

22MTC02

**CALCULUS  
(MECHANICAL)**

Instruction	3 L+1T Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

**COURSE OBJECTIVES:** This course aims to

1. To explain the solutions of system of linear equations by Matrix Methods.
2. To discuss mean value theorems.
3. To explain the Partial Derivatives and the extreme values of functions of two variables.
4. To explain the shape of curves, their areas and volumes of revolutions.
5. To discuss the convergence and divergence of the series.

**COURSE OUTCOMES:** After completion of this course, student will be able to

1. Apply the Matrix Methods to solve system of linear equations.
2. Analyse the geometrical interpretation of Mean value theorems and curvature.
3. Determine the extreme values of functions of two variables.
4. Find the shape of the curve, surface areas and volumes of revolution.
5. Examine the convergence and divergence of infinite Series.

**CO-PO ARTICULATION MATRIX**

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	3	-	-	-	-	-	-	-	2
CO 2	3	3	3	3	-	-	-	-	-	-	-	2
CO 3	3	3	3	3	-	-	-	-	-	-	-	2
CO 4	3	3	3	3	-	-	-	-	-	-	-	2
CO 5	3	3	3	1	-	-	-	-	-	-	-	1

**UNIT I**

**Matrices:** Rank of a matrix, Echelon form, consistency of linear system of equations. Linear dependence and independence of vectors. Eigen values, Eigenvectors, Properties of Eigen values and Eigen vectors, Cayley Hamilton theorem, Quadratic form, Reduction of quadratic form to canonical form by linear transformation, Nature of quadratic form.

**UNIT II**

**Calculus:** Rolle's Theorem, Lagrange's Mean value theorem, Cauchy's Mean value theorem (without proofs). Curvature, Radius of curvature, Centre of curvature, Evolute and Involute, Envelopes.

**UNIT III**

**Partial Differentiation and Its Applications:** Functions of two or more variables, Partial derivatives, Higher order partial derivatives, Total derivative, Differentiation of implicit functions, Jacobians, Taylor's expansion of functions of two variables, Maxima and minima of functions of two variables.

**UNIT IV**

**Applications of definite integrals:** Curve tracing of standard curves (Cartesian only), Applications of definite integrals to evaluate length of curves, surface areas and volumes of revolutions.



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**UNIT V**

**Sequences and Series:** Convergence of sequence and series. Tests for convergence of series: Comparison test, limit comparison test, D'Alembert's ratio test, Raabe's test, Cauchy's root test, Alternating series, Leibnitz's series, absolute and conditional convergence.

**TEXT BOOKS:**

1. B.S.Grewal, "Higher Engineering Mathematics", 44<sup>th</sup> Edition, Khanna Publishers, 2017.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 9<sup>th</sup> Edition, John Wiley & Sons, 2006.

**SUGGESTED READING:**

1. B.V.Ramana, "Higher Engineering Mathematics", 11<sup>th</sup> Reprint, Tata McGraw-Hill, New Delhi, 2010.
2. R.K.Jain, S.R.K.Iyengar, "Advanced Engineering Mathematics", 5<sup>th</sup> edition, Narosa Publications, 2016.
3. David.Poole, "Linear Algebra: A Modern Introduction", 2<sup>nd</sup> Edition, Brooks/ Cole, 2005.



**PROFESSOR & HEAD**  
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Gandipet, Hyderabad-500 075, Telangana

22CYC01

### CHEMISTRY (MECHANICAL)

Instruction  
Duration of SEE  
SEE  
CIE  
Credits

3P Hours per Week  
3 Hours  
60 Marks  
40 Marks  
3

**COURSE OBJECTIVES:** This course aims to

1. This syllabus helps at providing the concepts of chemical bonding and chemical kinetics to the students aspiring to become practicing engineers
2. Thermodynamic and Electrochemistry units give conceptual knowledge about processes and how they can be producing electrical energy and efficiency of systems.
3. To teach students the value of chemistry and to improve the research opportunities knowledge of stereochemistry and organic reactions is essential.
4. Water chemistry unit impart the knowledge and understand the role of chemistry in the daily life.
5. New materials lead to discovering of technologies in strategic areas for which an insight into Polymers, nanomaterials and basic drugs of modern chemistry is essential.

**COURSE OUTCOMES:** After completion of this course, student will be able to

1. Identify the microscopic chemistry in terms of molecular orbitals, intermolecular forces and rate of chemical reactions.
2. Discuss the properties and processes using thermodynamic functions, electrochemical cells and their role in batteries and fuel cells.
3. Illustrate the major chemical reactions that are used in the synthesis of organic molecules.
4. Classify the various methods used in treatment of water for domestic and industrial use.
5. Outline the synthesis of various Engineering materials & Drugs.

**CO-PO ARTICULATION MATRIX**

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	2	-	-	2	2	-	-	-	-	2
CO 2	3	2	2	-	-	2	2	-	-	-	-	2
CO 3	3	2	3	-	-	2	2	-	-	-	-	2
CO 4	3	2	3	-	-	2	2	-	-	-	-	2
CO 5	3	2	2	-	-	2	2	-	-	-	-	2

#### UNIT I

**Atomic and molecular structure and Chemical Kinetics:**

**Atomic and molecular structure:** Molecular Orbital theory - atomic and molecular orbitals. Linear combination of atomic orbitals (LCAO) method. Molecular orbitals of diatomic molecules. Molecular Orbital Energy level diagrams (MOED) of diatomic molecules & molecular ions ( $H_2$ ,  $He_2^+$ ,  $N_2$ ,  $O_2$ ,  $O_2^-$ ,  $CO$ ,  $NO$ ). Pi- molecular orbitals of benzene and its aromaticity.

**Chemical Kinetics:** Introduction, Terms involved in kinetics: rate of reaction, order & molecularity; First order reaction-Characteristics: units of first order rate constant & its half-life period, second order reaction-Characteristics: units of second order rate constant & its half-life period. Numericals.

#### UNIT II

**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, electrode potentials, and - Reference electrodes (NHE, SCE) electrochemical series. Nernst equation and its applications. Determination of pH using combined Glass & Calomel electrode. Potentiometric Acid base & Redox. Titrations, Numerical.

**Battery technology: Rechargeable batteries & Fuel cells:**

**Lithium batteries:** Introduction, construction, working and applications of  $Li-MnO_2$  and Li-ion batteries.

**Fuel Cells:** Introduction, difference between conventional cell and fuel cell, limitations & advantages. Construction, working & applications of methanol-oxygen fuel cell.

### UNIT III

**Stereochemistry and Organic reactions Stereochemistry:** Representations of 3 dimensional structures, Types of stereoisomerism-Conformational isomerism-confirmations of n-butane (Newman and sawhorse representations), Configurational isomerism -Geometrical (cis-trans) isomerism & Optical isomerism- optical activity, Symmetry and chirality: Enantiomers (lactic acid) & Diastereomers (Tartaric acid), Absolute configurations, Sequence rules for R&S notation.

**Types of Organic reactions:** Substitution Reactions- Electrophilic substitution (Nitration of Benzene); Nucleophilic Substitution ( $S_N1$  &  $S_N2$ ); Free Radical Substitution (Halogenation of Alkanes)

**Addition Reactions:** Electrophilic Addition - Markonikoff's rule, Free radical Addition - Anti Markonikoff's rule (Peroxide effect), Nucleophilic Addition - (Addition of HCN to carbonyl compounds) Eliminations-E1 and E2 (dehydrohalogenation of alkyl halides), Cyclization (Diels - Alder reaction)

### UNIT IV

**Water Chemistry:** Hardness of water - Types, units of hardness, Disadvantages of hard water, Alkalinity and Estimation of Alkalinity of water, Boiler troubles - scales & sludge formation, causes and effects, Softening of water by lime soda process (Cold lime soda process), ion exchange method and Reverse Osmosis. Specifications of potable water & industrial water. Disinfection of water by Chlorination; break point chlorination, BOD and COD definition, Estimation (only brief procedure) and significance, Numericals.

### UNIT V

**Engineering Materials and Drugs:** Introduction, Terms used in polymer science; Thermoplastic polymers (PVC) & Thermosetting polymers (Bakelite); Elastomers (Natural rubber). Conducting polymers- Definition, classification and applications.

**Polymers for Electronics:** Polymer resists for integrated circuit fabrication, lithography and photolithography Nano materials-Introduction to nano materials and general applications, basic chemical methods of preparation-Sol-gel method. Carbon nanotubes and their applications. Characterisation of nanomaterials by SEM and TEM (only Principle). 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, 16<sup>th</sup> edition (2015).
2. W.U. Malik, 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, 7<sup>th</sup> edition (2019).
4. A Textbook of Polymer Science and Technology, Shashi Chawla, Dhanpat Rai & Co. (2014)
5. T. Pradeep, Nano: The Essentials, Tata McGraw-Hill Education, Delhi, 2012
6. 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 & Company Ltd., 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, 8th edition (2006).



