PDEs – Jacobi, Gauss Seidel, ADI, methods. FD- solution for Viscous incompressible flow using Stream function – Vorticity method & MAC method

5	**FINITE VOLUME METHOD**	**Total Hrs**	9

Introduction to Finite volume method. Finite volume formulations for diffusion equation, convection diffusion equation. Solution algorithm for pressure velocity coupling in steady flows. Use of Staggered grids SIMPLE Algorithm.

Total hours to be taught	45

Text book (s)

1	John D Anderson, 'Computational Fluid Dynamics', Mc Graw Hill, Inc., 2015.
2	H.K.Versteeg - 2015, Malala Shekara, Introduction to " Finite Volume Method" Pearson
3	Muralidhar K, Sundararajan T, 'Computational Fluid flow and Heat transfer', Narosa Publishing House, 2003
4	Patankar, S.V, 'Numerical Heat transfer and Fluid flow', Hemisphere Publishing Company, New York,1980

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
16MEE 110	**MECHANICS OF COMPOSITE MATERIALS**	3	0	0	3	70	30	100

Objective (s)	1. An ability to identify the properties of fiber and matrix materials used in commercial composites, as well as some common manufacturing techniques. 2. An ability to predict the elastic properties of fiber composites based on the constituent properties. 3. An ability to analyze a laminated plate in bending, including finding laminate properties from lamina properties. 4. An ability to predict the failure strength of a laminated composite plate
Outcome (s)	1. Classify the composites, types of reinforcements, matrices and phases. 2. Recognize the fundamentals of orthotropic materials and mechanics of materials in micro and macro level. 3. Understand different fabrication methods of composites. 4. Demonstrate the fundamentals of directional stresses and strains. Transformation of stress and strain. 5. Understand the failure of composites including fracture. 6. Analyze different types of composite structures using plate and shell theory

1. Introduction: Fibres, Matrix materials, interfaces, polymer matrix composites, metal matrix composites, ceramic matrix composites and carbon carbon composites.	**Total Hrs**	**9**
2. Micromechanics of lamina and mechanical properties: Prediction of Elastic constants, micromechanical approach, Halpin-Tsai equations. Thermal properties, Hygro properties, mechanics of load transfer from matrix to fibre	**Total Hrs**	**9**
3. Macro-mechanics of lamina: Elastic constants of a lamina, relations between engineering constants and reduced stiffness and compliances. Variation of lamina properties with orientation, analysis of laminated composites, stresses and strains with orientation, inter-laminar stresses and edge effects. Simplified composite beam solutions. Bending of laminated beams	**Total Hrs**	**9**
4. Strength, fracture, fatigue and design: Tensile and compressive strength of unidirectional fibre composites, fracture modes in composites: single and multiple fractures, de-bonding, fibre pullout and de-lamination failure, fatigue of laminate composites. Effect of variability of fibre strength. Strength of an orthotropic lamina: Max stress theory, max strain criteria, maximum work (Tsai-Hill) criterion, quadratic interaction criteria. Designing with composite materials	**Total Hrs**	**9**
5. Analysis of laminated plates and shells: Plate equilibrium equations, Bending of composite plates, Levy and Navier solution for plates of composite materials. Analysis of composite cylindrical shells under axially symmetric loads.	**Total Hrs**	**45**
Total hours to be taught		

Text book (s)

1. Jones, R.M., *Mechanics of Composite Materials, Mc Graw Hill Co., 1967*
2. B.D.Agarwal et.al, *Analysis and performance of fiber composites*,3rd edition, Wiley sons., 2013
3. Ever J Barbero, *Introduction to composite materials design*, Taylor &Francis, 1999.

Reference(s)

1. Whitney, I.M. Daniel, R.B. Pipes, *Experimental Mechanics of Fibre Reinforced Composite Materials*, Prentice Hall, 1984
2. Hyer, M.W., *Stress Analysis of Fibre Reinforced Composite Materials*, Mc Graw Hill Co., 1998
3. Carl. T. Herakovich, *Mechanics of Fibrous Composites*, John Wiley Sons Inc., 1998.

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEE 121	**PRODUCT DESIGN AND PROCESS PLANNING**	L	T	P	C	E	I	Total
		3	0	0	3	70	30	100

Objective (s)	1. To impart the concepts about design and manufacturing engineering 2. To understand the ergonomic considerations to manufacture a product
Outcome (s)	1. Imparting basic foundation and advanced concepts about Design and Manufacturing Engineering. 2. Root cause analysis of a design engineering problem through basic and engineering sciences. 3. Understanding and learning of Manufacturing issues. 4. Imparting research activities through curriculum. 5. Solving complex design engineering problems. and apply latest engineering tools with advanced software knowledge . 6 .Mechanical engineering solutions to green and sustainable development

1.	Product design and process design functions, selection of a right product, essential factors of product design, Morphology of design, sources of new ideas for products, evaluation of new product ideas Product innovation procedure-Flow chart. Qualifications of product design Engineer. Criteria for success/failure of a product. Value of appearance, colours and Laws of appearance	**Total Hrs** 9
2.	Product reliability, Mortality Curve, Reliability systems, Manufacturing reliability and quality control. Patents: Definitions, classes of patents, applying for patents. Trademarks and copyrights. Cost and quality sensitivity of products, Elements of cost of a product, costing methods, cost reduction and cost control activities. Economic analysis, Break even analysis Charts. Value engineering in product design, creativity aspects and techniques. Procedures of value analysis – cost reduction, material and process selection.	**Total Hrs** 9
3.	Various manufacturing processes, degree of accuracy and finish obtainable, process capability studies. Methods of improving tolerances. Basic product design rules for Casting, Forging, Machining, Sheet metal and Welding. Physical properties of engineering materials and their importance on products. Selection of plastics, rubber and ceramics for product design	**Total Hrs** 9
4.	Industrial ergonomics: Man-machine considerations, ease of maintenance. Ergonomic considerations in product design-Anthropometry, Design of controls, man-machine information exchange. Process sheet detail and their importance, Advanced techniques for higher productivity. Just-in-time and Kanban System. Modern approaches to product design; quality function development, Rapid prototyping	**Total Hrs** 9
5.	Role of computer in product design and management of manufacturing, creation of manufacturing data base, Computer Integrated Manufacturing, communication network, production flow analysis, Group Technology, Computer Aided product design and process. Planning. Integrating product design, manufacture and production control	**Total Hrs** 9
	Total hours to be taught	**Total Hrs** 45

Text book (s)

1 Niebel, B.W., and Draper, A.B., Product design and process Engineering, Mc Graw Hill – Kogalkusha Ltd., Tokyo, 1974.

2 Chitale, A.K, and Gupta, R.C., Product Design and Manufacturing, Prentice Hall of India Pvt. Ltd., New Delhi, 2004

Reference(s)

1. Mahajan, M. Industrial Engineering and Production Management, Dhanpath Rai & Co., 2000

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
16MEE 112	**EXPERIMENTAL TECHNIQUES AND DATA ANALYSIS**	3	0	0	3	70	30	100

Objective (s)	1. To get acquainted with improving quality of product/process by studying various parameters 2. To gain the knowledge regarding improvement of productivity
Outcome (s)	1. Show the general principle of measurement 2. Classify and apply different transducers for converting cutting forces into suitable signals 3. State the design requirements of tool-force dynamometers 4. Understand various surface measurement aspects 5. Able to apply Taguchi methods for different optimization problems

1. Measurement of Cutting Forces: Strain gauge and piezoelectric transducers and their characteristics. Dynamometer construction, Bridge circuits. Instrumentation and calibration. Displacement and strain measurements by photoelasticity. Holography, Interferometer, Moir techniques, strain gauge rosettes	**Total Hrs**	**9**
2. Temperature Measurement: Circuits and instrumentation for different transducers viz, bimetallic, expanding fluid, electrical resistance, thermister, thermocouples, pyrometers Flow Measurement : Transducers for flow measurements of Non-compressible and compressible fluids. Obstruction and drag methods. Vortex shredding flow meters. Ultrasonic, Laser Dopler and Hotwire anemometer. Flow visualization techniques, Shadow graphs, Schlieren photography. Interferometer	**Total Hrs**	**9**
3. Metallurgical Studies: Optical and electron microscopy, X-Ray diffraction, Bragg's Law and its application for studying crystal structure and residual stresses, Electron spectroscopy, electron microprobe, Surface Measurements: Micro hardness, roughness, accuracy of dimensions and forms. 3-D co-ordinate, measuring machines	**Total Hrs**	**9**
4. Experiment design & data analysis: Statistical methods, Randomised block design, Latin and orthogonal squares, factorial design. Replication and randomization. Data Analysis: Deterministic and random data, uncertainty analysis, tests for significance: Chi-square, student's t' test. Regression modeling, direct and interaction effects. ANOVA, F-test. Time Series analysis, Autocorrelation and autoregressive modeling	**Total Hrs**	**9**
5. Taguchi Methods: Experiment design and planning with Orthogonal arrays and linear graphs. Additive cause effect model. Optimization of response level. Identification of Design and noise factors Performance evaluation and Optimization by signal to noise ratios. Concept of loss function and its application.	**Total Hrs**	**45**
	Total hours to be taught	

Text book (s)

1. Holman, J.P.: *Experimental Methods for Engineers*, McGraw Hill Int., New York
2. Venkatesh, V.C., and Chandrasekharan, *Experimental Methods in Metal Cutting*, Prentice Hall of India, Delhi

Reference(s)

1. Davis, O.V.; *The Design and Analysis of Industrial Experiments*, Longman, London
2. Box and Jenkins; *Time Series analysis, Forecasting and control*, Holden Day, Sanfrancisco
3. Dove and Adams, *Experimental stress analysis and motion measurement*, Prentice Hall of India, Delhi
4. Tapan P. Bagchi, *Taguchi Methods Explained*, Prentice Hall of India, Delhi

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
16MEE 113	**DESIGN FOR MANUFACTURE**	3	0	0	3	70	30	100

Objective (s)	1. To provide understanding of manufacturing processes and design concepts 2. To make the students understand the linkage required between design and manufacturing
Outcome (s)	Student will able to 1. understand constraints of manufacturing processes that limit design possibilities with respect to cycle time, material handling, and other factory costs 2. design suitable manufacturing process capable of designing metallic components 3. design suitable manufacturing process capable of designing non-metallic components 4. design welded assembly, gear box assembly etc. 5. design suitable manufacturing process capable of designing the bolted, screwed, flanged connections etc. 6. prepare a project or report applying DFM principles per an example from industry

1. Introduction: General design principles for manufacturability, strength and mechanical factors, mechanisms selection, evaluation method, geometrical tolerances, tolerance control and utilization. Economic Use of Raw Materials: Ferrous steel, hot rolled steel, cold finished steel, stainless steel, non ferrous materials aluminium, copper, brass, non metallic materials, plastics, rubber and composites	**Total Hrs**	**9**
2. Metallic Components Design: Metal extrusion, metal stamping, fine blanking, four slide parts, spring and wire forms, spun metal parts, cold headed parts, extruded parts, tube and section bends, rolled formed parts, power metal parts, forging electro forming parts, specialized forming methods, turned parts, machined round holes, drilled parts, milled parts.	**Total Hrs**	**9**
3. Non Metallic Components Design: Thermosetting plastic, injection moulded and rotational moulded parts, blow moulded, welded plastic articles, ceramics	**Total Hrs**	**9**
4. Assembled Parts Design: Welded parts, arc, resistance, brazed and soldered parts, gear box assembly, bearing assembly	**Total Hrs**	**9**
5. Assembled Parts Design: Retension, bolted connection, screwed connections, flanged connections, centred connections, press fitted connections, surface finishing, plated parts, heat treated parts, NC machining, group technology, low cost automation, computer aided manufacture, product design requirements. **Case Studies:** Identification of economical design and redesign for manufacture	**Total Hrs**	**45**
Total hours to be taught		

Text book (s)

1. James G. Bralla, —*Hand book of product design for manufacturing*‖ McGraw Hill Co., 1986
2. K.G. Swift —*Knowledge based design for Manufacture*‖, Kogan page Limited, 1987.

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEE 114	**DATA BASE MANAGEMENT SYSTEMS**	L	T	P	C	E	I	Total
		3	0	0	3	70	30	100

Objective (s)	1. To understand the different issues implementation of a database system. 2. To study the logical database designs, database modeling, relational network models 3. To understand data manipulation language to query and manage a database
Outcome (s)	After the completion of the course, the student will be able to : 1. Understand the basic concepts and applications of database systems. 2. Familiarized with commercial relational database system. 3. Demonstrate an understanding of the relational data model 4. Familiarized with indexing methods including B-tree, and hashing. 5. work successfully in a team by design and development of a database application 6. Understand the basics of query evaluation techniques and and query optimization

1. Introduction and E.R. Model: Purpose of database systems, Data abstraction, Data models, Data independent DDL, DML, DBA. Entities and entity sets. Relationships and relationship sets Mapping constraints, Primary Keys E-R diagrams, reducing E-R Diagram to tables.	**Total Hrs**	**9**
2. Relational model and relational database design: Structure of relational database, former query languages, commercial query languages. Modifying the database views. Pitfalls in relational database design and normalization.	**Total Hrs**	**9**
3. Network data model and hierarchical data model: data structure diagram, the DBTCCODASYL. Model data retrieval Update and set processing facility, Three structure diagram, data retrieval and update facility, virtual records	**Total Hrs**	**9**
4. File and System Structure, Indexing and Hashing: Physical storage media – file organization, buffer management, Mapping relations, networks and hierarchies to files – Index – sequential files. Bi-tree indexed files	**Total Hrs**	**9**
5. Distributed database, security and integrity: Design, transparency and autonomy, query processing, recovery, concurrency control, deadlock handling and coordinator selection. Security and integrity, near database application	**Total Hrs**	**9**
Total hours to be taught	**Total Hrs**	**45**

Text book (s)

1. Korth, H.F. Silbenhatz, A., *Database Concepts,* Mc Graw Hill, 1986
2. Gio Wiederhold, *Database Design,* Mc Graw Hill, 1983

Reference(s)

1. Jefferey O Ullman, *Principles of database systems*
2. C.J. Date, *An Introduction to database systems,* Addison Wisely, 1980.
3. Trembley and Soreson, *An Introduction to Data structures with applications,* Mc Graw Hills.

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEE 115	**FRACTURE MECHANICS**	L	T	P	C	E	I	Total
		3	0	0	3	70	30	100

Objective (s)	1. To introduce students to the concepts of materials fracture and failure analysis 2. To equip them with knowledge on how to design against catastrophic failures
Outcome (s)	At the completion of the course ,the student can: 1. Identify and explain the types of fractures of engineered materials and their characteristic features; 2. Understand the differences in the classification of fracture mechanics (LEFM and EPFM)• and how their corresponding parameters can be utilized to determine conditions under which engineering materials will be liable to fail catastrophically in service; 3. Understand and explain the mechanisms of fracture; 4. Appreciate the theoretical basis of the experimental techniques utilized for fracture 5. Develop expertise on the experimental techniques utilized for fracture and failure analysis 6. Learn simple LEFM testing methods for evaluating the fracture toughness of materials

1. Introduction: Crack in a Structure – Griffth Criterion – Cleavage fracture – Ductile fracture – Fatigue Cracking. Service failure analysis.	**Total Hrs**	**9**
2. Elastic Crack: Elastic Crack tip stress field – Solution to crack problems. Effect of finite size stress intensity factor – Special cases – Irwin plastic zone correction. Actual shape of plastic zone – Plane stress – Plane strain.	**Total Hrs**	**9**
3. Energy Principle: Energy release rate – Criterion for crack growth – Crack resistance curve – Principles of crack arrest – Crack arrest in practice Fatigue Crack Growth: Fatigue crack growth test, stress intensity factor, factors affecting stress intensity factor – Variable amplitude service loading, retardation model	**Total Hrs**	**9**
4. Elastic Plastic Fracture Mechanics: Elastic plastic fracture concept – Crack tip opening displacement – J-integral technique; Determination of J-using FEM	**Total Hrs**	**9**
5. Application of Fracture Mechanics: Fracture design – Selection of materials – fatigue crack growth rate curve – Stress intensity factor range – Use of crack growth law	**Total Hrs**	**9**
Total hours to be taught	**Total Hrs**	**45**

Text book (s)

1. David Broek – Elementary Engineering Fracture Mechanics: Sifth off an Noordhoff Internal Publishers – 1978.
2. Calcote, L.R., *The Analysis of Laminated Composite Structures*, Van Nostrand, 1969

Reference(s)

1. Jean Cemative and Jean Louis Chboche Mechanics of Solid Materials, Cambridge University Press Cambridge, 1987

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEE 116	**DESIGN OF PRESS TOOLS**	L	T	P	C	E	I	Total
		3	0	0	3	70	30	100

Objective (s)	1. To make the students understand the basic concepts involved in designing press tools 2. To make students capable of designing various press tools which are safe, easy to operate, reliable and economical for manufacturing.
Outcome (s)	Student will be able to 1. classify types of presses, characteristics and their principles. 2. understand the terminology in the design of Dies. 3. understand Elements of shearing dies 4. understand the basic concepts and principle involved in designing press tools. 5. ne in a position to independently design various press tools which will cater to requirement of industry 6. understand the different types of dies

1.	**Total Hrs**	**9**
Classification of Mechanical, Hydraulic, and pneumatic presses, Press Characteristics, safety devices in presses. Principles of stretch forming machines, principles of feeding and unloading equipment. Design principles of presses.		
2.	**Total Hrs**	**9**
Design of Dies: Introduction terminology shearing dies- types of dies – analysis process shearing clearance – size and tolerances of die opening and punch – force, power, energy in shearing – loading center, shearing with inclined edges – strip layouts, economical stock – Utilization.		
3.	**Total Hrs**	**9**
Elements of shearing dies – die plates – split dies, rules of development for split dies, inserts, types of punches, punch holders, punches – strippers – calculation of springs and rubber ejector, shedders, stops – pilots – stock guides – alignment system design for press tools		
4.	**Total Hrs**	**9**
Compound dies, progressive dies, stock feeding devices – cam actuated die, horn dies (type, sub-press dies) – precision shearing dies, shaving dies, lamination dies – Bending dies, theory of bending development of blank, spring back, curling, flanging and press brake dies, bending on press brake		
5.	**Total Hrs**	**9**
Drawing and forming Dies: Theory of drawing, blank development, strain factor, calculation of force, construction of drawing and drawing dies – Drawing of rectangular components (development, stages draw beeds) – Ironing (application of rubber and hydraulic system) – Defects in deep drawing – Modern Metal forming techniques – Discussion of various computer software for sheet metal design		
	Total hours to be taught **Total Hrs**	**45**

Texl book (s)

1. *Fundamentals of tool Design* – ASTME, Prentice Hall, New Delhi, 1987
2. *Die design Hand book* – AISME, Mc Graw Hills, New York, 1965

Reference(s)

1. Heinrich Makelt, *Mechanical Presses*, Edward Arnold, London, 1968
2. Serope Kalpakjain, *Mechanical Processing in Materials*, 1967
3. Javoronkov V.A and Chaturvedi. *R.C. Rolling of Metals*
4. Eary and Redds, *Shear Working of Metals*, Prentice Hall, New Delhi, 1969.
5. Honeyeeme R.W.K., *The plastic Deformation of metals*, Edward Arnold, London, 1968
6. Kamenschikov, *Forging Practice*, Mir. Pub., Moscow, 1968
7. *High Velocity Forming of metals*, ASME, Michigan, 1968
8. Bhattacharya.A, *New Technology*, Institute of Engineers, Calcutta, 1973

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEE 117	**DESIGN OF DIES**	L	T	P	C	E	I	Total
		3	0	0	3	70	30	100

Objective (s)	1. To make students understand the various steps and procedure involved in designing and manufacturing dies 2. To make students capable of solving complex geometric problems related to tool and die making
Outcome (s)	Upon completion of the subject, students will be able to: 1. Apply contemporary design principles when designing advanced moulds and dies; 2. Assess the performance of a given tool design based on the design criteria; 3. Evaluate the effects of a given tool design on the quality of the work. 4. Describe the principles of clamping, drill jigs and computer aided jig design 5. Design fixtures for milling, boring, lathe, grinding, welding; identify fixtures and cutting tools for NC machine tools 6. Explain the principles of dies and moulds design

1.	**Total Hrs**	**9**
Design principles for dies of thermo-plastic and thermo-setting components. Impression core cavities, strength of cavities, guide pillars and bushes, ejection systems, cooling methods, bolster types. Split moulds, methods of actuating the splits, moulds of threaded components, internal & external under cuts, moulds with under – feed systems. Design principles and standards for Transfer and compression moulding dies. Design of Tools: Mould for a spindle component with sleeve, pin ejection. Mould with splits Multi-cavity mould with stripper plate, inserts, ejectors.		
2.	**Total Hrs**	**9**
Design of Dies for metal mould Castings, Die casting, Shell moulding. Design of casting cavity, sprue, slug, fixed and movable cores, finger cam, core, pin, draft, ejector pins, ejector plate, gate, goose-neck, nozzle, over-flow, platen plunger, runner, slot, slide, vent, water line. Design of hot chamber, cold chamber machines, vertical, horizontal,, die locking machines, toggle and hydraulic systems, injection systems, rack and pinion, knockout pins and plates, hydraulic ejection, Other parts of die casting machines		
3.	**Total Hrs**	**9**
Design of various types of dies – Single cavity, multi cavity, combination, unit dies. Alignment of dies with sprue. Design approach for die elements. Selection of materials and heat treatment for die casting dies and elements – die casting alloys – types of die casting alloys, Case studies on executed dies and design details. Finishing, Trimming, and inspection. Gravity die casting – Die design with cores and inserts – Bulk forming tools		
4.	**Total Hrs**	**9**
Open die forging, Advantages of open die forging over closed die forging. Calculation of allowances and tolerances, Methods of open die forging. Design of dies. Closed die forging. Preparation of material for forging. Calculation of raw-stock, cutting off, heating in furnaces. Allowances and tolerances for closed die forging as per IS: 3469 1974		
5.	**Total Hrs**	**9**
Die blocks for forging operations. Design of fuller impression, Roller impression, Bender impression, Blocker impression, Finisher impression. Swaging tools. Planning layout of multi impression dies. Flash and cutter calculations – additional operations on forging, piercing, and trimming dies, coining dies. Horizontal forging machines. Design of upsetting dies. Calculations on upsetting dies – Press forging reducer rollers. Forging equipment. Layout of forge shop. Roll forming, wire drawing forward & backward extrusion		
	Total hours to be taught **Total Hrs**	**45**

Text book (s)

1. Rusinoff S.E., *Forging & Forming Metals*, Taraporewala, Bombay, 1952
2. Dochlar H.H., *Die Casting Dies*, Mc Grawhill, 1951

Reference(s)

1. I.S. Standards, BSI., New Delhi.
2. Pye R.G.W., *Injection Mould Design*, Longman scientific & Technical Publishers, London, 1989

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEE 118	**RAPID PROTOTYPING PRINCIPLES AND APPLICATIONS**	L	T	P	C	E	I	Total
		3	0	0	3	70	30	100

Objective (s)	1. To make students understand the basic concepts of various rapid prototyping technologies. 2. To understand and apply criterion for selecting appropriate RPT technique for any given application.
Outcome (s)	1. identify different process and key characteristics of RP technologies and commonly used RP systems 2. describe various CAD issues for rapid prototyping and related operations for STL model generation and manipulation 3. Explain and summarize typical rapid tooling processes for quick batch production of plastic and metal parts 4. critically explore technologies used for rapid prototyping in terms of their parameters, application, limitations, cost, materials, equipment, outcomes and implications 5. distinguish the types of Additive Manufacturing capabilities based on part geometry customer demands and CNC machine capabilities 6. identify different post processing techniques involved after rapid prototyping.

1.	**Introduction:** Prototyping fundamentals, Historical development, Fundamentals of Rapid Prototyping, Advantages and Limitations of Rapid Prototyping, Commonly used Terms, Classification of RP process, Rapid Prototyping Process Chain: Fundamental Automated Processes, Process Chain	**Total Hrs** 9
2.	**Liquid-based Rapid Prototyping Systems**: Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Solid ground curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies **Solid-based Rapid Prototyping Systems**: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies	**Total Hrs** 9
3.	**Powder Based Rapid Prototyping Systems:** Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. **Rapid Tooling:** Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT. Rapid Tooling Classification: Indirect Rapid Tooling Methods: Spray Metal Deposition, RTV Epoxy Tools, Ceramic tools, Investment Casting, Spin Casting, Die casting, Sand Casting, 3D Keltool process. Direct Rapid Tooling: Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP	**Total Hrs** 9
4.	**Rapid Prototyping Data Formats: STL** Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. **Rapid Prototyping Software's:** Features of various RP software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3D doctor	**Total Hrs** 9
5.	**RP Applications:** Application – Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture. **RP Medical and Bioengineering Applications:** Planning and simulation of complex surgery, Customised Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visulization of Biomolecules	Total hours to be taught **Total Hrs** 45

Text book (s)

1. Rapid prototyping: Principles and Applications - Chua C.K., Leong K.F. and LIM C.S, World Scientific publications , Third Edition, 2010
2. Rapid Manufacturing – D.T. Pham and S.S. Dimov, Springer , 2001

Reference(s)

1. Wholers Report 2000 – Terry Wohlers, Wohlers Associates, 2000
2. Rapid Prototyping & Manufacturing – Paul F Jacobs, ASME Press, 1996

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEE 119	**Flexible Manufacturing Systems**	L	T	P	C	E	I	Total
		3	0	0	3	70	30	100

Objective (s)	The course covers the significance of manufacturing systems over numerical control machining methods. The fundamentals of flexible manufacturing system are clearly stated from the design concepts that include usage of operation cycle description, robot automatic guided vehicle, chip removal, washing station, fixturing etc
Outcome (s)	Upon completion of the subject, student will be able to 1. the understand the elements of flexible manufacturing system 2. Students can independently develop the sequence of operations that are to be performed for manufacturing of a product 3. understand the functioning of programmable logical controller 4. understand Automated storage and retrieval systems 5. understand the concept of just in time manufacturing 6. understand the FMS design concept

1.	Evolution of Manufacturing Systems: FMS definition and description, General FMS considerations, Manufacturing cells, Cellular versus Flexible Manufacturing. Systems Planning: Objective, introduction planning, preparation guidelines, the project team, supplier selection, system description and sizing, facility preparation planning, FMS layouts. Human resources: staff considerations, team work, communication and involvement, the supervisors role, personnel selection, job classifications, employee training	**Total Hrs** 9
2.	Manufacturing's Driving Force: Definition, description and characteristics. Just in-time manufacturing, definition and description, benefits and relationship to FMS, implementation cornerstones, quality and quantity application principles. Single manufacture Cell – design scheduling of jobs on single manufacturing cells. Group Technology: Concepts, classification and coding, benefits and relationship to FMS, design of group technology using rank order clustering technique	**Total Hrs** 9
3.	FMS Design – Using Bottleneck, Extended bottleneck models, Processing and Quality Assurance: Turning centres, Machining centre, construction and operations performed, axes, programming, and format information, work-holding and work-changing equipment, automated features and capabilities, cleaning and deburring – station types and operation description, importance to automated manufacturing, coordinate measuring machines, types, construction and general function, operation cycle description, importance to flexible cells and systems	**Total Hrs** 9
4.	Automated movement and storage systems–AGVs, Robots, automated storage and retrieval systems, storage space design, queuing carousels and automatic work changers, coolant and chip Disposal and recovery systems, auxiliary support equipment, cutting tools and tool Management – introduction, getting control of cutting tools, Tool Management, tool strategies, data transfer, tool monitoring and fault detection, guidelines, work holding considerations, General fixturing, Modular fixturing. FMS and the relationship with workstations – Manual, automated and transfer lines design aspects	**Total Hrs** 9
5.	FMS: computer Hardware, Software, Communications networks and Nanotechnology – general functions, and manufacturing usages, hardware configuration, programmable logic controllers, cell controllers, communications networks, FMS implementation	**Total Hrs** 45
	Total hours to be taught	

Text book (s)

1. Parrish, D.J., *'Flexible Manufacturing'*, - Butter Worths – Heinemann, Oxford, 1993
2. Groover, M.P., *'Automation, Production Systems and CIM'*, - Prentice Hall India, 1989

Reference(s)

1. Kusiak, A., *'Intelligent Manufacturing Systems'*, - Prentice Hall, 1990
2. Considine,D.M., & Considine,G.D., *'Standard Handbook of Industrial Automation'*,-Chapman & Hall, 1986
3. Ranky, P.G., *'Design and Operation of FMS'*, - IFS Publishers, UK, 1988

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
16MEE 120	**NON-TRADITIONAL MACHINING AND FORMING**	3	0	0	3	70	30	100

Objective (s)	1. To make the students understand the need and the applications of nontraditional machining processes. 2. To choose the NTM processes for particular applications
Outcome (s)	Students can understand, 1.the importance ,principles of various Non-traditional processes 2.the processes of Thermal Metal Removal 3.the parameters and chemistry of Electro chemical process 4.the principles of Plasma Arc machining 5.the principles of laser Beam and Electron Beam machining 6.to make the comparison of conventional and high velocity forming methods

1.	**Introduction**: Need for non-traditional machining processes. Processes selection, classification, comparative study of different processes. **Mechanical Process**: Ultrasonic Machining-Definition-Mechanism of metal elements of the process- Tool feed mechanism. Theories of mechanics of causing effect of parameter applications. Abrasive **Jet Machining**: Principles - parameters of the process, applications, advantages and disadvantages. Water Jet **Machining (WJM)**: Schematic diagram, equipment used, advantages and applications	**Total Hrs** 9
2.	Thermal **Metal Removal Process**: Electric discharge machining Principle and operation – mechanism of meta removal, basic EDM circuitry-spark erosion. Analysis of relaxation type of circuit material removal rate in relaxation circuits- critical resistance parameters in Ro Circuit-Die electric fluids- Electrodes for surface finish. Applications. Wire EDM principle and operation. Wire materials, wire tension and its parameters. Applications	**Total Hrs** 9
3.	Electro **Chemical and Chemical Processes**: Electro chemical machining (ECM) Classification ECM process-principle of ECM Chemistry of the ECM parameters of the processes-determination of the metal removal rate - dynamics of ECM process-Hydrodynamics of ECM process-polarization. Tool Design-advantages and disadvantages - applications. Electro Chemical Grinding-Electro Chemical holding Electrochemical deburring. **Plasma Arc Machining**: Introduction-Plasma-Generation of Plasma and equipment Mechanism of metals removal, PAN parameters-process characteristics - type of torches applications	**Total Hrs** 9
4.	Electron **Beam Machining (EBM)**: Introduction-Equipment for production of Electron beam - Theory of electron beam machining Thermal & Non thermal types characteristics – applications. Laser **Beam Machining (LBM)**: Introduction-principle of generation of lasers Equipment and Machining procedure-Types of Lasers-Process characteristics-advantages and limitations-applications	**Total Hrs** 9
5.	**High Velocity Forming Process**: introduction - development of specific process selection-comparison of conventional and high velocity forming methods - Types of high velocity forming methods- explosion forming process-elector hydraulics forming magnetic pulse forming. Electro-Magnetic Forming. Rubber Pad Forming: Principle of the process, process details, process variants - Guerin, wheelon, Marforming and Hydro forming processes and applications	Total hours to be taught **Total Hrs** 45

Text book (s)

1. New Technology Institution of Engineers - Bhattacharya – India
2. Production Technology - HMT - Tata Mc Graw Hill - ISBN-10

Reference(s)

1. Modern Manufacturing Method - Adithan - New Age International (p) Limited
2. Modern Machining Processes - P.K. Mishra - Narosa Publishing House, New Delhi - 1997.