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22EEEC01

## BASIC ELECTRICAL ENGINEERING

Instruction  
Duration of SEE  
SEE  
CIE  
Credits

3 Hours per week  
3 Hours  
60 Marks  
40 Marks  
3

**COURSE OBJECTIVES:** This course aims to

1. To understand the behaviour of different circuit elements R, L & C, and the basic concepts of electrical AC circuit analysis
2. To comprehend the basic principle of operation of AC and DC machines
3. To infer about different types of electrical wires and cables, domestic and industrial wiring, safety rules and methods of earthing.

**COURSE OUTCOMES:** After completion of this course, student will be able to

1. Understand the concepts of Kirchhoff's laws and their application various theorems to get solution of simple dc circuits.
2. Predict the steady state response of RLC circuits with AC single phase/three phase supply.
3. Infer the basics of single phase transformer
4. Describe the construction, working principle of DC machine and 3-phase Induction motor.
5. Acquire the knowledge of electrical wires, cables, earthing, Electrical safety precautions to be followed in electrical installations and electric shock and its safety and energy calculations.

## CO-PO ARTICULATION MATRIX

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO-1	3	3	2	-	-	-	-	-	1	2	-	3
CO-2	3	3	2	-	-	-	-	-	1	2	-	3
CO-3	3	3	2	1	-	-	-	-	1	2	-	3
CO-4	2	1	-	-	-	-	-	-	1	2	-	3
CO-5	2	-	2	-	-	-	-	-	1	2	-	3

## UNIT I

DC Circuits: Electrical circuit elements (R, L and C), voltage and current sources, Kirchhoff current and voltage laws, analysis of simple circuits with dc excitation, Superposition, Thevenin's and Norton's Theorems.

## 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, series RL and RC. Three phase balanced circuits, voltage and current relations in star and delta connections.

## UNIT III

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

## UNIT IV

DC and AC Machines: DC Generators: Construction, Principle of operation, EMF equation, Classification, Characteristics of shunt generators. DC Motors: Classification, Torque Equation, Characteristics and Speed control of DC Shunt and Series Motors, Losses and efficiency Three - Phase Induction Motors: Principle of operation, Applications

**UNIT V**

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

22CSC01

**PROBLEM SOLVING AND PROGRAMMING**

Instruction  
Duration of SEE  
SEE  
CIE  
Credits

2L + 1T Hours per week  
3 Hours  
60 Marks  
40 Marks  
3

**COURSE OBJECTIVES:** This course aims to

1. Develop logical skills and basic technical skills so that students should be able to solve basic computational problems.
2. Learn any basic programming language.

**COURSE OUTCOMES:** After completion of this course, student will be able to

1. Understand real world problems and develop computer solutions for those problems.
2. Understand the basics of Python.
3. Apply Python for solving basic programming solutions.
4. Create algorithms/flowcharts for solving real-time problems.
5. Build and manage dictionaries to manage data.
6. Handle data using files.

**CO-PO ARTICULATION MATRIX**

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO-1	3	1	1	-	1	-	-	-	-	-	-	1
CO-2	3	1	1	-	1	-	-	-	-	-	-	1
CO-3	3	1	1	-	1	-	-	-	-	-	-	1
CO-4	3	1	1	-	1	-	-	-	-	-	-	1
CO-5	3	1	1	-	1	-	-	-	-	-	-	1
CO-6	3	1	1	-	1	-	-	-	-	-	-	1

**UNIT I**

**Introduction to Programming - Evolution of languages:** Machine, Assembly and High-level languages. *Software requirements for programming:* OS, compiler, linker, loader, editor. Design specification: Algorithms and Flowcharts.

**UNIT II**

**Data Types and Operators, Variable, Sequences and Iteration** - Data types, Expressions, Precedence Rules, Operators: arithmetic, relational, logical, bit-wise and miscellaneous operators; local variable, global variables, List, String, Tuples, Sequence mutation and accumulating patterns.

**UNIT III**

**Conditional Statement, Loops, Arrays and Strings, user-defined Data Types** - if, else, for, while, nested iteration, Concept and use of arrays, declaration and usage of arrays, 2-dimensional arrays, different types of user defined data types.

**UNIT IV**

**Dictionaries and Dictionary Accumulation, Functions/Methods** - Dictionary basics, operations, methods, accumulation, advantages of modularizing program into functions, function definition and function invocation. Positional parameters passing arrays to functions, recursion, library functions.

**UNIT V**

**File Handling and Memory Management** - Concepts of files and basic file operations, writing/reading data to/from a .csv file, Memory Management Operations.

**TEXT BOOKS AND REFERENCES:**

1. R.S. Salaria, "Programming for Problem Solving", First Edition, Khanna Book Publishing Co., Delhi.
2. Jeeva Jose, "Taming Python by Programming", Revised Edition, Khanna Book Publishing Co., Delhi.
3. Mark Lutz, "Learning Python", 5<sup>th</sup> Edition, O'Reilly Media, Inc.
4. Python Crash Course: A Hands-On, Project-Based Introduction to Programming by Eric Matthes, No Starch Press.
5. "Programming in Python", R.S. Salaria, Khanna Book Publishing Co., Delhi.

**NPTEL/SWAYAM COURSES:**

1. Introduction to Problem Solving and Programming, Video Lectures, Prof. D Gupta, IIT Delhi.
2. Problem Solving Aspects and Python Programming. Dr. S Malinga, Dr Thangarajan, Dr. S V Kogilavani, Kongu Engineering College.
3. <https://www.coursera.org/specializations/python-3-programming>





22CYC02

CHEMISTRY LAB  
(MECHANICAL)

Instruction  
Duration of SEE  
SEE  
CIE  
Credits:

3L Hours per Week  
3 Hours  
50 Marks  
50 Marks  
1.5

**COURSE OBJECTIVES:** This course aims to

1. To impart fundamental knowledge in handling the equipment / glassware and chemicals in chemistry laboratory.
2. To provide the knowledge in both qualitative and quantitative chemical analysis
3. The student should be conversant with the principles of volumetric analysis
4. To apply various instrumental methods to analyse the chemical compounds and to improve understanding of theoretical concepts.
5. To interpret the theoretical concepts in the preparation of new materials like drugs and polymers.

**COURSE OUTCOMES:** After completion of this course, student will be able to

1. Identify the basic chemical methods to analyse the substances quantitatively & qualitatively.
2. Estimate the amount of chemical substances by volumetric analysis.
3. Determine the rate constants of reactions from concentration of reactants/ products as a function of time.
4. Calculate the concentration and amount of various substances using instrumental techniques.
5. Develop the basic drug molecules and polymeric compounds.

CO-PO ARTICULATION MATRIX

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	2	-	-	2	2	-	-	-	-	2
CO 2	3	2	1	-	-	1	2	-	-	-	-	2
CO 3	3	2	3	-	-	2	2	-	-	-	-	2
CO 4	3	2	2	-	-	2	2	-	-	-	-	2
CO 5	3	2	3	-	-	2	2	-	-	-	-	2

## LIST OF EXPERIMENTS:

1. Introduction: Preparation of standard solution of oxalic acid and standardisation of NaOH.
2. Estimation of metal ions ( $\text{Co}^{+2}$  &  $\text{Ni}^{+2}$ ) by EDTA method.
3. Estimation of temporary and permanent hardness of water using EDTA solution
4. Determination of Alkalinity of water
5. Determination of rate constant for the reaction of hydrolysis of methyl acetate. (first order)
6. Determination of rate constant for the reaction between potassium per sulphate and potassium Iodide (second order)
7. Estimation of amount of HCl Conductometrically using NaOH solution.
8. Estimation of amount of HCl and  $\text{CH}_3\text{COOH}$  present in the given mixture of acids Conductometrically using NaOH solution.
9. Estimation of amount of HCl Potentiometrically using NaOH solution.
10. Estimation of amount of  $\text{Fe}^{+2}$  Potentiometrically using  $\text{KMnO}_4$  solution
11. Preparation of Nitrobenzene from Benzene.
12. Synthesis of Aspirin drug and Paracetamol drug.
13. Synthesis of phenol formaldehyde resin.

## TEXT BOOKS:

1. J. Mendham and Thomas, "Vogel's text book of quantitative chemical analysis", Pearson education Pvt.Ltd. New Delhi, 6<sup>th</sup> ed. 2002.
2. Senior practical physical chemistry by B.D.Khosla, V.C.Garg & A.Gulati; R. Chand & Co. New Delhi (2011).

## SUGGESTED READINGS:

Chaitanya Bharathi Institute of Technology (A)

*P. Reddy*  
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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.