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CDIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
16MEC 107	**COMPUTATIONAL LABORATORY**	0	0	3	2		50	50

Objective(s)

1. To understand how and why finite element technique works
2. To learn the selection of the element type for a defined problem.
3. To use ANSYS package to solve engineering problems for a variety of application
4. To learn to use finite element analysis in design
5. To know various fields of engineering where these tools can be effectively used to improve the output of a product
6. To impart the fundamental knowledge on using various analytical tools like ANSYS Engineering Simulation.

Outcome(s):

Students will be able to:

1. Use the tools like ANSYS in solving real time problems and day to day problems.
2. Apply the Finite Element Method for the calculation stresses, strains and deformations in any component
3. critically evaluate the model results in comparison to simplified analytical solutions
4. Versatility in using these tools for any engineering and real time applications.
5. Gain knowledge on utilizing these tools for a better project in their curriculum
6. Face industry with confidence in using these tools in their respective jobs

List of Experiments:

1. Introduction to Finite Element Analysis Software.
2. Static analysis of a corner bracket.
3. Statically indeterminate reaction force analysis.
4. Determination of Beam stresses and Deflection.
5. Bending analysis of a Tee-shaped beam.
6. Analysis of cylindrical shell under pressure.
7. Bending of a circular plate using axisymmetric shell element.
8. Stress analysis in a long cylinder.
9. Solidification of a casting.
10. Transient Heat transfer in an infinite slab.
11. Transient Thermal stress in a cylinder.
12. Vibration analysis of a simply supported beam.
13. Natural frequency of a motor generator.
14. Thermal – structural contact analysis of two bodies.
15. Drop test of a container (Explicit Dynamics).

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With effect from the academic year 2016- 2017

Scheme of Instruction & Examination
M.E. (CAD/CAM) – Mechanical Engineering - 4 Semesters (Full Time)

Semester - I

Sl. No	Subject	No. of Hrs. per week		Duration (Hrs)	Marks for		Total Marks	Credits
		Lecture	T/P/S		Internal Assessment	End Exam		
1.	Core	3	1	4	30	70	100	4
2.	Core	3	1	4	30	70	100	4
3.	Core	3	1	4	30	70	100	4
4.	Elective	3	--	3	30	70	100	3
5.	Elective	3	--	3	30	70	100	3
6.	Elective	3	--	3	30	70	100	3
7.	Laboratory	--	3	3	50	--	50	2
8.	Seminar - I	--	3	3	50	--	50	2
9.	Soft Skills	--	--	--	--	--	--	--
	Total	**18**	**09**		**340**	**360**	**700**	**25**

Semester - II

Sl. No	Subject	No. of Hrs. per week		Duration (Hrs)	Marks for		Total Marks	Credits
		Lecture	T/P/S		Internal Assessment	End Exam		
1.	Core	3	1		30	70	100	4
2.	Core	3	1		30	70	100	4
3.	Core	3	1		30	70	100	4
4.	Elective	3	--		30	70	100	3
5.	Elective	3	--		30	70	100	3
6.	Elective	3	--		30	70	100	3
7.	Laboratory - II	--	3		50	--	50	2
8.	Seminar - II	--	3		50	--	50	2
9.	Mini Project	--	2		50	--	50	1
	Total	**18**	**11**		**390**	**360**	**750**	**26**

Semester - III

Sl. No	Subject	Marks for		Total Marks	Credits
		Internal Assessment	End Exam		
1	Project Seminar* (i)Problem formulation and submission of synopsis within 8 weeks from the commencement of 3rd Semester. (50 Marks) (ii) Preliminary work on Project implementation. (50 Marks)	100	--	100	6
	Total	100		100	6

Semester - IV

Sl. No	Subject	Marks for		Total Marks	Credits
		Internal Assessment	End Exam		
1	Project Work	100	100	200	12

Note: Six core subjects, Six elective subjects, Two Laboratory Courses and Two Seminars, Mini Project and Soft Skills should normally be completed by the end of semester II.

* Project seminar presentation on the topic of Dissertation only, 50 marks awarded by the project guide and 50 marks by the internal committee

Credit requirements for the award of degree, lower limit and upper limit of credits for registration by a student in a semester Credit Requirement for the award of M.E/M. Tech. Degree is 69

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16MEC 110

MINIPROJECT GUIDELINES

Instruction	2 Hrs / week
Sessional	50 Marks
Credits	01

Objectives:

First year ME students will each do a 14-week mini project, each generally comprising about one week of prior reading, twelve weeks of active research, and finally a presentation of their work for assessment (see assessment information below). Each student will be allotted to a Faculty supervisor for mentoring.

Mini projects should present students with an accessible challenge on which to demonstrate competence in research techniques, plus the opportunity to contribute something more original. Mini projects should have inter disciplinary/ industry relevance. The students can select a mathematical modeling based/Experimental investigations or Numerical modeling. All the investigations are clearly stated and documented with the reasons/explanations. All the projects should contain A clear statement of the research objectives, background of work, Literature review, techniques used, prospective deliverables, benefit from this [line of] research, Detailed discussion on results, Conclusions and references.

Outcomes:

Students are able to
1. Formulate a specific problem and give solution
2. Develop model/models either theoretical/practical/numerical form
3. Solve, interpret/correlate the results and discussions
4. Conclude the results obtained and write the documentation in standard format

Assessment:

1. 50 % of marks for a scientific report on the project.
   Regarding the formatting and structure, the report should be written as a journal article using the style file of a journal appropriate for the field of the research (which journal format is most appropriate should be agreed between student and supervisor). If the journal you selected has a page limit, it can be ignored but the report should not exceed 8000 words (common sense should be used if there are a lot of equations).

   Regarding content, the report should be understandable by your fellow students, so the introduction and literature review could be a bit more detailed than in a research paper. The results and discussions are in elaborate form and at end conclusions and include references.

2. 50 % of marks for an oral presentation which will take place at the end of the semester and evaluation by a committee consist of Supervisor, one senior faculty and Head of the department or his nominee.

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Scheme of Instruction & Examination
M.E. (CAD/CAM) – Mechanical Engineering - 4 Semesters (Full Time)

Semester - I

Sl. No	Subject	No. of Hrs. per week		Duration (Hrs)	Marks for		Total Marks	Credits
		Lecture	T/P/S		Internal Assessment	End Exam		
1.	Core	3	1	4	30	70	100	4
2.	Core	3	1	4	30	70	100	4
3.	Core	3	1	4	30	70	100	4
4.	Elective	3	--	3	30	70	100	3
5.	Elective	3	--	3	30	70	100	3
6.	Elective	3	--	3	30	70	100	3
7.	Laboratory	--	3	3	50	--	50	2
8.	Seminar - I	--	3	3	50	--	50	2
9.	Soft Skills	--	--	--	--	--	--	--
	Total	18	09		340	360	700	25

Semester - II

Sl. No	Subject	No. of Hrs. per week		Duration (Hrs)	Marks for		Total Marks	Credits
		Lecture	T/P/S		Internal Assessment	End Exam		
1.	Core	3	1		30	70	100	4
2.	Core	3	1		30	70	100	4
3.	Core	3	1		30	70	100	4
4.	Elective	3	--		30	70	100	3
5.	Elective	3	--		30	70	100	3
6.	Elective	3	--		30	70	100	3
7.	Laboratory - II	--	3		50	--	50	2
8.	Seminar - II	--	3		50	--	50	2
9.	Mini Project	--	2		50	--	50	1
	Total	18	11		390	360	750	26

Semester - III

Sl. No	Subject	Marks for		Total Marks	Credits
		Internal Assessment	End Exam		
1	Project Seminar* (i)Problem formulation and submission of synopsis within 8 weeks from the commencement of 3rd Semester. (50 Marks) (ii) Preliminary work on Project implementation. (50 Marks)	100	--	100	6
	Total	100		100	6

Semester - IV

Sl. No	Subject	Marks for		Total Marks	Credits
		Internal Assessment	End Exam		
1	Project Work	100	100	200	12

Note: Six core subjects, Six elective subjects, Two Laboratory Courses and Two Seminars, Mini Project and Soft Skills should normally be completed by the end of semester II.

* Project seminar presentation on the topic of Dissertation only, 50 marks awarded by the project guide and 50 marks by the internal committee

Credit requirements for the award of degree, lower limit and upper limit of credits for registration by a student in a semester Credit Requirement for the award of M.E/M. Tech. Degree is 69

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEC 202	**ADVANCED THERMODYNAMICS**	L	T	P	C	E	I	Total
		3	1	0	4	70	30	100

Objective (s)	1. To review the basic laws of thermodynamics and create awareness of the importance of thermodynamic principles in engineering applications. 2. To understand the behavior of Real Gases vis-à-vis ideal gas. 3. To create awareness of the importance of combustion reactions in real time applications. 4. To understand thermodynamic applications in psychrometry, refrigeration. 5. To understand the basic principles power cycles and its relation with combustion processes. 6. To understand various methods of direct energy conversion
Outcome (s)	A student will be able to 1. apply various laws of thermodynamics to suit the engineering applications. 2. apply the knowledge of thermodynamics for the behavior of real gases. 3. understand the phenomenon of combustion in IC engines 4. select and design air conditioning or psychrometric process depending on application and comfort conditions 5. understand the application of power cycles to engineering practice. 6. understand various non-conventional energy conversion methods like fuel cells etc.

1. LAWS OF THERMODYNAMICS	**Total Hrs**	**9**
Review of Thermo dynamic Laws and Corollaries – Transient Flow Analysis – Second law of thermodynamics – Entropy - Availability and unavailability – Irreversibility – Thermo dynamic Potentials – Maxwell Relations – Specific Heat Relations – Mayer's relation - Evaluation of Thermodynamic properties of working substance		
2. PSYCHROMETRY AND AIR CONDITIONING PROCESS	**Total Hrs**	**9**
P.V.T. surface – Equations of state – Real Gas Behaviour – Vander Waal's equation - Generalised compressibility Factor – Energy properties of Real Gases – Vapour pressure – Clausius – Clapeyron Equation – Throttling – Joule – Thompson coefficient Non-reactive Mixture of perfect Gases – Governing Laws – Evaluation of properties – Pychrometric Mixture properties and psychrometric chart – Air conditioning processes – Cooling Towers – Real Gas Mixture		
3. COMBUSTION REACTIONS	**Total Hrs**	**9**
Combustion – Combustion Reactions – Enthalpy of Formation – Entropy of Formation – Reference Levels for Tables – Energy of formation – Heat of Reaction – Aiabatic flame Temperature General product – Enthalpies – Equilibrium. Chemical Equilibrium of Ideal Gases – Effects of Non-reacting Gases Equilibrium in Multiple Reactions. The van Hoff's Equation. The chemical potential and phase Equilibrium – The Gibbs phase Rule		
4. POWER CYCLES	**Total Hrs**	**9**
Power cycles, Review Binary vapour cycle, co-generation and Combined cycles – Second law analysis of cycles – Refrigeration cycles. Thermo Dynamics off irreversible processes – Introduction – phenomenological laws – Onsagar Reciprocity Relation – Applicability of the phenomenological Relations– Heat Flux and Entropy Production – Thermo dynamic phenomena – Thermo electric circuits		
5. DIRECT ENERGY CONVERSION	**Total Hrs**	**9**
Introduction – Fuel Cells - Thermo electric energy – Thermo-ionic power generation -Thermodynamic devices Magneto Hydrodynamic Generations – Photo voltaic cells.		
Total hours to be taught		

Text book (s)

1. Nag, P.K., "Basic and Applied Thermodynamics",TMH,2008
2. Holman, J.P., "Thermo Dynamics", Mc Graw Hill, 2008
4. Obert Edward. F. & Young Rober L, "Elements of Thermodynamics" McGraw Hills
5. Younus.A.cengel & Michael A. Boles " Thermodynamics an engineering approach sixth edition,TMH
6. Arian Bejan "Advanced Engineering Thermodynamics " 3rd Edition Wiley Publications,2006

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEC 203	**ADVANCED HEAT & MASS TRANSFER**	L	T	P	C	E	I	Total
		3	1	0	4	70	30	100

Objective (s)

Student will

1. understand the basic principles of fins and unsteady state heat transfer applied to industries.
2. learn various equations and their application in engineering heat transfer
3. understand boundary layer concept and their applications
4. learn about phase heat transfer and their applications
5. understand the importance of radiation heat transfer
6. learn about mass transfer and its applications in process industries

Outcome (s)

Student will be able to

1. apply the equations pertaining to unsteady state heat transfer and knowledge in extended surfaces
2. evaluate mass, momentum and energy equations with approximate and exact methods
3. apply heat transfer knowledge in calculation of boundary layer thickness and various dimensionless numbers
4. evaluate heat transfer coefficients under phase change phenomena
5. apply the knowledge of radiation heat transfer in various fields like solar engineering, design of reactors etc,
6. apply the knowledge of mass transfer in process industries

1. BRIEF INTRODUCTION TO DIFFERENT MODES OF HEAT TRANSFER — **Total Hrs** 9

Brief Introduction to different modes of heat transfer; Conduction: General heat conduction equation-Initial and Boundary conditions Steady State Heat Transfer: Simplified heat transfer in 1D and 2D – Fins.Transient heat conduction; Lumped system analysis- Heisler charts-semi infinite solid-use of shape factors in conduction - 2D transient heat conduction – product solutions

2. FINITE DIFFERENCE METHODS FOR CONDUCTION — **Total Hrs** 9

Finite Difference methods for Conduction: 1D & 2D steady state and simple transient heat conduction problems – implicit and explicit methods. Forced Convection: Equations of Fluid Flow – Concepts of Continuity, momentum equations – Derivation of Energy equation - Methods to determine heat transfer coefficient: Analytical Methods - Dimensional Analysis and concept of exact solution. Approximate Method – Integral analysis

3. EXTERNAL FLOWS — **Total Hrs** 9

External flows: Flow over a flat plate: Integral method for laminar heat transfer coefficient for different velocity and temperature profiles. Application of empirical relations to variation geometrics for Laminar and Turbulent flows. Internal flows: Fully developed flow: Integral analysis for laminar heat transfer coefficient – Types of flow – Constant Wall Temperature and Constant Heat Flux Boundary Conditions - Hydrodynamic & thermal entry lengths; use of empirical correlations

4. FREE CONVECTION & RADIATION — **Total Hrs** 9

Free convection: Approximate analysis on laminar free convective heat transfer – Boussinesque Approximation - Different geometries – combined free and forced convectionBoiling and condensation: Boiling curve – Correlations- Nusselt's theory of film condensation on a vertical plate – Assumptions & correlations of film condensation for different geometrics

5. MASS TRANSFER — **Total Hrs** 9

Radiation Heat Transfer: Radiant heat exchange in grey, non-grey bodies, with transmitting, reflecting and absorbing media, specular surfaces, gas radiation – radiation from flames. Mass Transfer: Concepts of mass transfer – Diffusion & convective mass transfer Analogies – Significance of non-dimensional numbers

Total hours to be taught

Text book (s)

1.Necati Ozisik "Heat Transfer" TMH 1998

2. Incropera Dewitt Fundamentals of Heat & Mass Transfer – John Wiley 2007

3. Yunus Cengel Heat Transfer: A basic approach – TMH 2008

4. R.C.Sachdeva Fundamentals of Engineering Heat & Mass Transfer" New Age International Publications 2010

5. J.P.Holman "Heat Transfer" Tata Mc Graw Hill, 2008

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEC 204		L	T	P	C	E	I	Total
	ADVANCED I.C. ENGINES	3	1	0	4	70	30	100

Objective (s)	1. importance of combustion phenomena in I.C. Engines 2. phenomena of the engine performance and decrease the pollutants knocking in SI and CI engines 3. concept of formation and control of different exhaust emissions from IC engines. 4. use of alternate fuel technology to improve 5. suggested modifications in I.C. engine to suit bio-fuels 6. basic concepts of recent trends with change of engine configuration
Outcome (s)	1. Describe the phenomena of combustion and knock in SI engines 2. Understand the normal and abnormal combustion in CI engines 3. Explain the sources and formation of various pollutants from IC engines 4. Understand how the undesirable exhaust emissions from IC engines are controlled 5. Demonstrate an understanding of technological, environmental and social impacts of alternative fuels 6. Explain modern concepts like Lean burn, stratification, HCCI and GD

1. SPARK IGNITION ENGINES	**Total Hrs**	**9**
Spark ignition engine mixture requirements – Fuel – Injection systems – Monopoint, Multipoint injection, Direct injection – Stages of combustion – Normal and abnormal combustion – Factors affecting knock – Combustion chambers		
2. COMPRESSION IGNITION ENGINES	**Total Hrs**	**9**
Stages of combustion in C.I. Engine – Direct and indirect injection systems – Combustion chambers – Normal and Abnormal Combustion – Knock in C.I Engines-Basic Concepts and Study of Fuel Spray – Introduction to Turbo charging		
3. POLLUTANT FORMATION AND CONTROL	**Total Hrs**	**9**
Pollutant – Sources – Formation of carbon monoxide, Unburnt hydrocarbon, Aldehydes, NOx, Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters and Particulate Traps- Methods of measurements and Introduction to emission norms		
4. ALTERNATIVE FUELS	**Total Hrs**	**9**
Alcohol, Hydrogen, Natural Gas and Liquefied Petroleum Gas- Properties, Suitability, Merits and Demerits as fuels, Engine Modifications		
5. RECENT TRENDS	**Total Hrs**	**9**
Modification in I.C. engine to suit bio-fuels- Lean Burn Engines – Stratified charge Engines – homogeneous charge compression ignition (HCCI) engines and GDI concepts		
Total hours to be taught		

Text book (s)

1. Obert, E.F.Internal Computation Engines Harper & Row, Publishers N.Y3rd edition 1973
2. GILL, P.W.and Smith (Jr,J.H, fundamentals of Internal combustion Engines, Oxford & IBH publishing Co.New Delhi, 1967.

References:

1. Heywood, J.B, Internal Combustion engine fundamentals, McGrave Hills, Book Co, New York, 1988.
2. Taylor C.F.and Taylor, E,S,The Internal Combustion Engine in Theory and Practice, M.I.T.Press, 1968
3. Mathur,M.L.and Sharma,R.P.,Internal Combustion Engine,Dhanpat Rai & Sons, Delhi, 5th Edition,1990
4. Ganeshan, V., Internal Combustion engines, Tata Mc Graw Hills Publishing Co.Ltd, New Delhi 1984

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEE 215	**THERMAL AND NUCLEAR POWER PLANTS**		T	P	C	E	I	Total
		3	0	0	3	70	30	100

Objective (s)	Student will be able to understand the 1. Performance of steam power plant and to observe the importance of combustion of coal 2. Working principles of steam generators, turbines & condensers 3. Combined cycle effect in gas turbine power plants 4. Compare different nuclear reactors and estimate the economical benefits 5. Calculate the different energy tariffs under various load conditions 6. pressure, temperature and flow parameters of a power plant
Outcome (s)	Students will be able to 1. analyze on combustion of coal and find performance of different power plant cycles. 2. analyze various steam generators, cooling towers, turbines & condensers. 3. analysis on combined cycle, power plants and waste heat recovery systems. 4. design various types of nuclear reactors taking safety precautions and making economically beneficial. 5. calculate the energy rates of power distribution considering the factors affecting the economy. 6. determine the pressure, temperature and flow measurements of steam and water to operate the power plant most efficiently and suggest various remedies to control pollutants.

1. Layout of Power Plants	**Total Hrs**	**9**
Sources of Energy, types of Power Plants, Direct Energy Conversion System, Energy Sources in India, Recent developments in Power Generation. Combustion of Coal, Volumetric Analysis, Gravimetric Analysis, Flue gas Analysis. Steam Power Plants: Introduction – General Layout of Steam Power Plant, Modern Coal-fired Steam Power Plants, Power Plant cycles, Fuel handling, Combustion Equipment, Ash handling, Dust Collectors		
2. Combined Cycle Power plant	**Total Hrs**	**9**
Cogeneration, Combined cycle Power Plants, Analysis, Waste-Heat Recovery, IGCC Power Plants, Fluidized Bed Combustion – Advantages & Disadvantages		
3. Nuclear Power Plant	**Total Hrs**	**9**
Nuclear Physics, Nuclear Reactors, Classification – Types of Reactors, Site Selection, Methods of enriching Uranium, Applications of Nuclear Power Plants. Nuclear Power Plants Safety: By-Products of Nuclear Power Generation, Economics of Nuclear Power Plants, Nuclear Power Plants in India, Future of Nuclear Power		
4. Economics of Power Plant	**Total Hrs**	**9**
Economics of Power Generation: Factors affecting the economics, Load Factor, Utilization factor, Performance and Operating Characteristics of Power Plants. Economic Load Sharing, Depreciation, Energy Rates, Criteria for Optimum Loading, Specific Economic energy problems		
5. Power Plant Instrumentation	**Total Hrs**	**9**
Classification, Pressure measuring instruments, Temperature measurement and Flow measurement. Analysis of Combustion gases, Pollution – Types, Methods to Control.		
	Total hours to be taught	**45**

Text book (s)

1. EL- Wakil, M.M., "Power Plant Technology " Mc Graw Hill, New York, 1985
2. Weis Man, J.and Eckert, R, "Modern Power Plant Engineering", PHI, New Delhi, 1983

References:

1. Arora and Domkundwar, "A course in Power Plant Engineering", Dhanpat Rai & sons 2002
2. P.K. Nag, "Power Plant Engineering," TMH, 2003
3. P.C.Sharma, "Power Plant Engineering" Kotaria Publications, 2007

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CBIT	Autonomous Regulation						
Department	Mechanical Engineering	Programme Code & Name			M.E. Thermal Engineering		
Semester-I							
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks	
16MEE 201		L	T	P	C	E	I	Total
	COMPUTER AIDED GRAPHICS AND DESIGN	3	0	0	3	70	30	100

Objective (s)	1. Understand the basics of computer aided design. 2. To impart knowledge on design process 3. Recognize and explain the uses of wireframe and surface entities 4. Understand solid modeling representation schemes 5. Understand and apply various Geometric transformations 6. Understand various advanced modeling concepts
Outcome (s)	Students are able to: 1. apply design concepts in design , analysis and can visualize the models through the graphics standards . 2. implement Various transformations on geometric models for manipulation 3. recognize various wireframe entities and model them. 4. apply surface modeling techniques for the generating various parts and implement 5. differentiate various solid modeling techniques 6. able to perform modeling using the software by understanding advanced modeling concepts

1	**INTRODUCTION TO CAD**	**Total Hrs**	**9**
Criteria for selection of cad workstations, Shigle design process, Design criteria, Geometric modeling , Entities, 2d and 3d primitives, Computer Aided Design , Iterative Design ,CAD process Geometric Transformations : 2d Translation , Scaling, Rotation, Reflection and shearing, Homogeneous Coordinates , Rotation and Scaling about arbitrary points , 3D transformations Windowing - View ports -Clipping transformations Graphics standards: GKS , IGES , PDES and their relevance			
2	**MODELING of CURVES**	**Total Hrs**	**9**
Analytic curves : Lines, Circles, Ellipse, Conics. Synthetic curves – Cubic, Bezier, B-Splines, NURBS. Curve Manipulations Wireframe Modeling and its advantages and Limitations			
3	**SURFACE MODELING**	**Total Hrs**	**9**
Analytic Surfaces: Plane Surface, Ruled Surface, Surface of Revolution, Tabulated Cylinder. Synthetic Surface - Cubic, Bezier, B-spline, Coons ,Surface Manipulations , Surface Modeling Techniques			
4	**SOLID MODELING**	**Total Hrs**	**9**
Boundary Representation (B-rep) & Constructive Solid Geometry (CSG) Modeling Graph Based Model, Boolean Models, Instances, Cell Decomposition & Spatial – Occupancy Enumeration,			
5	**SOLID MODELING USING SOFTWARE**	**Total Hrs**	**9**
Feature Based Modeling, Conceptual Design ,Modeling of oil storage tanks, Cylinder head , Piston, Cylinder liner, Crank Shaft, Exhaust manifold ,Catalytic Converter			
		Total hours to be taught	**45**

Text book (s)

1. Ibrahim Zeid, "CAD/CAM, Theory and Practice", McGraw Hill, 1998.
2. Foley, Van Dam, Feiner and Hughes, "Computer Graphics Principles and Practice", 2nd Ed., Addison – Wesley, 2000.

Reference Book(s)

1. E. Micheal, "Geometric Modelling", John Wiley & Sons, 1995.
2. Hill Jr, F.S., "Computer Graphics using open GL", Pearson Education, 2003.

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CBIT	*Autonomous Regulation*							
Department	Mechanical Engineering		Programme Code & Name		M.E. CAD/CAM & Thermal Engineering			
Semester-I								
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
16MEE 207	**ENGINEERING RESEARCH METHODOLOGY**	3	0	0	3	70	30	100

Objective (s)

1. To motivate the students to choose research as career.
2. To make the students to formulate the research problem.
3. To identify various sources for literature review and data collection.
4. To prepare the research design
5. To equip the students with good methods to analyze the collected data
6. To write a report and interpret the results

Outcome (s)

Students will be able to

1. define research problem
2. review and asses the quality of literature from various sources.
3. understand and develop various research designs.
4. collect the data by various methods: observation, interview, questionnaires.
5. analyze problem by statistical techniques: ANOVA, F-test, Chi-square
6. improve the style and format of writing a report for technical paper/ Journal report

1	**Research Methodology:**	**Total Hrs**	9

Objectives and Motivation of Research, Types of Research, Research Approaches, Significance of Research, Research Methods verses Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general.
Defining the Research Problem: Selection of Research Problem, Necessity of Defining the Problem, Technique involved in Defining a Problem.

2	**Literature Survey**:	**Total Hrs**	9

Importance and purpose of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Information through Internet.
Literature Review: Need of Review, Guidelines for Review, Record of Research Review.

3	**Research Design:**	**Total Hrs**	9

Meaning of Research Design, Need of Research Design, Feature of a Good Design, Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Steps in sample design, types of sample designs.

4	**Data Collection:**	**Total Hrs**	9

Methods of data collection, importance of Parametric test, testing of proportions, testing of variance of two normal population, and Non Parametric test, relation between Spearman's r's and Kendall's W
Data Analysis: Tests for significance: Chi-square, ANOVA, F-test.

5	**Interpretation and report writing:**	**Total Hrs**	9

Meaning of interpretation, layout of research report, Types of reports, Mechanics of writing a report.
Research Proposal Preparation: Writing a Research Proposal and Research Report, Writing Research Grant Proposal.

Text Book (s):

1. C.R Kothari, Research Methodology, Methods & Technique; New Age International Publishers, 2004
2. R. Ganesan, Research Methodology for Engineers, MJP Publishers, 2011

References:

3. Y.P. Agarwal, Statistical Methods: Concepts, Application and Computation, Sterling Publs., Pvt., Ltd., New Delhi, 2004
4. Vijay Upagade and Aravind Shende, Research Methodology, S. Chand & Company Ltd., New Delhi, 2009
5. P. Ramdass and A. Wilson Aruni, Research and Writing across the Disciplines, MJP Publishers

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEE 205	**DESIGN OF GAS TURBINES**	L	T	P	C	E	I	Total
		3	0	0	3	70	30	100

Objective (s)	Student will understand 1. To create awareness of the importance of principles of design of gas turbine and methods of improvement of efficiency. 2. the principles of design of rotary compressors and its classification 3. the operating principles of combustion chamber for gas turbine applications 4. to familiarize the design of blades and their cooling systems used in gas turbine 5. the principles of axial flow compressor 6. the design principles of gas turbine blades
Outcome (s)	Student will be able to 1. thermal efficiency of gas turbine cycle and its improvements by different methods 2. various methods used in improving performance of the gas turbine cycle 3. design elements in rotary compressors 4. understand the importance of various types of combustion chambers used in gas turbines 5. design or analyze the forces on blade of gas turbine 6. suggest different cooling methods of gas turbine blades

1. THERMODYNAMIC ANALYSIS OF GAS TURBINE CYCLES	**Total Hrs**	**9**
Joule/Brayton. Open and Closed Cycles. Methods of improving cycle efficiency – Inter-cooling. Reheating and Regeneration		
2. DESIGN OF ROTARY COMPRESSORS	**Total Hrs**	**9**
Applications of Turbo Compressors (Centrifugal and axial flow) in Gas turbine power plant. Euler equation of energy transfer in a turbomachine. Design of two stage centrifugal compressor with vaneless and vaned diffusers. Design of multi stage axial flow compressors		
3. COMBUSTION CHAMBERS OF GAS TURBINES	**Total Hrs**	**9**
Types of combustion chambers. Combustion chamber design for modern gas turbines. Can type, annular and tube type of combustors		
4. DESIGN OF AXIAL FLOW TURBINES	**Total Hrs**	**9**
Matching of compressor and turbine for varying load operation. Gas turbine for super charging and cryogenic applications. Small gas turbines for space applications		
5. DESIGN AND CONSTRUCTION OF GAS TURBINE ROTORS AND BLADES	**Total Hrs**	**9**
Blade materials. Blade attachment techniques. Cooling methods of turbine blades. Simple analysis of turbine blade vibrations and balancing of rotors.		
Total hours to be taught		**45**

Text book (s)

1. D.G.Wilson,The Design of High efficiency Turbomachinery and Gas Turbines, The MIT Press, Cambridge, U.K.
2. M.P.Boyce, Gas Turbine Engineering hand book, Gulf Publishing Co., New York.

References:

1. E. Balje, Turbo machines – A guide to Selection and Theory, John Wiley & Sons, New York
2. J.S. Rao, Rotor Dynamics, Wiley Eastern Publication, New Delhi.