22MBC02

## COMMUNITY ENGAGEMENT

Instruction  
SEE  
CIE  
Credits

3P Hours per week  
Nil  
50 Marks  
1.5

**COURSE OBJECTIVES:** This course aims to

1. Develop an appreciation of Rural culture, life-style and wisdom among the Students.
2. Learn about the various livelihood activities that contribute to Rural economy.
3. Familiarize the Rural Institutions and the Rural Development Programmes in India.

**COURSE OUTCOMES:** After the completion of this Course, Student will be able to

1. Gain an understanding of Rural life, Culture and Social realities.
2. Develop a sense of empathy and bonds of mutuality with Local Communities.
3. Appreciate significant contributions of Local communities to Indian Society and Economy.
4. Exhibit the knowledge of Rural Institutions and contributing to Community's Socio-Economic improvements.
5. Utilise the opportunities provided by Rural Development Programmes.

**MODULE I: APPRECIATION OF RURAL SOCIETY**

Rural life style, Rural society, Caste and Gender relations, Rural values with respect to Community, Nature and Resources, elaboration of 'soul of India lies in villages' (Gandhi), Rural Infrastructure.

**MODULE II: UNDERSTANDING RURAL ECONOMY AND LIVELIHOOD**

Agriculture, Farming, Landownership, Water management, Animal Husbandry, Non-farm Livelihood and Artisans, Rural Entrepreneurs, Rural markets, Rural Credit Societies, Farmer Production Organization/Company.

**MODULE III: RURAL INSTITUTIONS**

Traditional Rural organizations, Self-Help Groups, Panchayati Raj Institutions (Gram Sabha), Gram Panchayat, Standing Committees, Local Civil Society, Local Administration.

**MODULE IV: RURAL DEVELOPMENT PROGRAMMES**

History of Rural Development in India, Current National Programmes: SarvaShikshaAbhiyan, BetiBhachao, BetiPadhao, Ayushman, Bharat, Swachh Bharat, PM AwasYojana, Skill India, Gram Panchayat Decentralised Planning, NRLM, MNREGA etc.

**TEXT BOOKS:**

1. Singh, Katar, Rural Development: Principles, Policies and Management, Sage Publications, New Delhi, 2015.
2. A Hand book on Village Panchayat Administration, Rajiv Gandhi Chair for Panchayati Raj Studies, 2002.
3. United Nations, Sustainable Development Goals, 2015, un.org/sdgs
4. M.P Boraia, Best Practices in Rural Development, Shanlax Publishers, 2016.

**JOURNALS:**

1. Journal of Rural development (published by NIRD & PR, Hyderabad).
2. Indian Journal of Social Work, (by TISS, Bombay).
3. Indian Journal of Extension Educations (by Indian Society of Extension Education).
4. Journal of Extension Education (by Extension Education Society).
5. Kurukshetra (Ministry of Rural Development, GOI).
6. Yojana (Ministry of Information & Broadcasting, GOI).

22CSC02

## PROBLEM SOLVING AND PROGRAMMING LAB

Instruction  
Duration of SEE  
SEE  
CIE  
Credits

3P Hours per week  
3 Hours  
50 Marks  
50 Marks  
1.5

**COURSE OBJECTIVES:** This course aims to

1. Master the fundamentals of writing Python scripts.
2. Learn Python elements such as variables, flow controls structures, and functions.
3. Discover how to work with lists and sequence data, and files.

**COURSE OUTCOMES:** After completion of this course, student will be able to

1. Understand various Python program development Environments.
2. Demonstrate the concepts of Python.
3. Implement algorithms/flowcharts using Python to solve real-world problems.
4. Build and manage dictionaries to manage data.
5. Write Python functions to facilitate code reuse.
6. Use Python to handle files and memory.

## CO-PO ARTICULATION MATRIX

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
1	3	2	1	-	-	-	-	-	-	-	-	1
2	3	3	2	2	3	-	-	-	-	-	-	1
3	2	3	3	2	3	-	-	-	-	-	-	1
4	2	3	3	2	2	-	-	-	-	-	-	1
5	2	3	3	3	3	-	-	-	-	-	-	1
6	2	3	3	3	3	-	-	-	-	-	-	1

## LABORATORY / PRACTICAL EXPERIMENTS:

1. Explore various Python Program Development Environments.
2. Demonstration of input/output operations.
3. Demonstration of operators.
4. Demonstration of selective control structures.
5. Demonstration of looping control structures.
6. Demonstration of List, Tuple and Set
7. Demonstration of Python Dictionaries.
8. Implementation of searching and sorting techniques.
9. Implementation of string manipulation operations.
10. File handling and memory management operations.

## TEXT BOOKS AND REFERENCES:

1. R.S. Salaria, "Programming for Problem Solving", First Edition, Khanna Book Publishing Co., Delhi.
2. Jeeva Jose, "Taming Python by Programming", Revised Edition, Khanna Book Publishing Co., Delhi.
3. Mark Lutz, "Learning Python", 5<sup>th</sup> Edition, O'Reilly Media, Inc.,
4. Python Crash Course: A Hands-On, Project-Based Introduction to Programming by Eric Matthes, No Starch Press.
5. "Programming in Python", R.S. Salaria, Khanna Book Publishing Co., Delhi.

## NPTEL/SWAYAM COURSES:

1. Introduction to Problem Solving and Programming, Video Lectures, Prof. D Gupta, IIT Delhi.
2. Problem Solving Aspects and Python Programming, Dr. S Malina, Dr. Thangarajan, Dr. S V Kogilavani, Kongu Engineering College.
3. <https://www.coursera.org/specializations/python-3-programming>.



**PROFESSOR & HEAD**  
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22MEEC37

**ROBOTICS AND DRONES LAB  
(COMMON TO ALL BRANCHES)**

Instruction

CIE

Credits

2T + 2P Hours per week

100 Marks

3

**COURSE OBJECTIVES:** This course aims to

1. To develop the students' knowledge in various robot and drone structures and their workspace.
2. To develop multidisciplinary robotics that have practical importance by participating in robotics competitions
3. To develop students' skills in performing spatial transformations associated with rigid body motions, kinematic and dynamic analysis of robot systems.
4. Through projects done in lab, increase the true hands-on student learning experience and enhance their conceptual understanding, increase students' ability, competence and teamwork skills on dealing with real-life engineering problems

**COURSE OUTCOMES:** After completion of course, students would be able to

1. Demonstrate knowledge of the relationship between mechanical structures of robotics and their operational workspace characteristics
2. Understand mechanical components, motors, sensors and electronic circuits of robots and build robots.
3. Demonstrate knowledge of robot controllers.
4. Use Linux environment for robotic programming.
5. Write Python scripts to control robots using Python and Open CV.

**CO-PO ARTICULATION MATRIX**

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	1	1	1	2	1	1	1	2	2	2
CO2	2	3	1	2	3	1	1	1	1	2	2	1
CO3	2	2	2	2	2	1	1	1	1	2	2	2
CO4	2	2	1	2	2	2	1	1	1	2	2	2
CO5	1	1	1	1	1	3	3	3	1	3	3	3

**LAB EXPERIMENTS:**

1. Assembling of robot mechanical components, mounting of motors, sensors, electronic circuits to the chassis.
2. Connecting to electronic circuitry: motor drivers, incremental encoders proximity sensors, micro controller.
3. Different types of batteries, selection of suitable battery for application, safety precaution.
4. Introduction to Linux Command Line Interface: basic file and directory management and other useful commands
5. Controlling robot using Python: i) Move robot using Python code, ii) Make robot move in patterns using Python
6. Robot programming with Sensor inputs: i) Read sensor data using Python, ii) Visualize sensor data using Python, iii) Code robot to avoid obstacles by using sensor data
7. Open CV: i) Create an Image and display an image; ii) Read and change pixel values; iii) Create colored shapes and save image; iv) Extract the RGB values of a pixel; v) Reading and Writing Videos
8. Open CV: i) Extraction of Regions of Interest; ii) Extraction of RGB values of a pixel
9. Coding robot to work with colors, follow colored objects, identifying shape of the object-oriented
10. Projects: i) Making a line follower robot using a Camera; ii) Writing code for a complex function Assembly of a drone

**SUGGESTED READINGS:**

1. <https://www.geeksforgeeks.org/robotics-introduction/>
2. <https://www.ohio.edu/mechanical-faculty/williams/html/PDF/IntroRob.pdf>
3. <https://www.idtechex.com/en/research-report/new-robotics-and-drones-2018-2038-technologies-forecasts-players/584>
4. <https://dronebotworkshop.com/>

22EEEC02

## BASIC ELECTRICAL ENGINEERING LAB

Instruction  
Duration of SEE  
SEEE  
CIE  
Credits

2P Hours per week  
3 Hours  
50 Marks  
50 Marks  
1

**COURSE OBJECTIVES:** This course aims to

1. To acquire the knowledge on different types of electrical elements and to verify the basic electrical circuit laws and theorems.
2. To determine the parameters and power factor of a coil, calculate the time and frequency responses of RLC circuits and to familiarize with measurement of electric power & energy.
3. To determine the characteristics of Transformers, dc, ac machines and switch gear components

**COURSE OUTCOMES:** At the end of the course, the student are expected to

1. Comprehend the circuit analysis techniques using various circuit laws and theorems.
2. Analyse the parameters of the given coil and measurement of power and energy in AC circuits
3. Determine the turns ratio/performance parameters of single-phase transformer
4. Infer the characteristics of DC shunt motor different tests.
5. Illustrate different parts and their function of electrical components, equipment and machines.