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEE 206	**ADVANCED ENERGY SYSTEMS**	L	T	P	C	E	I	Total
		3	0	0	3	70	30	100

Objective (s)	Student will understand 1. to create awareness of the importance of the principles of various non- conventional energy resources power and design concepts of wind tunnel 2. the working principles of various collectors used in solar 3. the importance of biogas and its production and the principles of waste heat recovery 4. stress the need for cogeneration systems 5. the design principles of wind rotor blades of wind turbine 6. the principles of waste heat recovery boilers
Outcome (s)	A student will be able to 1. design solar collectors, wind mill as per specifications 2. understand the potential of biogas plants and need for waste heat recovery in the scenario of energy savings 3. understand the need for cogeneration and various methods adopted for it 4. optimize the power plant efficiency 5. optimize power plant efficiency 6. design rotors of wind mill according to consideration of aerodynamics

1. SOLAR ENERGY	**Total Hrs**	**9**
Solar energy: solar radiation – measurement, collection and storage, design of flat plate and parabolic concentrating collectors. Solar power plants. Photo voltaic power systems. Application of SPV and Solar Thermal Systems		
2. WIND ENRGY	**Total Hrs**	**9**
Estimation of wind energy potential. Horizontal and vertical axis wind turbine rotors. Aerodynamic design considerations for wind rotor blades. Wind electric generators-operation and control. Aero generators for battery charging.		
3. BIO MASS	**Total Hrs**	**9**
Bio mass energy: Sources of biomass. Energy from solid wastes. Biomass for energy production. Methane production. Bio mass energy conversion technologies. Use of Bio-gasifier. Bio mass power generation using agricultural residues. Introduction of Hybrid energy systems		
4. WASTE HEAT RECOVERY	**Total Hrs**	**9**
Principles of waste heat recovery and co-generation. Analysis of heat recovery systems. Regenerators and recuperators for waste heat recovery. Advantages of fluidized bed boilers. Atmospheric fluidized bed combustion (AFBC), Pressurized fluidized bed combustion (PFBC and Circulation fluidized bed combustion (CFBC).		
5. CO-GENERATION POWER SYSTEMS	**Total Hrs**	**9**
Co-generation power systems, Condensate and back pressure steam turbines. Design of waste heat recovery boilers. Combined cycle power plants based on waste heat recovery. Integrated gasification combined cycle (IGCC) power plants. Optimization of Power plant cycle efficiency. Clean coal technologies		
Total hours to be taught		**45**

Text book (s)

1. D.A. Relay, Waste Heat Recovery System.
2. G.C. Drydin, The efficient Use of Energy.

References:

1. J.A. Duffire and W.A. Beckmen, Solar Energy Thermal Processes
2. A.B. Meinel, Applied Solar Energy.
3. V.D. Hunt, Wind Power.
4. N.H Ravindranath and D O Hall, Bio Mass, Energy and Environment, Oxford University Press .V Jadhav, Energy and Environment, Himalaya publishing house, Mumbai

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEE 207		L	T	P	C	E	I	Total
	FUELS & COMBUSTION	3	0	0	3	70	30	100

Objective (s)	To make student understand 1. conventional energy resources and different types of solid fuels available with their properties 2. various processing methods of solid fuels 3. the principles of refining liquid fuels and their properties, analysis and handling 4. various types of gaseous fuels and their properties, process and cleaning 5. the thermodynamics of combustion and stoichiometric relations. 6. features of different types of burners
Outcome (s)	A student will be able to 1. list different solid fuels for different applications 2. know the various methods of processing solid fuels 3. know the properties handling and storage of liquid fuels 4. understand the production of various methods of gaseous fuels and identify fuels for various applications 5. understand different methods of combustion and estimate the air fuel ratio, adiabatic flame temperature based on the fuel. 6. understand design considerations of burners

1.CONVENTIONAL AND NON-CONVENTIONAL ENERGY RESOURCES	**Total Hrs**	**9**
Introduction: General, Conventional energy resources, Solar energy, Nuclear power, Energy from biomass, Wind power, Tidal power, Geothermal energy, Energy survey for India, Rocket Fuels, Definitions, Units, Measures		
2. SOLID FUEL-COAL	**Total Hrs**	**9**
Solid Fuels: General, Biomass, Peat, Lignite or Brown Coal, Sub-bituminous Coal or Black Lignite, Bituminous Coal, Semi-anthracite, Anthracite, Cannel coal and Boghead coal, Natural coke (Jhama)/SLV fuel, Origin of coal, Composition of coal, Analysis and properties of coal, Action of heat on coal, Oxidation of coal, Hydrogenation of coal, Classification of coal. Processing of Solid Fuels: General Coal preparation, Storage of coal, Coal carbonization, Briquetting of solid fuels, Liquefaction of solid fuels		
3. LIQUID FUELS	**Total Hrs**	**9**
Liquid Fuels : General, Petroleum, Origin of Petroleum, Petroleum production, Composition of petroleum, Classification of petroleum, Nature of Indian crude's, Petroleum processing, Important petroleum products, Properties and testing of petroleum and petroleum products, Petroleum refining in India, Liquid fuels from sources other than petroleum, Gasification of liquid fuels, Storage and handling of liquid fuels.		
4. GASEOUS FUELS	**Total Hrs**	**9**
Gaseous fuels: General, Types of gaseous fuels, Natural gas, Methane from coal mines, Producer gas, Water gas, Carbureted water gas, Complete gasification of coal, Underground gasification of coal, Coal gas, Blast furnace gas, Gases from biomass, Refinery gases, Liquefied petroleum gases (LPG), Oil gasification, Cleaning and purification of gaseous fuels		
5. COMBUSTION PROCESS	**Total Hrs**	**9**
Combustion Process (Stoichiometry and Thermodynamics): Combustion Stoichiometry : General, Examples, Rapid methods of combustion stoichiometry. Combustion Thermodynamics : General Combustion Process (Kinetics): Nature of combustion process, Types of combustion processes, Mechanism of combustion reaction, Spontaneous Ignition Temperature (SIT), Velocity of flame propagation, Limits of inflammability, Structure of flame, Flame stability, Kinetics of liquid fuel combustion, Kinetics of solid fuel combustion. Combustion Applications: General, Gas burners, Oil burners, Coal burning equipment		
Total hours to be taught		**45**

Text book (s)

1. Loftness, R.L.," Energy hand book", New York, Van Nostrand 1998.
2. Wilson, P.J. and J.H. Wells, "Coal, Coke and Coal Chemicals", New York : McGraw-Hill, 1960

References:

1. "Gas Engineers Handbook", New York : Industrial Press, 1966.
2. Williams, D.A. and G. James, "Liquid Fuels", London Pergamon, 1963
3. Minkoff, G.J., and C.F.H. Tipper, "Chemistry of Combustion Reaction", London Butterworths, 1962.
4. Samir Sarkar, "Fuels & Combustion", Orient Long man 1996

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEE 208	**POWER PLANT CONTROL AND INSTRUMENTATION**	L	T	P	C	E	I	Total
		3	0	0	3	70	30	100

Objective (s)	Student will understand 1. the principles of static and dynamic characteristics of instruments 2. working principles of feedback control concepts of electrical parameters 3. To create awareness of the importance of working principles of various measuring instruments and their applications in engineering industry 4. To understand characteristics of instruments 5. To familiarize the principles of data acquisition along influence of electrical parameters on instrumentation 6. To understand the principles of modeling of power systems
Outcome (s)	A student will be able to 1. estimate static and dynamic characteristics of instruments 2. estimate the influence of electrical parameters on measurements 3. understand theory on stability of instruments used for thermal systems 4. model power systems using various numerical methods 5. estimate the role of computers for data acquisition 6. represent various types of process control system

1. STATIC & DYNAMIC CHARACTERISTICS OF INSTRUMENTS	**Total Hrs**	**9**
Static & dynamic characteristics of instruments, sensors, signal processing & data transmission elements, indicating & recording elements.		
2. DATA ACQUISITION	**Total Hrs**	**9**
Use of computers for data acquisition & instrumentation for measuring temperature, pressure flow, speed, vibration & noise		
3. ELECTRICAL PARAMETERS	**Total Hrs**	**9**
On-line process instruments. Automatic process control systems Representation. Feedback control concepts. Transient & Frequency response. Types of controllers		
4. STABILITY OF INSTRUMENTS	**Total Hrs**	**9**
Stability, Digital Control System Modern Control theory. Boiler Control, Governing & Control of turbo-machines		
5. COMPUTER AIDED POWER SYSTEMS ANALYSIS	**Total Hrs**	**9**
Modeling of power system, components, Formation of bus admittance and impedance matrices, Power flow solution Gauss-Seidel, Newton Raphson, and fast de-coupled load flow, Short Circuit studies, Static equivalents of power system, Basic concepts of security analysis and state estimation.		
Total hours to be taught		**45**

Text book (s)

Beckwith and Buck, Mechanical Measurements

A.K.Tayal, Instruments and Mechanical Measurements, Galgotia Publication

References:

1. McCloy and Martin H.R., The Control of Fluid Power, Longman Publication, 1973
2. Williams, D.A. and G. James, "Liquid Fuels", London Pergamon, 1963
3. David Lindsley "Power-Plant Control and Instrumentation "IEE Control Engineering Series 585
4. W.Bolton "Instrumentation and Control Systems", 1st Edition Elsevier, 2004

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEE 209	**DESIGN OF PUMPS AND COMPRESSORS**		T	P	C	E	I	Total
		3	0	0	3	70	30	100

Objective (s)	Student will understand 1. the basic concepts of build mechanics & governing laws of fluid flow 2. the various principles involved in maintenance of pumps 3. To create awareness of the importance of working principles of design of rotary pumps and rotary compressors 4. To understand the concepts of selection and design of pumps 5. To familiarize the principles involved in testing and maintenance of pumps 6. To understand the concept of design and selection of drive of rotary compressors along with impellors
Outcome (s)	A student will be able to 1. apply the laws of fluid mechanics to turbo machines 2. install a pumping system & monitor the maintenance of the pumps 3. select pump depending on application 4. do testing of pumping systems 5. to select drive and develop layout of the compressor system 6. to design different types of impellors of centrifugal compressor

1. INTRODUCTION TO PUMPS AND COMPRESSORS	**Total Hrs**	**9**
Characteristics of working fluids, Fluid mechanics concepts and governing laws of fluid flow.		
2. DESIGN OF PUMPS	**Total Hrs**	**9**
Pumps – various components and their functions. Classification of pumping systems – based on the applications and working fluids. Design of pumps – data required for the design of pump and design calculations. Selection of the drive – Types of drives, their behavior and advantages, Selection of the pumps- types of pumps. Selection of piping and other components. Development of a schematic layout of the piping system		
3. OPERATION AND MAINTANANCE OF PUMPS	**Total Hrs**	**9**
Operation and maintenance – installation of pumping system. Testing of the pumping systems – Various methods based on the working fluid, drive and pump etc., Maintenance of the pumps – Prediction and correction methods, Factors affecting the maintenance and their evaluation		
4. ROTARY COMPRESSORS	**Total Hrs**	**9**
Rotary compressor system – various components and their functions. Classification of compressors. Design of compressor – data and analysis. Characteristics of the compressors. Selection of the drive and compressors. Development of the schematic layout of the compressor system.		
5. DESIGN OF IMPELLORS	**Total Hrs**	**9**
Design of impeller, Types of impellers – centrifugal and axial. Design of a diffuser – Vaneless and vaned diffuser. Types of casings, casing design. Performance characteristics of turbo compressors.		
Total hours to be taught		**45**

Text book (s)

1. S.M. Yahya, Turbines, Compressors and Fans, Tata McGraw Hill Publishing Co
2. Val.S. Lobanoff and Robert R. Ross, Centrifugal Pumps – Designs and Application, Jaico book publishing Co

References:

3. Igor J. Karassik and Joseph P. Messina "Pump Handbook 1986
4. Kovats, Andre, Design and performance of centrifugal and axial flow pumps and compressors, Oxford, New York, Pergamon Press, 1964.

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEE 210			T	P	C	E	I	Total
	NUMERICAL METHODS	3	0	0	3	70	30	100

Objective (s)	Student will understand 1. the non-linear set of equations in engineering practice 2. linear set of equations applied to engineering applications 3. the importance of working principles of numerical analysis and its applications in engineering 4. understand the various sets of equations used in engineering applications 5. familiarize the concept of various methods of interpolation and its importance in engineering 6. understand various techniques used for solving differential equations used in engineering applications
Outcome (s)	A student will be able to 1. apply different techniques in solving linear and non linear sets of equations 2. apply different methods of interpolation techniques 3. solve numerical differentiation by different methods concerned to engineering practice 4. apply different techniques for numerical differentiation 5. identify various techniques of numerical methods applicable to engineering applications 6. apply different procedures to solve ordinary differential equations

1. LINEAR SETS OF EQUATIONS	**Total Hrs**	**9**
Gauss Elimination, LV Decomposition, Matrix Inversion, Scalar Tridiagonal Matrix, Thomas Algorithm, Gauss Seidel Method, Secant Method		
2. NON-LINEAR SETS OF EQUATIONS	**Total Hrs**	**9**
Solving nonlinear sets of equations Minimization of function, Newton's Method, Quasi-Newton Method, Steepest Descent Method, Eigen Values & Vectors.		
3. INTERPOLATION	**Total Hrs**	**9**
Interpolation & Polynomial Approximation Least Squares Method, Lagrange Interpolation, Hermite Interpolation, Cubic Spline Interpolation, Chebeshev Polynomials & Series		
4. NUMERICAL DIFFERENTIATION	**Total Hrs**	**9**
Numerical Differentiation & Integration Numerical Differentiation, Richardson's Extrapolation, Definite & Indefinite Integrals, Simpson's Rule, Trapezoid Rule, Gaussian Quadrature		
5. ORDINARY DIFFERNENTIAL EQUATIONS	**Total Hrs**	**9**
First and Higher Order Taylor Series, First order Runge-kutta Method, Fourth order Runge-kutta Method, Stiff Equations, Errors, Convergence Criteria		
	Total hours to be taught	**45**

Text book (s)

1. Cheney E. Ward, Kincaid D.R., Numerical Methods and Applications, 2008, Cengage Learning
2. Gerald C.F., Wheatley P.O., Applied Numerical Analysis, 7th Ed, Pearson Education

References:

1. Burden R.L., Faires J.D., Numerical Analysis: Theory and Applications, 2005, Cengage Learning
2. Chapra S.C., Canale R.P., Numerical Methods for Engineers, 4th Ed,Tata McGraw Hill
3. Mathews J.H., Fink K.D., Numerical Methods using MA TLAB, 4th Ed, Pearson Education
4. Press W.H., Taukolsky S.A., Vetterling W.T., Flannery B.P., Numerical Recipes in C++, 2nd Ed, Cambridge University Press

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CBIT	Autonomous Regulation							
Department	Mechanical Engineering			Programme Code & Name		M.E. Thermal Engineering		
Semester-I								
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
16MEC 2062	**THERMAL SYSTEMS LABORATORY (Lab-1)**	0	0	3	2		50	50
Objective(s)	1. To evaluate the performance of computerized I.C Engine 2. To determine heat transfer coefficient in two phase heat transfer 3. To determine effectiveness of cross flow heat exchanger 4. To evaluate the performance of heat pipe 5. To evaluate the thermal properties of fluids 6. To conduct performance test on solar collectors							
Outcome(s)	A student will be able to 1. estimate the thermal efficiency of IC engine 2. prove that value of convection heat transfer coefficient is very high with two phase heat transfer 3. estimate the effectiveness of cross flow heat exchanger and prove that it is very high compared with other configurations 4. calculate heat of condensation and vaporization pipe 5. estimate the efficiency of solar collector 6. find out properties of fluids such as coefficient of thermal expansion, enthalpy of fusion							

List of Experiments:

1. Performance Evaluation on single cylinder 4-stroke SI Engine with alternate fuels with computer interfacing.
2. Performance Evaluation on single cylinder 4 stroke CI Engine with alternate fuels with computer interfacing
3. Determination of heat transfer coefficient in Film wise and Drop wise condensation
4. Cross flow Heat Exchanger.
5. Heat Pipe Demonstration
6. Performance text on Axial flow compressor
7. Performance test on solar collector
8. Determination of coefficient of thermal expansion of Solids, Liquids and Gases
9. Determination of thermal capacity of Solids
10. Determination of isentropic coefficient of air by Clement-Desormes method
11. Measure of enthalpy of fusion and solidification
12. Measurement of Temperature Distribution in the interior and external Surface of an electric water heater with thermometers and thermo-camera

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With effect from the academic year 2016- 2017

Scheme of Instruction & Examination
M.E. (THERMAL ENGINEERING) – 4 Semesters (Full Time)

Semester - I

Sl. No	Subject	No. of Hrs. per week		Duration (Hrs)	Marks for		Total Marks	Credits
		Lecture	T/P/S		Internal Assessment	End Exam		
1.	Core	3	1	4	30	70	100	4
2.	Core	3	1	4	30	70	100	4
3.	Core	3	1	4	30	70	100	4
4.	Elective-1	3	--	3	30	70	100	3
5.	Elective-2	3	--	3	30	70	100	3
6.	Elective-3	3	--	3	30	70	100	3
7.	Laboratory - I	--	3	3	50	--	50	2
8.	Seminar - I	--	3	3	50	--	50	2
9.	Soft Skills	--	--	--	--	--	--	--
	Total	18	09		340	360	700	25

Semester - II

Sl. No	Subject	No. of Hrs. per week		Duration (Hrs)	Marks for		Total Marks	Credits
		Lecture	T/P/S		Internal Assessment	End Exam		
1.	Core-4	3	1		30	70	100	4
2.	Core-5	3	1		30	70	100	4
3.	Core-6	3	1		30	70	100	4
4.	Elective-4	3	--		30	70	100	3
5.	Elective-5	3	--		30	70	100	3
6.	Elective-6	3	--		30	70	100	3
7.	Laboratory - II	--	3		50	--	50	2
8.	Seminar - II	--	3		50	--	50	2
9.	Mini Project	--	2		50	--	50	1
	Total	18	11		390	360	750	26

Semester - III

Sl. No	Subject	Marks for		Total Marks	Credits
		Internal Assessment	End Exam		
1	Project Seminar* (i) Problem formulation and submission of synopsis within 8 weeks from the commencement of 3rd Semester. (50 Marks) (ii) Preliminary work on Project implementation. (50 Marks)	100	--	100	6
	Total	100		100	6

Semester - IV

Sl. No	Subject	Marks for		Total Marks	Credits
		Internal Assessment	End Exam		
1	Project Work	100	100	200	12

Note : Six core subjects, Six elective subjects, Two Laboratory Courses and Two Seminars, Mini Project and Soft Skills should normally be completed by the end of semester II.

* Project seminar presentation on the topic of Dissertation only, 50 marks awarded by the project guide and
50 marks by the internal committee

Credit requirements for the award of degree, lower limit and upper limit of credits for registration by a student in a semester Credit Requirement for the award of M.E/M. Tech. Degree is 69

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEC 105	**FINITE ELEMENT TECHNIQUES**	L	T	P	C	E	I	Total
		3	1	0	4	70	30	100
Objective (s)	1. Identify mathematical model for solution of common engineering problems 2. Enable the students to formulate the design problems into FEA 3. Enable the students to perform engineering simulations using Finite Element Analysis software							
Outcome (s)	Students are able to 1. implement finite element formulations to axial and quadratic elements and solve problems with hand calculations numerically 2. formulate numerically the truss, beam and frame elements and solve for deflection, strains and stresses 3. formulate numerically the plane and axisymmetric triangular elements and quadrilateral elements then solve for deflections, strains and stresses in structural mechanics problems 4. apply FE formulations to heat transfer of 1D and 2D elements and solve for temperature and heat flux in slabs, walls and plates 5. apply FE formulations to dynamic analysis of 1D and 2D elements and solve for eigen values and eigen vectors in bars and beams 6. apply FE formulations to 3D solids, plates and for non linear problems							

1. FIELD PROBLMES AND MODELING	**Total Hrs**	**10**
Introduction to Finite Element Method of solving field problems. Stress and Equilibrium. Boundary conditions. Strain-Displacement relations. Stress-strain relations. One Dimensional Problem: Finite element modeling. Local, natural and global coordinates and shape functions. Potential Energy approach: Assembly of Global stiffness matrix and load vector. Finite element equations, treatment of boundary conditions. Quadratic shape functions		
2. ANALYSIS OF TRUSSES AND FRAMES	**Total Hrs**	**10**
Analysis of plane truss with number of unknowns not exceeding two at each node. Analysis of Beams: Element stiffness matrix for two noded, two degrees of freedom per node for beam element. Analysis of frames with two translations and a rotational degree of freedom at each node		
3. TWO DIMENSIONAL STRESS ANALYSIS	**Total Hrs**	**10**
Finite element modeling of two dimensional stress analysis problems with constant strain triangles treatment of boundary conditions. Two dimensional four noded isoparametric elements treatment of boundary conditions. Two dimensional four noded isoparametric elements and numerical integration. Finite element modeling of Axisymmentric solids subjected of axisymmetric loading with triangular elements. Convergence requirements and geometric isotropy		
4. HEAT TRANSFER PROBLEMS AND DYNAMIC ANALYSIS	**Total Hrs**	**10**
Steady state heat transfer analysis: One dimensional analysis of a fin and two dimensional, conduction analysis of thin plate, Time dependent field problems: Application to one dimensional heat flow in a rod. Dynamic analysis: Formulation of finite element modeling of Eigen value problem for a stepped bar and beam. Evaluation of Eigen values and Eigen vectors, Analysis of a uniform shaft subjected to torsion using Finite Element Analysis.		
5. THREE DIMENSIONAL PROBLEMS IN SRESS ANALYSIS	**Total Hrs**	**10**
Finite element formulation of three dimensional problems in stress analysis, Bending of elastic plates: Thin and Thick plate formulations, Introduction to non-linear problems and Finite Element analysis software's		
Total hours to be taught		

Text book (s)

1. Tirupathi R Chandrupatla and Ashok.D. Belegundu, Introduction of Finite Element in Engineering. Prentice Hall of India, 2004
2. Rao S.S.,The Finite Element Methods in Engineering, 2nd Edn Pergamon Press, 2001.
3. David.V.Hutton, " Fundamentals of Finite Element Analysis", Tata McGraw Hill,2003

References:

1. Robert Cook , "Concepts and applications of finite element analysis", 4e, John Wiley and sons,2009
2. Reddy J.N., An Introduction to Finite Element Methods ,Mc Graw Hill Company, 1984
3. K..J Bathe, Finite element procedures, 2nd Edn,Prentice Hall of India,2007
4. Logan, D. L. (2011). First course in finite element method, (5th Ed.). Mason, OH: SouthWestern, Cengage Learning.

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEC 201	**FLUID FLOWS & GAS DYNAMICS**	L	T	P	C	E	I	Total
		3	1	0	4	70	30	100

Objective (s)	Student will 1. understand different types of fluid flows and various functions related to fluids 2. learn important equations related to fluids 3. understand the concept of boundary layer 4. learn the concept of steady flow energy equation 5. understand the isentropic behavior of gas in nozzles 6. learn about shocks of fluids
Outcome (s)	Student will be able to 1. understand the concept of stream and velocity potential function 2. apply of the knowledge of equations for analysis in CFD 3. calculate thickness of boundary layer and shear stress 4. apply SFEE for various types of turbomachines 5. design nozzles and diffusers 6. estimate various parameters in fluids subjected to shocks

1. FLUID FLOWS	**Total Hrs**	**9**
Fluid flow: Classification of fluids. Lagrangian and Eularian Methods of Study of fluid flow. Velocity and acceleration vectors. Circulation and Vorticity. Stream lines. Stream tube. Path lines. Streak lines and Time lines. Stream function and Potential function		
2. LAW OF FLUID FLOWS	**Total Hrs**	**9**
Basic laws of fluid flow – Continuity. Euler's and Bernoulli's equations. Incompressible and Compressible flows. Potential and viscous flows. Navier – Stoke's equation and applications		
3. CONCEPT OF BOUNDARY LAYER	**Total Hrs**	**9**
Flow over an aerofoil – Lift and Drag coefficients. Boundary layer theory – laminar and turbulent boundary layers. Hydrodynamic and thermal boundary layer equations. Flow separation in boundary layers		
4. FUNDAMENTALS OF GAS DYNAMICS	**Total Hrs**	**9**
Gas dynamics: Energy equation for flow and non flow processes. Application of Steady flow energy equation for turbines, turbo-compressors, nozzles and diffusers. Adiabatic energy equation. Acoustic velocity, Mach Number. Stagnation properties. Relationships between static and stagnation properties. Various regimes of flow – Steady flow ellipse		
5. PRINCIPLES OF GAS DYNAMICS APPLICABLE TO SHOCKS	**Total Hrs**	**9**
Isentropic flow through variable area passages. Design of supersonic and subsonic nozzles and diffusers. Super sonic flows. Expansion and Shock waves. Normal and Oblique Shock waves. Prandtl-Meyer and Rankine-Hugoniot Relations. Simple problems on normal and oblique shock waves.		
Total hours to be taught		

Text book (s)

1. C P Kothandaraman, R Rudramoorthy, Basic Fluid Mechanics, New Age Intl. Publishers, 2014
2. S.M. Yahya, Fundamentals of Compressible flow, Wiley Eastern Ltd,2014
3. S. Radhakrishnan, "Fundamentals of Compressible flow," TMH,,2014

References:

1. Shapiro, Compressible fluid flow. Ronold Press, New York, 1956
2. Liepmen & Rosko, Elements of Gas Dynamics, Wiley, New York, 1956.
3. Zoeb Hussain, Gas Dynamics Though Problem

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CBIT	Autonomous Regulation							
Department	Mechanical Engineering			Programme Code & Name		M.E. Thermal Engineering		
Semester-I								
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
16MEC 205	**COMPUTATIONAL FLUID DYNAMICS**	3	1	0	4	70	30	100

Objective (s)	1. To understand the basic equations and concept of CFD. 2. To make the students to learn concept of PDEs and finite difference methods. 3. To study various types of grid generation and errors in numerical solution. 4. To learn the Crank-Nihcolson, Implicit and Explicit methods 5. To prepare the students with Jacobi, Gauss Seidel and ADI methods 6. To enkindle the students importance of FVM
Outcome (s)	Students will be able to 1. derive CFD governing equations and turbulence models. 2. apply elliptical, parabolic and hyperbolic PDEs and forward, backward and center difference methods . 3. understand errors, stability, consistency and develop O,H and C grid generated models. 4. evaluate the use of Crank-Nihcolson, Implicit and Explicit methods. 5. analyze problem by Jacobi, Gauss Seidel and ADI methods. 6. solve conduction and convection problems using FVM

1	**BASIC EQUATIONS IN FLUID DYNAMICS**	**Total Hrs**	**9**
Continuity, Momentum and Energy equations, Navier Stokes equations, Reynolds and Favre averaged N – S equations. Introduction to turbulence, Turbulence models-mixing length model, K-ε turbulence Model.			
2	**CLASSIFICATION OF PDEs**	**Total Hrs**	**9**
Elliptic, parabolic and hyperbolic equations, Initial and boundary conditions. Concepts of Finite difference methods – forward, backward and central difference.			
3	**GRID GENERATION**	**Total Hrs**	**9**
Grid Generation- Types of grid O,H,C. Coordinate transformation, Unstructured grid generation, Errors, Consistency, Stability analysis by von Neumann. Convergence criteria.			
4	**FINITE DIFFERENCE SOLUTIONS**	**Total Hrs**	**9**
Finite difference solutions-Parabolic PDEs – Euler, Crank Nicholson, Implicit methods, Elliptic PDEs – Jacobi, Gauss Seidel, ADI, methods. FD- solution for Viscous incompressible flow using Stream function – Vorticity method & MAC method			
5	**FINITE VOLUME METHOD**	**Total Hrs**	**9**
Introduction to Finite volume method. Finite volume formulations for diffusion equation, convection diffusion equation. Solution algorithm for pressure velocity coupling in steady flows. Use of Staggered grids SIMPLE Algorithm.			
		Total hours to be taught	**45**

Text book (s)

1	John D Anderson, 'Computational Fluid Dynamics', Mc Graw Hill, Inc., 2015.
2	H.K.Versteeg - 2015, Malala Shekara, Introduction to " Finite Volume Method" Pearson
3	Muralidhar K, Sundararajan T, 'Computational Fluid flow and Heat transfer', Narosa Publishing House, 2003
4	Patankar, S.V, 'Numerical Heat transfer and Fluid flow', Hemisphere Publishing Company, New York,1980

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEE105	**OPTIMIZATION TECHNIQUES**	L	T	P	C	E	I	Total
		3	1	0	4	70	30	100

Objective (s)	1. To Understand the need of the optimization methods. 2. To introduce the fundamental concepts of Optimization Techniques 3. To provide students with the modeling skills necessary to describe and formulate optimization problems 4. To make the learners aware of the importance of optimizations in real scenarios 5. To provide the concepts of various classical and modern methods of for constrained and unconstrained problems in both single and multivariable 6. Get a broad picture of the various applications of optimization methods used in engineering.
Outcome (s)	1. Formulate and solve Linear programming problem 2. Apply different techniques to solve Non Linear programming problem 3. Implement constrained optimization techniques 4. Analyze dynamic programming and integer programming problems 5. Develop schedule for projects and apply PERT/CPM techniques 6. Apply Queuing theory to real life situations

1. LINEAR AND TRASPORTATION PROBLEMS	**Total Hrs**	**9**
Statement of Optimization Problem, Linear Programming: Simplex Method, Revised Simplex Method, Sensitivity Analysis, Parametric Programming, and Transportation Problem		
2. NON-LINEAR PROBLEMS	**Total Hrs**	**9**
Nonlinear Programming: Approach, Convergence and Scaling of Design variables; Unconstrained Optimization Direct Search Methods: Random Search, Univariate, Simplex Method; Indirect Search Methods: Steepest Descent, Conjugate Gradient, Newton, Quasi Newton, DFP Methods;		
3. NON-LINEAR PROGRAMMING	**Total Hrs**	**9**
Constrained Optimization Direct Methods: Lagrange Multipliers, Kuhn-Tucker, conditions, Beal's method, Indirect Method: Penalty Function and Applications		
4. DYNAMIC PROGRAMMING	**Total Hrs**	**9**
Introduction to Dynamic Programming; Concept of Sub optimization and the principle of optimality; Linear and Continuous Dynamic Programming with Applications; Introduction to Integer Programming; Cutting Plane Method; Branch and Bound method; Introduction to Genetic Algorithms, particle swarm optimization		
5. PROJECT SCHEDULING	**Total Hrs**	**9**
Sequencing and Scheduling, Project Scheduling by PERT-CPM; Probability and cost consideration in Project scheduling; Queuing Theory, Single and multi server models; Queues with combined arrivals and departures; Queues with priorities for service		
Total hours to be taught	**Total Hrs**	**45**

Text book (s)

1. Rao,S.S. Engineering "Optimization Theory and Practice", New Age Int. Pub., 3rd Ed., 1996.
2. Haug,E.J.and Arora, J.S., "Applied Optimal Design", Wiley Inter Science Publication, NY, 1979.