CO-PO ARTICULATION MATRIX

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	2	-	-	2	2	-	-	-	-	2
CO 2	3	2	1	-	-	1	2	-	-	-	-	2
CO 3	3	2	3	-	-	2	2	-	-	-	-	2
CO 4	3	2	2	-	-	2	2	-	-	-	-	2
CO 5	3	2	3	-	-	2	2	-	-	-	-	2

## LIST OF LABORATORY EXPERIMENTS/DEMONSTRATIONS:

1. Verification of KCL and KVL.
2. Verification of Thevenin's theorem.
3. Verification of Norton's theorem.
4. Charging and discharging of Capacitor.
5. Determination of parameters of a choke or coil by Wattmeter Method.
6. Power factor improvement of single-phase AC System.
7. Active and Reactive Power measurement of a single-phase system using  
(i) 3-Ammeter method (ii) 3-Voltmeter method
8. Measurement of 3-Phase Power in a balanced system
9. Calibration of single-phase energy meter.
10. Verification of Turns/voltage ratio of single-phase Transformer.
11. Open Circuit and Short Circuit tests on a given single phase Transformer
12. Brake test on DC Shunt Motor
13. Speed control of DC Shunt Motor
14. Demonstration of Measuring Instruments and Electrical Lab components.
15. Demonstration of Low-Tension Switchgear Equipment/Components
16. Demonstration of cut - out section of Machines like DC Machine, Induction Machine etc.

Note: TEN experiments to be conducted to cover all five Course Outcomes.

22MTC05

## VECTOR CALCULUS AND DIFFERENTIAL EQUATIONS (MECHANICAL)

Instruction  
Duration of SEE  
SEE  
CIE  
Credits

3 L+1T per week  
3 Hours  
60 Marks  
40 Marks  
4

### COURSE OBJECTIVES: This course aims to

1. To explain scalar and vector functions with its Physical interpretations.
2. To discuss vector line, surface and volume integrals.
3. To explain relevant methods to solve first order differential equations.
4. To discuss the solution of higher order Differential Equations
5. To learn Numerical solution of ODE and Engineering problems.

### COURSE OUTCOMES: After completion of this course, student will be able to

1. Apply the vector differential operators to Scalars and Vector functions.
2. Solve line, surface & volume integrals by Greens, Gauss and Stoke's theorems.
3. Calculate the solutions of first order linear differential equations.
4. Solve higher order linear differential equations
5. Find solution of algebraic, transcendental and ODE by Numerical Methods.

### CO-PO ARTICULATION MATRIX

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	3	-	-	-	-	-	-	-	2
CO 2	3	3	3	3	-	-	-	-	-	-	-	2
CO 3	3	3	3	3	-	-	-	-	-	-	-	2
CO 4	3	3	3	3	-	-	-	-	-	-	-	2
CO 5	2	2	2	2	-	-	-	-	-	-	-	1

#### UNIT I

**Vector Differential Calculus and multiple Integrals:** Scalar and Vector point functions, vector operator Del, Gradient, Directional derivative, Divergence, Curl, Del applied twice to point functions, Del applied to product of point functions (vector identities), Irrotational fields and Solenoidal fields, Double integral, Change of order of Integration and Triple integrals.

#### UNIT II

**Vector Integral Calculus:** Line integral, Surface integral and Volume integral. Verification of Green's theorem in a plane (without proof), verification of Stoke's theorem (without proof) and Gauss's divergence theorem (without proof).

#### UNIT III

**First Order Ordinary Differential Equations:** Exact differential equations, Equations reducible to exact equations, Linear equation, Bernoulli's equation, Clairaut's equation, Riccati's equation, Orthogonal trajectories, Rate of decay of Radio-active materials.

#### UNIT IV

**Higher Orders Linear Differential Equations:** Higher order linear differential equations with constant coefficients, rules for finding Complementary function, Particular Integral and General solution. Method of variation of parameters, solution of Cauchy- Euler equation, LR and LCR circuits

#### UNIT V

**Numerical Methods:** Solution of Algebraic and transcendental equations by Bisection method, Regula-Falsi method Newton-Raphson method. Numerical Solutions of First Order Ordinary differential equations by Taylor's series method, Euler's method, Modified Euler's method and Runge-Kutta method of fourth order.

**TEXT BOOKS:**

1. B.S.Grewal, "Higher Engineering Mathematics", 44<sup>th</sup> Edition, Khanna Publishers, 2017.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 9<sup>th</sup> Edition, John Wiley & Sons, 2006.

**SUGGESTED READING:**

1. N.P.Bali and Dr. Manish Goyal, "A text book of Engineering Mathematics", 9<sup>th</sup> edition, Laxmi Publications, 2017.
2. R.K.Jain, S.R.K.Iyengar, "Advanced Engineering Mathematics", 5<sup>th</sup> edition, Narosa Publications, 2016.



22PYC05

### MECHANICS AND MATERIALS SCIENCE (CIVIL & MECHANICAL)

Instruction  
Duration of SEE  
SEE  
CIE  
Credits

3L Hours per week  
3Hours  
60Marks  
40Marks  
3

**COURSE OBJECTIVES:** This course aims to

1. Acquire knowledge about physics of oscillations and rotational motion
2. Understand the physical properties of crystalline and magnetic materials
3. Aware of characteristic properties of dielectric materials and superconductors
4. Familiarize with coherent properties of light waves.

**COURSE OUTCOMES:** After completion of this course, student will be able to

1. Compare the various types of oscillations
2. Demonstrate rotational motion of rigid body
3. Classify different types of crystals and their imperfections
4. Identify magnetic and dielectric materials for engineering applications
5. Make use of lasers and superconductors in technological applications

#### CO-PO ARTICULATION MATRIX

CO/PSO PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C01	3	1	1	1	1	2	2	1	1	2	1	2
C02	3	1	2	1	2	2	2	1	2	2	2	2
C03	2	2	1	1	1	1	1	1	1	2	2	2
C04	3	2	2	2	2	2	2	1	1	2	1	2
C05	3	2	2	2	2	1	2	2	1	2	1	2

#### UNIT I

**Oscillations:** Simple harmonic motion–Harmonic oscillator Damped harmonic motion–over damped, critically damped and under damped oscillators–Forced oscillations and resonance.

#### UNIT II

**Rigid body Dynamics:** Definition of rigid body–Rotational kinematic relations–Angular momentum and torque Equation of motion for a rotating rigid body Inertia tensor and its properties– Euler's equations and applications: law of energy conservation and law of conservation of angular momentum.

#### UNIT III

**Crystallography:** Space lattice Unit cell Crystal systems –Bravais lattices Number of atoms per unit cell Coordination number Atomic radius Packing fraction (for *sc, bcc, fcc*) Lattice planes Miller indices Bragg's law Experimental determination of lattice constant of a cubic crystal by powder X-ray diffraction method Structure of NaCl.

**Crystal Imperfections:** Classification of defects–Point defects–Concentration of Schottky and Frenkel defects.

#### UNIT IV

**Dielectric Materials:** Introduction–Dielectric polarization–Types of dielectric polarization: electronic & ionic polarizations (quantitative); orientation & space-charge polarizations (qualitative) –Frequency and temperature dependence of dielectric polarization–Determination of dielectric constant (Schering bridge method) Ferroelectricity–Barium titanate–Applications of ferroelectrics.

**Magnetic Materials:** Origin of magnetism – Magnetic moment - Bohr magneton–Classification of magnetic materials: dia, para, ferro, anti-ferro and ferrimagnetic materials – Weiss molecular field theory–Domain theory Hysteresis curve, soft and hard magnetic materials –Applications.

#### UNIT V

**Lasers:** Characteristics of lasers – Einstein's coefficients – Amplification of light by population inversion – Ruby, He-Ne, semiconductor laser – Applications of lasers in engineering and medicine.

**Fiber Optics:** Introduction – Construction – Principle – Propagation of light through an optical fiber – Numerical aperture and acceptance angle – Step-index and graded-index fibers – Pulse dispersion – Fiber losses – Fiber optic communication system – Applications

**Superconductors:** General properties of superconductors – Meissner's effect – Type I and Type II superconductors – BCS theory (qualitative) – Applications.

**TEXT BOOKS:**

1. B. K. Pandey and S. Chaturvedi, *Engineering Physics*, Cengage Publications, 2012.
2. M. N. Avadhanulu and P. G. Kshirsagar, *A Text Book of Engineering 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. Murugesan and Kiruthiga Sivaprasath, *Modern Physics*, S. Chand Publications, 2014.
2. V. Rajendran, *Engineering Physics*, McGraw-Hill 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; 6<sup>th</sup> Revised edition, 2015.

22CEC01

## ENGINEERING MECHANICS

Instruction  
Duration of SEE  
SEE  
CIE  
Credits

3L+1T Periods per week  
3 Hours  
60 Marks  
40 Marks  
4

**COURSE OBJECTIVES:** This course aims to

1. Understand the resolution of forces and to obtain resultant of all force systems,
2. Understand equilibrium conditions of static loads for smooth and frictional surface
3. Analyse simple trusses for forces in various members of a truss
4. Obtain centroid, centre of gravity for various regular and composite areas and bodies
5. Obtain Moment of inertia for various regular and composite areas and bodies and also to obtain Mass moments of inertia of elementary bodies

**COURSE OUTCOMES:** After completion of this course, student will be able to

1. Calculate the components and resultant of coplanar forces system and Draw free body diagrams to analyze the forces in the given structure
2. Understand the mechanism of friction and can solve friction problems
3. Analyse simple trusses for forces in various members of a truss.
4. Determine the centroid of plane areas, composite areas and centres of gravity of bodies.
5. Determine moments of inertia, product of inertia of plane and composite areas and mass moments of inertia of elementary bodies

CO-PO ARTICULATION MATRIX

PO / PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-

## UNIT - I

**Resolution and Resultant of Force System:** Basic concepts of a force system. Components of forces in a plane. Resultant of coplanar concurrent force system. Moment of a force, couple and their applications. Resultant of coplanar non-concurrent force system

**Equilibrium of force system:** Free body diagrams, equations of equilibrium of planar force systems and its applications. Problems on general case of coplanar force systems.

## UNIT - II

**Theory of friction:** Introduction, types of friction, laws of friction, application of friction to a single body & connecting systems. Wedge and belt friction

## UNIT - III

**Analysis of Simple Trusses:** Introduction to trusses, Assumptions, analysis of simple trusses using method of joints and method of sections.

## UNIT-IV

**Centroid:** Significance of centroid, moment of area, centroid of line elements, plane areas, composite areas, theorems of Pappus & its applications. Center of gravity of elementary and composite bodies

## UNIT - V

**Moment of Inertia:** Definition of MI, Area MI, Polar Moment of Inertia, radius of gyration, transfer theorem, Moment of Inertia of elementary & composite areas, and Product of inertia. Mass moments of inertia of elementary bodies.

**TEXT BOOKS:**

1. K. Vijay Kumar Reddy and J. Suresh Kumar, Singer's Engineering Mechanics, BS Publications, Hyderabad, 2011.
2. Ferdinand L. Singer, Engineering Mechanics, Harper and Collins, Singapore, 1904.

**SUGGESTED READING:**

1. A. Nelson, Engineering Mechanics, Tata McGraw Hill, New Delhi, 2010.
2. S. Rajashekar & G. Sankarasubramanyam, Engineering Mechanics, Vikas publications, Hyderabad, 2002.
3. S.B. Junarkar and HJ Shah, Applied Mechanics, Charotar publishers, New Delhi, 2001.
4. Basudeb Bhattacharyya, Engineering Mechanics, Oxford University Press, New Delhi, 2008.
5. A K Tayal, Engineering Mechanics, Umesh Publications, New Delhi, 2010.

22EGC01

**ENGLISH  
(COMMON TO ALL BRANCHES)**

Instruction  
Duration of SEE  
SEE  
CIE  
Credits

2L Hours per week  
3Hours  
60 Marks  
40 Marks  
2

**COURSE OBJECTIVES:** This course aims to

1. To the role and importance of communication while developing their basic communication skills in English.
2. To basics of writing coherent paragraphs and formal emails.
3. To techniques of writing a précis and formal letters by using acceptable grammar and appropriate vocabulary.
4. To description, definition and classification of processes while enabling them to draft formal reports following a proper structure.
5. To gaining adequate reading comprehension techniques.

**COURSE OUTCOMES:** After completion of this course, student will be able to

1. Illustrate the nature, process and types of communication and communicate effectively without barriers.
2. Construct and compose coherent paragraphs, emails and adhering to appropriate mobile etiquette.
3. Apply techniques of precision to write a précis and formal letters by using acceptable grammar and appropriate vocabulary.
4. Distinguish formal from informal reports and demonstrate advanced writing skills by drafting formal reports.
5. Critique passages by applying effective reading techniques.

**CO-PO-PSO ARTICULATION MATRIX**

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1	1	1	1	1	1	1	2	3	3	2	3
CO 2	1	1	1	1	-	1	1	1	2	2	1	2
CO 3	-	2	1	1	-	2	1	1	2	2	1	2
CO 4	1	2	1	2	1	2	2	1	2	2	1	2
CO 5	1	2	1	2	1	1	1	1	1	2	1	2

**UNIT I**

**Understanding Communication in English:** Introduction, nature and importance of communication; Process of communication; Types of communication - verbal and non-verbal; Barriers to communication; Intrapersonal and interpersonal communication; Understanding Johari Window.

**Vocabulary & Grammar:** The concept of Word Formation; Use of appropriate prepositions and articles.

**UNIT II**

**Developing Writing Skills I:** Paragraph writing. – Structure and features of a paragraph; Cohesion and coherence. Rearranging jumbled sentences. Email and Mobile etiquette.

**Vocabulary & Grammar:** Use of cohesive devices and correct punctuation.

**UNIT III**

**Developing Writing Skills II:** Précis Writing: Techniques of writing precisely. Letter Writing – Structure, format of a formal letter; Letter of request and the response

**Vocabulary and Grammar:** Subject-verb agreement. Use of prefixes and suffixes to form derivatives. Avoiding redundancies.

**UNIT IV**

**Developing Writing Skills III:** Report writing – Importance, structure, elements of style of formal reports; Writing a formal report.

**Vocabulary and Grammar:** Avoiding ambiguity - Misplaced modifiers. Use of synonyms and antonyms.

**UNIT V**

**Developing 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; Use of 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.



**PROFESSOR & HEAD**  
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22PYC08

**MECHANICS AND MATERIALS SCIENCE LABORATORY  
(CIVIL & MECHANICAL)**

Instruction  
Duration of SEE  
SEE  
CIE  
Credits

3P Hours per week  
3Hours  
50Marks  
50Marks  
1.5

**COURSE OBJECTIVES:** This course aims to

1. Apply the concepts of physics while doing experiments
2. Learn the working of lasers and optical fibers
3. Understand the properties of magnetic and dielectric materials
4. Capable of measuring mechanical properties of solids and liquids
5. Understand the motion of electrons in electric and magnetic fields

**COURSE OUTCOMES:** After completion of this course, student will be able to

1. Estimate the error in an experimental measurement
2. Make use of lasers and optical fibers in engineering applications
3. Recall the physical properties of dielectrics and magnetic materials
4. Find the mechanical properties of solids and viscosity of liquids
5. Demonstrate the motion of electrons in electric and magnetic fields

**CO-PO ARTICULATION MATRIX**

CO /PSO /PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	1	3	1	3	3	2	1	2
CO2	3	2	1	2	2	2	1	2	2	1	1	3
CO3	3	2	3	2	3	1	2	2	3	2	1	2
CO4	3	3	2	2	2	1	2	3	2	1	1	3
CO5	3	1	2	3	2	1	1	2	2	2	1	2

**LIST OF EXPERIMENTS:**

1. Error Analysis : Estimation of errors in the determination of time period of a torsional pendulum
2. Flywheel : Determination of moment of inertia of given flywheel
3. Compound Pendulum : Determination of acceleration due to gravity
4. Young's Modulus : Determination of Young's modulus of the given steel bar/wooden scale by non-uniform bending method
5. Helmholtz's Resonator : Determination of resonating volume of air and neck correction
6. Melde's Experiment - : Determination of frequency of the electrically maintained vibrating bar/fork
7. Viscosity of Liquid : Determination of viscosity of a given liquid by oscillating disc method
8. Coupled Oscillator : To determine the coupling constant of a coupled oscillator performing parallel and antiparallel oscillation
9. Dielectric Constant : Determination of dielectric constant of given PZT sample

10. M & H Values : Determination of magnetic moment M of a bar magnet and absolute value H of horizontal component of earth's magnetic field
11. B-H Curve : Determination of hysteresis loss of given specimen
12. Thermoelectric Power : Determination of thermoelectric power of given sample
13. Laser : Determination of wavelength of given semiconductor laser
14. Optical Fiber : Determination of numerical aperture and power losses of given optical fiber
15.  $e/m$  of an electron : Determination of specific charge of an electron by J.J. Thomson method

NOTE: A minimum of TWELVE experiments should be done.