Reference(s)

1. Douglas J. Wilde, "Globally Optimal Design", Jhon Wiley & Sons, New York, 1978
2. Johnson Ray C., "Optimum Design of Mechanical Elements", John Wiley & Sons, 1981.
3. S.D. Sharma, S.D. "Operations Research", Khanna Publications, 2001.
4. David Goldberg, "Genetic Algorithms", pearson publications, 2006.
5. Maurice cleric, "Particle Swarm Optimization", ISTE Publications, 2006
6. Prem Kumar Gupta, "Operations Research", S Chand publications, 2008

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CBIT	Autonomous Regulation						
Department	Mechanical Engineering	Programme Code & Name			M.E. (THERMAL ENGINEERING)		
Semester-I							
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks	
		L	T	P	C	End Exam	Internal Assessment	Total
16MEE 202	**TURBO MACHINES**	3	0	0	3	70	30	100

Objectives	1. To learn principles and equations of turbo machinery. 2. To know about velocity triangle and power developed by steam turbines. 3. To understand the working principles of Pelton, Francis and Kaplan turbines. 4. To familiarize the working principles of axial flow compressor 5. To understand the working principle of Centrifugal compressor and its performance 6. To learn the power required for Rotary compressors and power developed by Gas turbines
Outcomes	Students will be able to 1. apply gas dynamics equations depending upon applications. 2. estimate the power developed by steam turbines 3. calculate hydraulic efficiency of Impulse and Reaction turbines 4. find efficiency, pressure rise and degree of reaction of axial flow compressor 5. analyze the slip factor and performance of centrifugal compressor 6. understand cycles and improve the cycle efficiency in gas turbines

1	**FUNDAMENTALS OF TURBO MACHINES:**	**Total Hrs**	7
Classifications, Applications, Isentropic flow. Energy transfer. Efficiencies, Static and Stagnation conditions, Continuity equations, Euler's flow through variable cross sectional areas.			
2	**STEAM TURBINES:**	**Total Hrs**	9
Convergent and Convergent-Divergent nozzles, Energy Balance, Effect of back pressure, Design of nozzles. Steam Turbines: Impulse turbines, Work done and Velocity triangle, Efficiencies Compounding.			
3	**HYDRAULIC TURBINES:**	**Total Hrs**	9
Introduction, Classification of turbines, Impulse and reaction turbines, construction, working and performance of Pelton, Francis and Kaplan Turbines, Selection of turbines: specific speed, unit quantities			
4	**AXIAL FLOW COMPRESSORS AND CENTRIFUGAL COMRESSORS:**	**Total Hrs**	9
Work and velocity triangles, Efficiencies, Stage pressure rise, Degree of reaction, Performance of compressors Types; Velocity triangles and efficiencies; slip factor; performance of compressors			
5	**GAS TURBINES:**	**Total Hrs**	9
Principle of working – Classification – Joule's cycle – workdone and efficiency – Brayton Cycle – Optimum Pressure ratio for maximum power and maximum efficiency – P_{max} and η_{max} – Improvement in cycle performance – Intercooling, Reheating and Regeneration (Heat exchanging) – Problems using these principles			
		Total hours to be taught	43

Text book (s)

1. S.M. Yahya, Turbines, Compreessors and Fans, Fourth edition, Tata McGraw-Hill Education Pvt. Ltd., 2010
2. Gopalakrishnan G, Prithvi Raj D, "A treatise on Turbomachines", Scitec Publications, Chennai, 2002
3. Seppo. A. Korpela, Principles of Turbomachinery, John Wiley & sons Inc. Publications, 2011

Reference(s)

1. R.K.Turton, Principles of Turbomachinery, E & F N Spon Publishers, London & New York.
2. Dennis G. Shepherd, Principles of Turbomachines, Macmillan, 2007

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEE 207		L	T	P	C	E	I	Total
	FUELS & COMBUSTION	3	0	0	3	70	30	100

Objective (s)	To make student understand 1. conventional energy resources and different types of solid fuels available with their properties 2. various processing methods of solid fuels 3. the principles of refining liquid fuels and their properties, analysis and handling 4. various types of gaseous fuels and their properties, process and cleaning 5. the thermodynamics of combustion and stoichiometric relations. 6. features of different types of burners
Outcome (s)	A student will be able to 1. list different solid fuels for different applications 2. know the various methods of processing solid fuels 3. know the properties handling and storage of liquid fuels 4. understand the production of various methods of gaseous fuels and identify fuels for various applications 5. understand different methods of combustion and estimate the air fuel ratio, adiabatic flame temperature based on the fuel. 6. understand design considerations of burners

1.CONVENTIONAL AND NON-CONVENTIONAL ENERGY RESOURCES	**Total Hrs**	**9**
Introduction: General, Conventional energy resources, Solar energy, Nuclear power, Energy from biomass, Wind power, Tidal power, Geothermal energy, Energy survey for India, Rocket Fuels, Definitions, Units, Measures		
2. SOLID FUEL-COAL	**Total Hrs**	**9**
Solid Fuels: General, Biomass, Peat, Lignite or Brown Coal, Sub-bituminous Coal or Black Lignite, Bituminous Coal, Semi-anthracite, Anthracite, Cannel coal and Boghead coal, Natural coke (Jhama)/SLV fuel, Origin of coal, Composition of coal, Analysis and properties of coal, Action of heat on coal, Oxidation of coal, Hydrogenation of coal, Classification of coal. Processing of Solid Fuels: General Coal preparation, Storage of coal, Coal carbonization, Briquetting of solid fuels, Liquefaction of solid fuels		
3. LIQUID FUELS	**Total Hrs**	**9**
Liquid Fuels : General, Petroleum, Origin of Petroleum, Petroleum production, Composition of petroleum, Classification of petroleum, Nature of Indian crude's, Petroleum processing, Important petroleum products, Properties and testing of petroleum and petroleum products, Petroleum refining in India, Liquid fuels from sources other than petroleum, Gasification of liquid fuels, Storage and handling of liquid fuels.		
4. GASEOUS FUELS	**Total Hrs**	**9**
Gaseous fuels: General, Types of gaseous fuels, Natural gas, Methane from coal mines, Producer gas, Water gas, Carbureted water gas, Complete gasification of coal, Underground gasification of coal, Coal gas, Blast furnace gas, Gases from biomass, Refinery gases, Liquefied petroleum gases (LPG), Oil gasification, Cleaning and purification of gaseous fuels		
5. COMBUSTION PROCESS	**Total Hrs**	**9**
Combustion Process (Stoichiometry and Thermodynamics): Combustion Stoichiometry : General, Examples, Rapid methods of combustion stoichiometry. Combustion Thermodynamics : General Combustion Process (Kinetics): Nature of combustion process, Types of combustion processes, Mechanism of combustion reaction, Spontaneous Ignition Temperature (SIT), Velocity of flame propagation, Limits of inflammability, Structure of flame, Flame stability, Kinetics of liquid fuel combustion, Kinetics of solid fuel combustion. Combustion Applications: General, Gas burners, Oil burners, Coal burning equipment		
Total hours to be taught		**45**

Text book (s)

1. Loftness, R.L.," Energy hand book", New York, Van Nostrand 1998.
2. Wilson, P.J. and J.H. Wells, "Coal, Coke and Coal Chemicals", New York : McGraw-Hill, 1960

References:

1. "Gas Engineers Handbook", New York : Industrial Press, 1966.
2. Williams, D.A. and G. James, "Liquid Fuels", London Pergamon, 1963
3. Minkoff, G.J., and C.F.H. Tipper, "Chemistry of Combustion Reaction", London Butterworths, 1962.
4. Samir Sarkar, "Fuels & Combustion", Orient Long man 1996

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEE 203	**FLUID POWER SYSTEMS**	L	T	P	C	E	I	Total
		3	1	0	4	70	30	100

Objective (s)	Student will understand 1. behavior and properties of fluids 2. working principles of hydraulic pumps & motors 3. working principles of hydraulic control valves 4. working principles of various elements associated with hydraulic power 5. characteristics and applications of pneumatics 6. working and operating principles of pneumatic transmission lines
Outcome (s)	A student will be able to 1. understand various types of fluids along with properties used for different applications 2. select motor and pump depending on application 3. analyze the various types of hydraulic valves 4. calculate design nozzles and other elements used for hydraulic purposes such as in pneumatics 5. apply the principles of engineering for linear dynamics 6. Design feedback control of elements

1. HYDRAULIC FLUIDS	**Total Hrs**	**9**
Advantages and Disadvantages of Fluid control, Types of Hydraulic Fluids, physical, chemical and thermal properties of hydraulic fluids, selection of hydraulic fluid, fluid flow fundamentals		
2. HYDRAULIC PUMPS AND CONTROL VALVES	**Total Hrs**	**9**
Hydraulic Pumps and Motors: Basic Types and constructions, ideal pump and motor analysis, Performance curves and parameters, Hydraulic Control Valves- Valve configurations, general valve analysis, critical center, open center, three way spool valve analysis and Flapper valve analysis, pressure control valves, single and two stage pressure control valves, flow control valves, introduction to electro hydraulic valves		
3. HYDRAULIC POWER ELEMENTS	**Total Hrs**	**9**
Hydraulic Power Elements: Valve controlled motor, valve controlled piston, three way valve controlled piston, pump controlled motor, pressure transients in power elements		
4. PNEUMATICS	**Total Hrs**	**9**
Characteristics of Pneumatics, Applications of Pneumatics, Basic Pneumatic elements, Steady flow of Ideal gases, orifice and nozzle calculations, capillary flow, flow of real gases, linearised flow equations in Orifices and Nozzles. Steady state analysis of pneumatic components: Multiple restriction and volume calculations, sensing chambers, valves, Single acting actuators.		
5. TRANSIENTS IN ELEMENTARY PNEMATIC SYSTEMS	**Total Hrs**	**9**
Linear dynamics-linear pneumatic spring rate, linear dynamics of a variable volume of gas, Pneumatic transmission lines, linear dynamics in single acting actuators. Applications in industrial process controls: On-Off pneumatic feedback systems, feedback control of proportional gain, derivative action, integral action, Design of a Pneumatic Pressure Regulator		
	Total hours to be taught	**45**

Text book (s)

1. Herbert E. Merritt, "Hydraulic Control Systems", John Wiley & Sons, 1967.
2. W. Anderson, The Analysis and Design of Pneumatic Systems, Wiley, 1967.

References:

1. A.B. Goodwin, Fluid Power Systems, Macmillan, 1976.
2. Anthony Esposito, "Fluid power with applications", Prentice Hall, 7th Edition, 2002.
3. Arthur Akers, Max Gassman, Richard Smith, "Hydraulic Power System Analysis", Taylor and Francis Group, 2006
4. John Pippenger & Tyler Hicks, "Industrial Hydraulics", 3rd edition, McGraw Hill, 1980

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CBIT	Autonomous Regulation	Semester-I				A.Y 2016-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
16MEE 211	**ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL**	3	1	0	4	70	30	100

Objective (s)	Student will understand 1. different methods to control air pollution 2. the importance of harmful effects of different types of pollution levels and their effect on human beings and environment 3. different techniques adopted in solid waste management 4. causes and remedies for water pollution 5. other types of pollution like oils, pesticides, noise etc. 6. controlling methods adopted to reduce pollution from their power plants
Outcome (s)	A student will able to 1. Estimate pollution levels in various resources and suggest suitable remedial methods to control them 2. analyze air pollutants and suggest controlling methods 3. suggest a suitable solid waste disposal system 4. suggest suitable remedy to control water pollution 5. suggest suitable remedy to control other pollutants like oils, pesticides, noise etc. 6. Suggest a suitable instrumentation for pollution control

1	**AIR POLLUTION**	**Total Hrs**	**9**
Sources and Effect - Acid Rain - Air Sampling and Measurement - Analysis of Air Pollutants - Air Pollution Control Methods and Equipments - Issues in Air Pollution control.			
2	**SOLID WASTE MANAGEMENT**	**Total Hrs**	**9**
Sources and Classification - Characteristics of solid waste-Potential methods of solid waste Disposal – Process and Equipments for Energy Recovery from Municipal Solid Waste and Industrial Solid Waste			
3	**WATER POLLUTION**	**Total Hrs**	**9**
Sources and Classification of Water Pollutants - Characteristics - Waste Water Sampling Analysis - Waste Water Treatment - Monitoring compliance with Standards - Treatment, Utilization and Disposal of Sludge			
4	**OTHER TYPES OF POLLUTION**	**Total Hrs**	**9**
Noise Pollution and its impact - Oil Pollution - Pesticides - Radioactivity Pollution Prevention and Control			
5	**POLLUTION FROM THERMAL POWER PLANTS AND CONTROL METHODS:**	**Total Hrs**	**9**
Instrumentation for pollution control - Water Pollution from Tanneries and other Industries and their control			
		Total hours to be taught	**45**

Text book (s)

1. G.Masters" Introduction to Environmental Engineering and Science, Prentice -Hall 1998 International Editions.
2. S.Peavy, D.R..Rowe, G.Tchobanoglous "Environmental Engineering" - McGraw- Hill Book Company,NewYork.1985.

References

1. H.Ludwig, W.Evans :" Manual of Environmental Technology in Developing Countries, 1991
2. Environmental Considerations in Energy Development, Asian Development Bank (ADB), Manilla 1991

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CBIT	Autonomous Regulation						
Department	Mechanical Engineering	Programme Code & Name			M.E. Thermal Engineering		
Semester-I							
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
16MEE 212	**REFRIGERATION MACHINERY & COMPONENTS**	3	0	0	3	70	30	100
Objective (s)	Student will understand 1. different types compressors and their working 2. the importance of design of condensors 3. different types of evaporators 4. different types Refrigerant driers strainers, Receivers, Accumulators 5. other types of pollution like oils, pesticides, noise etc. 6. System Accessories and Controls							
Outcome (s)	A student will able to 1. estimate energy efficiency aspects of Hermetic compressors 2. analyze heat transfer coefficient, Fouling factor, Friction factor 3. design of evaporators 4. evaluate different types Refrigerant driers strainers, Receivers, Accumulators, Low pressure receivers 5. deal with refrigerant pumps, cooling tower fans, 6. teat air conditioners, refrigerators, visicoolers, cold rooms,							

1	**REFRIGERANT COMPRESSORS**	**Total Hrs**	**9**
Hermetic compressors - Reciprocating, Rotary, Scroll Compressors, Open type compressors- Reciprocating, Centrifugal, Screw Compressors. Semi hermetic compressors – Construction , working and Energy Efficiency aspects. Applications of each type.			
2	**DESIGN OF CONDENSERS**	**Total Hrs**	**9**
Estimation of heat transfer coefficient, Fouling factor, Friction factor. Design procedures, Wilson plots, Designing different types of condensers, BIS Standards, Optimization studies.			
3	**DESIGN OF EVAPORATORS**	**Total Hrs**	**9**
: Different types of evaporators, Design procedure, Selection procedure, Thermal Stress calculations, matching of components, Design of evaporative condensers.			
4	**REFRIGERATION SYSTEM COMPONENTS**	**Total Hrs**	**9**
Evaporators and condensers - Different types, capacity control, circuitry, Oil return, Oil separators - Different types Refrigerant driers strainers, Receivers, Accumulators, Low pressure receivers, Air Washers, Spray ponds.			
5	**SYSTEM ACCESSORIES AND CONTROLS**	**Total Hrs**	**9**
Refrigerant Pumps, Cooling Tower fans, Compressor Motor protection devices, Oil equalizing in multiple evaporators, Different Defrosting and capacity control methods and their implications -Testing of Air conditioners, Refrigerators, Visicoolers, Cold rooms, Calorimetric tests.			
		Total hours to be taught	45

Text book (s)	
1	Chlumsky, "Reciprocating & Rotary compressors", SNTL Publishers for Technical literature, 1965.
2	Hains, J.B, "Automatic Control of Heating & Air conditioning" Mc Graw Hill, 1981.
Reference(s)	
1	Althose, A.D. & Turnquist, C.H. "Modern Refrigeration and Air-conditioning" Good Heart -Wilcox Co. Inc., 1985.
2	Recent release of BIS Code for relevant testing practice.
3	ASHRAE Hand book: Equipments, 1998
4	Cooper &Williams, B. "Commercial, Industrial, Institutional Refrigeration, Design, Installation and Trouble Shooting " Eagle Wood Cliffs (NT) Prentice Hall, 1989.