22EGC02

**ENGLISH LAB  
(COMMON TO ALL BRANCHES)**

Instruction	
Duration of SEE	2P Hours per week
SEE	3 Hours
CIE	50 Marks
Credits	50 Marks
	1

**COURSE OBJECTIVES:** This course aims to

- To nuances of Phonetics and give them sufficient practice in correct pronunciation.
- To word stress and intonation.
- To listen to listening comprehension material for honing their listening skills.
- To activities enabling them overcome their inhibitions while speaking in English with the focus being on fluency rather than accuracy.
- To team work, role behavior while developing their ability to discuss in groups and making oral presentations.

**COURSE OUTCOMES:** After successful completion of the course the students will be able to

- Define the speech sounds in English and understand the nuances of pronunciation in English.
- Apply stress correctly and speak with the proper tone, intonation and rhythm.
- Analyze listening comprehension texts to enhance their listening skills.
- Determine the context and speak appropriately in various situations.
- Design and present effective posters while working in teams, and discuss and participate in Group discussions.

**CO-PO ARTICULATION MATRIX**

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	-	-	-	-	-	-	-	-	1	1	-	1
CO 2	-	-	-	-	-	1	-	1	2	2	1	2
CO 3	-	-	-	-	-	1	1	1	2	1	1	2
CO 4	1	-	-	-	-	1	2	2	2	3	1	3
CO 5	1	1	1	1	1	2	2	2	3	3	2	3


**LIST OF EXERCISES:**

- Introduction to English Phonetics:** Introduction to auditory, acoustic and articulatory phonetics, organs of speech: the respiratory, articulatory and phonatory systems.
- 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.
- Word stress:** Primary stress, secondary stress, functional stress, rules of word stress.
- Rhythm & Intonation:** Introduction to Rhythm and Intonation. Major patterns, intonation of English with the semantic implications.
- Listening skills** – Practice with Software available in (K-van solutions)
- Public speaking** – Speaking with confidence and clarity in different contexts on various issues.
- Group Discussions** - Dynamics of a group discussion, group discussion techniques, body language.
- Pictionary** – weaving an imaginative story around a given picture.
- Information Gap Activity** – Writing a brief report on a newspaper headline by building on the hints given
- Poster presentation** – Theme, poster preparation, team work and representation.

**SUGGESTED READING:**

- T Balasubramanian. A Textbook of English Phonetics for Indian Students, Macmillan, 2008.
- J Sethi et al. A Practical Course in English Pronunciation (with CD), Prentice Hall India, 2005.
- Priyadarshi Patnaik. Group Discussions and Interviews, Cambridge University Press Pvt Ltd 2011
- Aruna Koneru, Professional Speaking Skills, Oxford University Press, 2016

Chaitanya Bharathi Institute of Technology (A)

  
**PROFESSOR & HEAD**  
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22MEC01

## CAD AND DRAFTING

Instruction  
Duration of SEE  
SEE  
CIE  
Credits

1 T + 3 D Hours per week  
3Hours  
50Marks  
50Marks  
2.5

**COURSE OBJECTIVES:** This course aims to

1. To get exposure to a cad package and its utility.
2. Understanding orthographic projections.
3. To visualize different solids and their sections in orthographic projection
4. To prepare the student to communicate effectively by using isometric projection.
5. To prepare the student to use the techniques, skills, and modern tools necessary for practice.

**COURSE OUTCOMES:** After completion of this course, student will be able to

1. Become conversant with appropriate use of CAD software for drafting.
2. Recognize BIS, ISO Standards and conventions in Engineering Drafting.
3. Construct the projections of points, lines, planes, solids
4. Analyse the internal details of solids through sectional views
5. Create an isometric projections and views

## CO-PO ARTICULATION MATRIX

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2	2	-	1	2	3	1	3
CO2	3	2	2	1	2	2	-	1	2	2	1	2
CO3	3	3	2	1	2	2	-	1	2	2	1	2
CO4	3	3	3	2	2	2	-	1	2	2	1	2
CO5	3	2	2	1	2	2	-	1	2	2	1	2

## LIST OF EXERCISES:

1. Introduction to CAD package: Settings, draw, modify tools, dimensioning and documentation
2. Construction of Conic Sections by General method
3. Orthographic projection: Principles, conventions, Projection of points
4. Projection of straight lines: Simple position, inclined to one plane
5. Projection of straight lines inclined to both the planes (without traces and mid-point)
6. Projection of planes: Perpendicular planes
7. Projection of planes: Oblique planes
8. Projection of solids: Simple position
9. Projection of solids: Inclined to one plane
10. Sections of solids: Prism, pyramid in simple position
11. Sections of solids: Cone and cylinder in simple position.
12. Isometric projections and views
13. Conversion of isometric views to orthographic projections and vice-versa.

## TEXT BOOKS:

1. N.D.Bhatt, "Elementary Engineering Drawing", Charotar Publishers, 2012.
2. K.Venugopal, "Engineering Drawing and Graphics + AutoCAD", New Age International Pvt.Ltd,2011.
3. Basanth Agrawal and C M Agrawal, "Engineering Drawing", 2/e, McGraw-Hill Education (India) Pvt. Ltd.

**SUGGESTED READING:**

1. Shaw M.B and Rana B.C., "Engineering Drawing", 2/e, Pearson, 2009.
2. K.L. Narayana and P.K. Kanniah, "Text Book of Engineering Drawing", Scitech Publications, 2011.



22MEC38

## DIGITAL FABRICATION LAB

Instruction	
Duration of SEE	3P Hours per week
SEE	3 Hours
CIE	50 Marks
Credits	50 Marks 1.5

**COURSE OBJECTIVES:** This course aims to

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. 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. 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.

**COURSE OUTCOMES:** After completion of course, students would be able to

1. Understand safety measures to be followed in workshop to avoid accidents.
2. Identify various tools used in carpentry, house wiring and plumbing.
3. Make a given model by using workshop trades like carpentry, plumbing, House wiring and 3d modeling using solid works software for Additive Manufacturing.
4. Perform pre-processing operations on STL files for 3D printing, also understand reverse engineering process.
5. Conceptualize and produce simple device/mechanism of their choice.

## CO-PO ARTICULATION MATRIX

CO/PSO PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	-	-	-	-	-	-	-	1
CO2	1	-	-	-	1	-	-	-	-	-	-	2
CO3	2	1	1	1	3	-	1	-	-	-	-	2
CO4	2	2	2	1	3	-	-	-	-	-	-	2
CO5	3	2	1	-	3	-	-	-	-	-	-	2

**LIST OF EXERCISES:**  
**GROUP-1**

1. To make a lap joint on the given wooden piece according to the given dimensions.
2. To make a dove tail-joint on the given wooden piece according to the given dimensions.
3. A. Wiring of one light point controlled by one single pole switch, a three pin socket controlled by a single pole switch  
B. 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
4. Stair case wiring-wiring of one light point controlled from two different places independently using two 2-way switches.
5. To make external threads for GI pipes using die and connect the GI pipes as per the given diagram using taps, couplings & bends.
6. A. To connect the GI pipes as per the given diagram using, couplings, unions, reducer & bends.  
B. To connect the GI pipes as per the given diagram using shower, tap & valves and Demonstrate by giving water connection

**GROUP- 2**

1. To Study the method of Additive Manufacturing process using a 3D printer
2. To create a 3D CAD model of a door bracket using a modeling software
3. To Print a door bracket using an extruder type 3D Printer.
4. To create a 3D CAD model by reverse Engineering
5. To Design an innovative component using the CAD software
6. To Print the selected innovative component by the students using a 3D printer

**TEXT BOOKS:**

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., Elements of Workshop Technology, Vol. I, 2008 and Vol II, Media promoters and publishers private limited, Mumbai, 2010.
2. Kalpakjian S. And Steven S. Schmid, Manufacturing Engineering and Technology, 4th edition, Pearson Education India Edition, 2002.
3. Sachidanand Jha, 3D PRINTING PROJECTS: 200 3D Practice Drawings For 3D Printing On Your 3D Printer, June 7, 2019.