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEE 213	**ENERGY MANAGEMENT**	L	T	P	C	E	I	Total
		3	0	0	3	70	30	100

Objective (s)	1. To create awareness of the importance of the energy auditing and determination of 2. evaluation methods of engineering projects 3. To understand the principles of energy management for various types of industries 4. To understand the need and necessity of energy auditing and estimate the budget for industry 5. To understand the importance of renewable energies in the scenario of depletion of conventional energy resources
Outcome (s)	A student will be able to 1. grasp the importance of energy auditing 2. estimate the requirement of any proposed industry 3. evaluate the projects and he can act as energy consultant 4. realize the importance of alternative energy techniques in the context of depletion of conventional energy resources 5. evaluation of projects : payback – annualised costs – investor's rate of return – present worth – internal rate of return 6. know importance of alternative energy sources

1. PRINCIPLES OF ENERGY MANAGEMENT	**Total Hrs**	**9**
Managerial Organization – Functional Areas for i. Manufacturing Industry ii. Process Industry iii. Commerce iv. Government. Role of Energy. Manager in each of these organizations initiating.		
2. ENERGY AUDITING	**Total Hrs**	**9**
Energy Audit: Definition and Concepts, Types of Energy Audits – Basic Energy Concepts – Resources for Plant Energy Studies – Data Gathering – Analytical Techniques Energy Conservation: Technologies for Energy Conservation , Design for Conservation of Energy materials – energy flow networks – critical assessment of energy usage– formulation of objectives and constraints – synthesis of alternative options and technical analysis of options – process integration.		
3. ECONOMIC ANALYSIS	**Total Hrs**	**9**
Economic Analysis: Scope, Characterization of an Investment Project – Types of Deprecication – Time Value of money – budget considerations, Risk Analysis		
4. METHODS OF EVALUATION OF PROJECTS	**Total Hrs**	**9**
Methods of Evaluation of Projects : Payback – Annualised Costs – Investor's Rate of return – Present worth – Internal Rate of Return – Pros and Cons of the common methods of analysis – replacement analysis. Energy Consultant: Need of Energy Consultant – Consultant Selection Criteria.		
5. ALTERNATIVE ENERGY SOURCES	**Total Hrs**	**9**
Alternative Energy Sources : Solar Energy – Types of devices for Solar Energy Collection – Thermal Storage System – Control Systems-Wind Energy – Availability – Wind Devices – Wind Characteristics – Performance of Turbines and systems		
Total hours to be taught		**45**

Text book (s)

1. W.C. Turner "Energy Management Hand book" 5th edition, the Fair Mount Press
2. R.Murphy and G.Mc Kay "Energy Management", Butterworth Publications

References:

1. C.B.Smith "Energy Management Principles" Pergamon Press
2. Stephen W.Fardo, Dile, R.Patric, "Energy conservation Guide Book" Fair Mount Press
3. Frank Krieth, D.Yogi Goswamy "Energy management & conservation hand book" CRC Press 2008

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEE 214	**CONVECTIVE HEAT TRANSFER**	L	T	P	C	E	I	Total
		3	0	0	3	70	30	100

objective (s)	1. to create the awareness of the importance of principles of heat transfer by convection and its applications in engineering along with solution 2. to understand the principles, different types of convection heat transfer and their equations to apply for various engineering applications 3. to familiarize the concept of forced convection and its behavior pipes 4. to understand the principles of conjugate heat transfer and its applications in engineering heat transfer
outcome (s)	a student will be able to 1. select the mode of convection heat transfer rate and calculate heat transfer rate depending on the application 2. use this theory in advanced subjects like cfd and various software packages 3. calculate the heat transfer rate in conjugative system like porous media, 4. calculate the rate of heat transfer with the combination of conduction and convection in applications like heat exchangers 5. evaluate forced and free convection 6. analyse flow through the porous media

1. NTRODUCTION TO CONVECTIVE HEAT TRANSFER	**Total Hrs**	**9**
Forced, free & combined convection – convective heat transfer coefficient – Application of dimensional analysis to convection – Physical interpretation of dimensionless numbers. Equations of Convective Heat Transfer: Continuity, Navier-Strokes equation & energy equation for steady state flows – similarity – Equations for turbulent convective heat transfer – Boundary layer equations for laminar, turbulent flows – Boundary layer integral equations		
2. FORCED CONVECTION	**Total Hrs**	**9**
External Laminar Forced Convection: Similarity solution for flow over an isothermal plate – integral equation solutions – Numerical solutions – Viscous dissipation effects on flow over a flat plate. External Turbulent Flows: Analogy solutions for boundary layer flows – Integral equation solutions – Effects of dissipation on flow over a flat plate. Internal Laminar Flows: Fully developed laminar flow in pipe, plane duct & ducts with other cross-sectional shapes – Pipe flow & plane duct flow with developing temperature field – Pipe flows & plane duct flow with developing velocity & temperature fields. Internal Turbulent Flows: Analogy solutions for fully developed pipe flow –Thermally developing pipe & plane duct flow.		
3. NATURAL CONVECTION	**Total Hrs**	**9**
Boussineq approximation – Governing equations – Similarity – Boundary layer equations for free convective laminar flows – Numerical solution of boundary layer equations. Free Convective flows through a vertical channel across a rectangular enclosure – Horizontal enclosure – Turbulent natural convection		
4. COMBINED CONVECTION	**Total Hrs**	**9**
Governing parameters & equations – laminar boundary layer flow over an isothermal vertical plate – combined convection over a horizontal plate – correlations for mixed convection – effect of boundary forces on turbulent flows – internal flows - internal mixed convective flows – Fully developed mixed convective flow in a vertical plane channel & in a horizontal duct		
5. HEAT TRANSFER THROUGH POROUS MEDIA	**Total Hrs**	**9**
Area weighted velocity – Darcy flow model – energy equation – boundary layer solutions for 2-D forced convection – Fully developed duct flow – Natural convection in porous media – filled enclosures – stability of horizontal porous layers		
	Total hours to be taught	**45**

Text book (s)

1. Patrick H. Oosthuigen & David Naylor "Introduction to Convective Heat Transfer Analysis" (TMH)
2. Kays & Crawford "Convective Heat & Mass Transfer" TMH, 2000

References:

1. Oosthigen, "Convective Heat and Mass Transfer" McGrawhill, 1998
2. Adrian Bejan "Convection Heat Transfer", 2nd Edition John Wiley,1984

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CBIT	Autonomous Regulation	Semester-1				AY - 2006-17		
Department	Mechanical Engineering	Programme Code & Name				M.E. CAD/CAM		
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
16MEC 207	**COMPUTATIONAL FLUID DEYNAMCS LABORATORY (Lab-II)**	L	T	P	C	E	I	Total
		0	0	3	2		50	50

Objective(s)

Student to understand the

1. Concept of fluid mechanics
2. Basic steps in a CFD simulation: ANSYS Workbench design modular and meshing
3. Simulation of steady and unsteady problems
4. Physics setup involves boundary conditions
5. Solution of Thermal related problems
6. Post processor of workbench tool for various problems

Outcome(s):

A student will be to

1. analyze laminar flow problems in plates and pipes
2. solve steady and unsteady flows
3. perform analysis free and forced convection
4. evaluate thermal flow in hot and cold fluid
5. simulate NACA aerofoil blades
6. analyze problems related to combustion

The following simulations will be performed using ANSYS workbench tools

List of Experiments:

1. Laminar Flow over Flat plate
2. Laminar Pipe Flow.
3. Steady Flow past a Cylinder
4. Unsteady Flow past a Cylinder
5. Two Dimensional Steady Free Convection
6. Forced Convection for pipe cross section.
7. Study of Hot & Cold Fluid Mix
8. Flow analysis of Airfoil.
9. Compressible Flow in a Nozzle
10. Partially Premixed Combustion
11. Supersonic Flow Over Wedge
12. Bifurcating Artery

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With effect from the academic year 2016- 2017

Scheme of Instruction & Examination
M.E. (THERMAL ENGINEERING) – 4 Semesters (Full Time)

Semester - I

Sl. No	Subject	No. of Hrs. per week		Duration (Hrs)	Marks for		Total Marks	Credits
		Lecture	T/P/S		Internal Assessment	End Exam		
1.	Core	3	1	4	30	70	100	4
2.	Core	3	1	4	30	70	100	4
3.	Core	3	1	4	30	70	100	4
4.	Elective-1	3	--	3	30	70	100	3
5.	Elective-2	3	--	3	30	70	100	3
6.	Elective-3	3	--	3	30	70	100	3
7.	Laboratory - I	--	3	3	50	--	50	2
8.	Seminar - I	--	3	3	50	--	50	2
9.	Soft Skills	--	--	--	--	--	--	--
	Total	**18**	**09**		**340**	**360**	**700**	**25**

Semester - II

Sl. No	Subject	No. of Hrs. per week		Duration (Hrs)	Marks for		Total Marks	Credits
		Lecture	T/P/S		Internal Assessment	End Exam		
1.	Core-4	3	1		30	70	100	4
2.	Core-5	3	1		30	70	100	4
3.	Core-6	3	1		30	70	100	4
4.	Elective-4	3	--		30	70	100	3
5.	Elective-5	3	--		30	70	100	3
6.	Elective-6	3	--		30	70	100	3
7.	Laboratory - II	--	3		50	--	50	2
8.	Seminar - II	--	3		50	--	50	2
9.	Mini Project	--	2		50	--	50	1
	Total	**18**	**11**		**390**	**360**	**750**	**26**

Semester - III

Sl. No	Subject	Marks for		Total Marks	Credits
		Internal Assessment	End Exam		
1	Project Seminar* (i) Problem formulation and submission of synopsis within 8 weeks from the commencement of 3rd Semester. (50 Marks) (ii) Preliminary work on Project implementation. (50 Marks)	100	--	100	6
	Total	100		100	6

Semester - IV

Sl. No	Subject	Marks for		Total Marks	Credits
		Internal Assessment	End Exam		
1	Project Work	100	100	200	12

Note : Six core subjects, Six elective subjects, Two Laboratory Courses and Two Seminars, Mini Project and Soft Skills should normally be completed by the end of semester II.

* Project seminar presentation on the topic of Dissertation only, 50 marks awarded by the project guide and
50 marks by the internal committee

Credit requirements for the award of degree, lower limit and upper limit of credits for registration by a student in a semester Credit Requirement for the award of M.E/M. Tech. Degree is 69

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With effect from the academic year 2016- 2017

16MEC210

MINIPROJECT GUIDELINES

Instruction	2 Hrs / week
Sessional	50 Marks
Credits	01

Objectives:

First year ME students will each do a 14-week mini project, each generally comprising about one week of prior reading, twelve weeks of active research, and finally a presentation of their work for assessment (see assessment information below). Each student will be allotted to a Faculty supervisor for mentoring.

Mini projects should present students with an accessible challenge on which to demonstrate competence in research techniques, plus the opportunity to contribute something more original. Mini projects should have inter disciplinary/ industry relevance. The students can select a mathematical modeling based/Experimental investigations or Numerical modeling. All the investigations are clearly stated and documented with the reasons/explanations. All the projects should contain A clear statement of the research objectives, background of work, Literature review, techniques used, prospective deliverables, benefit from this [line of] research, Detailed discussion on results, Conclusions and references.

Outcomes:

Students are able to
1. Formulate a specific problem and give solution
2. Develop model/models either theoretical/practical/numerical form
3. Solve, interpret/correlate the results and discussions
4. Conclude the results obtained and write the documentation in standard format

Assessment:

1. 50 % of marks for a scientific report on the project.
   Regarding the formatting and structure, the report should be written as a journal article using the style file of a journal appropriate for the field of the research (which journal format is most appropriate should be agreed between student and supervisor). If the journal you selected has a page limit, it can be ignored but the report should not exceed 8000 words (common sense should be used if there are a lot of equations).

   Regarding content, the report should be understandable by your fellow students, so the introduction and literature review could be a bit more detailed than in a research paper. The results and discussions are in elaborate form and at end conclusions and include references.

2. 50 % of marks for an oral presentation which will take place at the end of the semester and evaluation by a committee consist of Supervisor, one senior faculty and Head of the department or his nominee.

PROFESSOR & HEAD
Department of Mechanical Engineering
Bharathi Institute of Technology (A)
Hyderabad-500 075. Telangana

With effect from the academic year 2016- 2017

Scheme of Instruction & Examination
M.E. (THERMAL ENGINEERING) – 4 Semesters (Full Time)

Semester - I

Sl. No	Subject	No. of Hrs. per week		Duration (Hrs)	Marks for		Total Marks	Credits
		Lecture	T/P/S		Internal Assessment	End Exam		
1.	Core	3	1	4	30	70	100	4
2.	Core	3	1	4	30	70	100	4
3.	Core	3	1	4	30	70	100	4
4.	Elective-1	3	--	3	30	70	100	3
5.	Elective-2	3	--	3	30	70	100	3
6.	Elective-3	3	--	3	30	70	100	3
7.	Laboratory - I	--	3	3	50	--	50	2
8.	Seminar - I	--	3	3	50	--	50	2
9.	Soft Skills	--	--	--	--	--	--	--
	Total	**18**	**09**		**340**	**360**	**700**	**25**

Semester - II

Sl. No	Subject	No. of Hrs. per week		Duration (Hrs)	Marks for		Total Marks	Credits
		Lecture	T/P/S		Internal Assessment	End Exam		
1.	Core-4	3	1		30	70	100	4
2.	Core-5	3	1		30	70	100	4
3.	Core-6	3	1		30	70	100	4
4.	Elective-4	3	--		30	70	100	3
5.	Elective-5	3	--		30	70	100	3
6.	Elective-6	3	--		30	70	100	3
7.	Laboratory - II	--	3		50	--	50	2
8.	Seminar - II	--	3		50	--	50	2
9.	Mini Project	--	2		50	--	50	1
	Total	**18**	**11**		**390**	**360**	**750**	**26**

Semester - III

Sl. No	Subject	Marks for		Total Marks	Credits
		Internal Assessment	End Exam		
1	Project Seminar* (i) Problem formulation and submission of synopsis within 8 weeks from the commencement of 3rd Semester. (50 Marks) (ii) Preliminary work on Project implementation. (50 Marks)	100	--	100	6
	Total	100		100	6

Semester - IV

Sl. No	Subject	Marks for		Total Marks	Credits
		Internal Assessment	End Exam		
1	Project Work	100	100	200	12

Note : Six core subjects, Six elective subjects, Two Laboratory Courses and Two Seminars, Mini Project and Soft Skills should normally be completed by the end of semester II.

* Project seminar presentation on the topic of Dissertation only, 50 marks awarded by the project guide and
50 marks by the internal committee

Credit requirements for the award of degree, lower limit and upper limit of credits for registration by a student in a semester Credit Requirement for the award of M.E/M. Tech. Degree is 69