**SUGGESTED READING:**

1. Gowri P, Hariharan and A. Suresh Babu, Manufacturing Technology – I, Pearson Education, 2008.
2. Oliver Bothmann , 3D Printers: A Beginner's Guide , January 1, 2015



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With Effect from the Academic Year 2021 – 2022

20MEC04

**MATERIAL SCIENCE AND METALLURGY**

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** Student will understand

1. Structure property relations, analyze the failures of metals and their prevention.
2. Fatigue, creep and diffusion mechanisms.
3. Classification of steels and their application .
4. Working principle of various heat treatment operations
5. Principles of extractive metallurgy.

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

1. Understand the crystal structure and various imperfections of crystals.
2. Related material failure by fatigue and creep.
3. Interpret phase diagrams and TTT diagrams.
4. Understand the methods of improvement of mechanical properties by various heat treatment operations.
5. Differentiate the properties and applications of ceramics, polymers and composites.

**UNIT - I**

**Plastic Deformation:** Introduction to engineering materials, Imperfections in crystals, Dislocation in crystals, Types of dislocations, Effect of slip and twinning on plastic deformation, Strain hardening, Cold and hot working, Bauschinger effect, Recovery, Recrystallization, Grain growth and its effect on mechanical properties of metals.

**Fracture:** Types of fracture in metals, Ductile and brittle fracture, Griffith theory of brittle fracture, Crack propagation and ductile to brittle transition temperature.

**UNIT - II**

**Diffusion:** Fick's laws of diffusion, Application of diffusion theory in mechanical engineering.

**Fatigue:** S-N curve, Fatigue crack propagation, Effect of metallurgical variables on fatigue of metal, Low and high cycle fatigue, Experimental determination of fatigue strength (RR-Moore Test).

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

**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.

**Alloy Steels:** Effects of alloying elements like Nickel, Chromium, Manganese, Silicon, Tungsten and Titanium, Types of stainless steel, HSLA, TRIP, HSS, Brass, Bronze, Their

  
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composition and properties.

#### UNIT - IV

**Heat Treatment:** Purpose of heat treatment, Annealing, Normalizing, Hardening, Tempering, Construction and interpretation of T-T-T diagram, Austempering and Martempering, Case hardening, Carburizing, Nitriding, Carbo-nitriding, Flame hardening, Induction hardening, Laser and Electron beam hardening.

**Introduction to Non-Destructive Testing:** Importance of Non-Destructive Testing, Types: Liquid Penetrant Testing, Ultrasonic Testing, Radiography Testing, Applications of Non-Destructive Testing.

#### UNIT - V

**Introduction to Extractive Metallurgy:** Method of production of pig iron by blast furnace, Cast iron by cupola furnace and method of production of steel by electric arc process.

**Polymers and Ceramics:** Polymerization, Thermoplastics and thermosetting plastics, Elastomers, Resins, Types, properties and applications of ceramics

**Composites:** Concept of composites, Matrix and reinforcement, Classification and Applications of composites.

#### Text Books:

1. V. Raghavan, Materials Science and Engineering, 4<sup>th</sup> edition, Prentice Hall of India Ltd., New Delhi, 2005.
2. S.H. Avner, Introduction to Physical Metallurgy, 2<sup>nd</sup> edition, Tata McGraw Hill Publishers, New Delhi, 2005.

#### Suggested Reading:

1. S.P. Nayak, Engineering Metallurgy and Material Science, 6<sup>th</sup> edition, Charotar Publishing House, Gujarat, 2005.
2. G. E. Dieter, Mechanical Metallurgy, 3<sup>rd</sup> edition, Tata McGraw Hill, New Delhi, 2005.
3. W.D. Callister (Adapted by R. Balasubramaniam), Materials Science and Engineering, 2<sup>nd</sup> edition, Wiley India, New Delhi, 2014.

  
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With Effect from the Academic Year 2021-22

20MEC05

**STRENGTH OF MATERIALS**

Instruction  
Duration of SEE  
SEE  
CIE  
Credits

3 L+1T Hours per Week  
3 Hours  
60 Marks  
40 Marks  
4

**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 of various loads and configurations.
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 shear stresses in beams, principal stresses, strains and phenomenon of torsion.
5. Student will acquire knowledge in estimating stresses for thin, thick cylindrical shells and buckling of columns.

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

1. Determine stresses and strains in members subjected to axial loads and temperature changes.
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, analyze stress, strain and deflection due to torsion in circular members.
4. Analyze shear stress distribution in different sections of beams and find out principal stresses and strains.
5. Find out stresses and strains in thin, thick cylindrical shells and able to calculate critical buckling loads in 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, Strain energy for axial and torsional loads.

**UNIT - II**

**Beams:** Definition of shear force and bending moment, Relation between intensity of loading, Shear force and bending moment, Shear force and bending moment diagrams for cantilever, Simply supported and overhanging beams, Theory of simple bending, Moment of resistance and comparison of various cross-sections.

**UNIT - III**

**Slopes and Deflections:** Slope and deflection calculations of cantilever, Simply supported



beams subjected to point loads and uniformly distributed loads with Macaulay's and double integration methods.

**Torsion of Circular Cross-sections:** Theory of pure torsion, Power transmission in solid and hollow circular shafts, Combined bending and torsion.

#### UNIT – IV

**Shear Stresses in Beams:** Distribution of shear stresses in rectangular, I-section, T-section, Solid and hollow circular sections.

**Principal Stresses and Strains:** Analysis of biaxial state of stress with and without shear, Mohr's Circle.

#### UNIT – V

**Cylinders:** Stresses in thin and thick cylinders with internal and external pressures.

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

#### Textbooks:

1. S.S. Rattan., Strength of Materials, 3<sup>rd</sup> edition, Tata Mc-Graw Hill, 2017.
2. Ferdinand P. Beer, E. Russell Johnston, John T. Dewolf and David F. Mazurek., Mechanics of Materials, 8<sup>th</sup> edition, McGraw-Hill, New York, 2020.

#### Suggested Reading:

3. James M Gere, Mechanics of materials, 8<sup>th</sup> edition, Cengage Learning, 2013.
4. R.C. Hibbeler, Mechanics of Materials, 9<sup>th</sup> edition, Pearson, 2018.
5. S. Ramamrutham., Strength of Materials, 16<sup>th</sup> edition, Dhanpatrai and Sons, 2011.

  
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20MEC06

## MANUFACTURING PROCESSES

Instruction  
Duration of SEE  
SEE  
CIE  
Credits

4 L Hours per Week  
3 Hours  
60 Marks  
40 Marks  
4

**Objectives:** To enable the students to

1. Understand various terms related to manufacturing processes
2. Understand various manufacturing processes
3. Provide the ability to solve simple problems such as riser design and sheet metal calculations
4. Compare various Manufacturing processes
5. Select suitable manufacturing process for a given component

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

1. Define various terms related to manufacturing processes
2. Demonstrate the understanding of various manufacturing processes
3. Solve simple problems such as riser design and sheet metal calculations
4. Compare various manufacturing processes
5. Choose suitable manufacturing process for a given component

## UNIT – I

**Manufacturing Processes:** Classification and importance.

**Casting:** Introduction, Classification of casting processes, Types of patterns, Pattern materials, Pattern allowances, Elements of gating system, Types of gates, Purpose and requirements of riser, Chvorinov's rule, Optimum shape and dimensions of riser, Riser design by Caine's method and Modulus method.

## UNIT - II

**Moulding and Melting:** Moulding sand and its ingredients, Required properties of moulding sand, Core and core prints, Melting by Cupola furnace, Induction and arc furnace, Casting defects and remedies

**Special Casting Processes:** Pressure die casting, Centrifugal casting, shell moulding, Investment casting and CO<sub>2</sub> moulding.

## UNIT- III

**Arc Welding:** Introduction to welding, Classification of welding processes, DCSP, DCRP, AC, shielded metal arc welding, Submerged arc welding, Gas-Tungsten arc welding and gas metal arc welding.

**Resistance Welding:** Principle, Spot, Projection, Seam, Butt and percussion welding processes.

**Solid State Welding:** Friction welding, Ultrasonic welding and explosive welding

**Other Welding Processes:** Oxy-Acetylene welding, Laser beam welding, Electron beam welding, Soldering and brazing.

## UNIT – IV

**Bulk Deformation Processes:** Open die, Closed die and isothermal forging processes, Rolling

process, Nomenclature of rolling , Geometric relationships in rolling, Direct, indirect, hydrostatic and impact extrusion processes , Wire drawing process

**Sheet Metal Operations:** Shearing process, Shearing load, Energy required, Types of shearing processes, Cup drawing process, Calculation of blank diameter for a given cup, Drawing load, Sheet bending process and bend allowance.

**High Energy Rate Forming Processes:** Explosive forming, Electro-hydraulic forming and electromagnetic forming.

#### UNIT – V

**Additive Manufacturing:** Introduction, Stereolithography, Fused deposition modeling, Selective laser sintering and applications of additive manufacturing

**Powder Processing:** Introduction, Production of powders, Mixing, Blending, Compacting and Sintering, Merits, Demerits and application of powder metallurgy products.

**Processing of Plastics, Ceramics and Composites:** Injection moulding, Blow moulding and thermoforming of plastics, Injection moulding and slip casting of ceramics, Roll bending and filament winding of composites.

#### Text Books:

1. G.K. Lal and S.K. Choudhury., Fundamentals of Manufacturing Processes, Alpha science International Ltd., 2005.
2. Mikell P.Grover., Principle of Modern Manufacturing, 5<sup>th</sup> edition, Wiley ; 2014,

#### Suggested Reading:

3. P.N. Rao., Manufacturing Technology, Vol.1, 3<sup>rd</sup> edition, Tata McGraw Hill Publ., 2011.
4. John Schey., Introduction to Manufacturing Processes, 2<sup>nd</sup> edition, McGraw Hill Education, 1999
5. Amitabh Ghosh and Mallick., Manufacturing Science, 4<sup>th</sup> edition, Assoc. East West Press Pvt. Ltd., 2011.

  
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20MTC08

**PARTIAL DIFFERENTIAL EQUATIONS AND STATISTICS**

Instruction	3 L + 1 THours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

**Objectives:**

1. To learn Numerical solution of ODE and Engineering problems.
2. To form PDE and to find its solution.
3. To know the model of wave and heat equations.
4. Able to fit the hypothetical data using probability distribution.
5. To learn fitting of distribution and predicting the future values.

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

1. Find solution of initial value problems of ODE by numerical method.
2. Solve Linear and non-linear PDE's.
3. Solve one-dimension wave and heat equations and two dimension Laplace equation.
4. Use the basic probability for fitting the Random phenomenon.
5. Analyze the random fluctuations of probability distribution and principles of least square approximations for the given data.

**UNIT-I:**

**Numerical Methods:** Solution of algebraic and transcendental equations by bisection method, Regula-Falsi method, Newton-Raphson method, Numerical solutions of first order ordinary differential equations by Taylor's series method, Euler's method, Modified Euler's method and Runge-Kutta method of fourth order.

**UNIT-II:**

**Partial Differential Equations:** Formation of partial differential equations, Linear equations of first order (Lagrange's linear equations), Solution of first order non-linear partial differential equation (standard forms) and Charpits method.

**UNIT-III:**

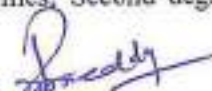
**Applications of Partial Differential Equations:** Solution by method of separation of variables, Solution of one dimensional wave equation, Solution of one dimensional heat equation, Solution of two dimensional Laplace equation and its related problems.

**UNIT-IV:**

**Basic Probability:** Basic probability, Conditional probability, Baye's theorem, Random variable, Discrete probability distribution and continuous probability distribution, Expectation, Addition and multiplication theorem of expectation, Properties of variance, Moments (moments about the mean and moments about a point)

**UNIT-V:**

**Probability Distributions and Curve Fitting:** Poisson distribution, MGF and cumulants of the Poisson distribution, Normal distribution, Characteristics of normal distribution MGF and CGF of normal distribution, Areas under normal curve, Correlation, Coefficient of correlation and lines of regression, Curve fitting by the method of least squares, Fitting of straight lines, Second degree parabola, Exponential and growth curves.



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**Textbooks:**

1. B.S. Grewal, Higher Engineering Mathematics, 44th Edition, Khanna Publishers, 2017.
2. S.C.Gupta and V.K. Kappoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 2014.

**Suggested Reading:**

1. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. S. J. Farlow, Partial Differential Equations for Scientists and Engineers, Dover Publications, 1993.
3. Sheldon Ross, A First Course in Probability, 9th Edition, Pearson publications, 2014.

  
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With Effect from the Academic Year 2021-22

20CSC06

**BASICS OF DATA STRUCTURES**  
(Common for all Programmes except CSE & IT)

Instruction	2 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	2

**Prerequisites:**

Basic knowledge of programming language such as C or C++ is preferred (but not mandatory) and some mathematical maturity also will be expected.

**Objectives:** To introduce

1. Basic linear and non-linear data structures.
2. Analyzing the performance of operations on data structures.
3. Different sorting and searching techniques and their complexities.

**Outcomes:** The students will be able to

1. Identify various data structures, searching & sorting techniques and their applications.
2. Describe the linear and non-linear data structures, searching and sorting techniques.
3. Apply suitable data structures to solve problems.
4. Analyze various searching and sorting techniques.
5. Evaluate the linear and non-linear data structures.

**UNIT – 1**

**Introduction:** Data types, Data structures, Types of data structures, Operations, ADTs, Algorithms, Comparison of algorithms, Complexity, Time and space tradeoff.

**Recursion:** Introduction, Format of recursive functions, Recursion vs Iteration, Examples.

**UNIT – 2**

**Linked Lists:** Introduction, Linked lists and types, Representation of linked list, Operations on linked list, Comparison of linked lists with arrays and dynamic arrays.

**UNIT – 3**

**Stacks and Queues:** Introduction to stacks, Applications of stacks, Implementation and comparison of stack implementations, Introduction to queues, Applications of queues and implementations, Priority queues and applications

**Searching and Sorting:** Linear searching, Binary Searching, Sorting algorithms, Bubble sort, Selection sort, Quick sort, Heap sort

**UNIT – 4**

**Trees:** Definitions and concepts, Operations on binary trees, Representation of binary tree, Conversion of general trees to binary trees, Representations of trees, Tree traversals and Binary search tree.

**UNIT –5**

**Graphs:** Introduction, Applications of graphs, Graph representations, graph traversals, Minimal Spanning Trees


  
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**Text Books:**

1. Narasimha Karumanchi, Data Structures and Algorithms Made Easy, CareerMonk Publications, 2017
2. E.Horowitz ,S. Sahni and Susan Anderson-Freed, Fundamentals of Data structures in C, 2<sup>nd</sup> Edition, Silicon Press, 2007)
3. RecmaThareja, Data Structures using C, Oxford, 2014

**Suggested Reading:**

1. [https://www.tutorialspoint.com/data\\_structures\\_algorithms/index.htm](https://www.tutorialspoint.com/data_structures_algorithms/index.htm)
2. <https://www.edx.org/course/foundations-of-data-structures>
3. <https://sites.google.com/site/merasemester/data-structures/data-structures-1#DS>
4. <https://www.cs.usfca.edu/~galles/visualization/Algorithms>
5. <https://www.coursera.org/specializations/data-structures-algorithms>



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20EGM03

**UNIVERSAL HUMAN VALUES II: UNDERSTANDING HARMONY**

(Common for all Programs)

Instruction	2 L+1T Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	3

**Course Objectives:**

This course aims to:

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society, and nature/existence.
2. Understanding (or developing clarity) of the harmony in human being, family, society, and nature/existence.
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

**Course Outcomes:**

Upon completion of this course, students will be able to:

1. Students are expected to become more aware of themselves, and their surroundings (family, society, nature)
2. They would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
3. They would have better critical ability.
4. They would also become sensitive to their commitment towards what they have understood (human values, human relationship, and human society).
5. It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

The course has 28 lectures and 14 practice sessions:

**UNIT-I****Course Introduction - Need, Basic Guidelines, Content and Process for Value Education**

- Purpose and motivation for the course, recapitulation from Universal Human Values-I
- Self-Exploration-what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation-as the process for self-exploration.
- Continuous Happiness and Prosperity- A look at basic Human Aspirations.
- Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority.
- Understanding Happiness and Prosperity correctly- A critical appraisal of the current Scenario.
- Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence)



rather than as arbitrariness in choice based on liking-disliking.

## UNIT-II

### Understanding Harmony in the Human Being - Harmony in Myself

- Understanding human being as a co-existence of the sentient 'I' and the material 'Body'.
- Understanding the needs of Self ('I') and 'Body' - happiness and physical facility.
- Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer).
- Understanding the characteristics and activities of 'I' and harmony in 'I'.
- Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail.
- Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.

## UNIT-III

### Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship

- Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship.
- Understanding the meaning of Trust; Difference between intention and competence.
- Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship.
- Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co -existence as comprehensive Human Goals.
- Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

## UNIT-IV

### Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

- Understanding the harmony in the Nature.
- Interconnectedness and mutual fulfilment among the four orders of nature - recyclability and self-regulation in nature.
- Understanding Existence as Co-existence of mutually interacting units in all - pervasive space.
- Holistic perception of harmony at all levels of existence.

Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.



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**UNIT-V****Implications of the above Holistic Understanding of Harmony on Professional Ethics**

- Natural acceptance of human values.
- Definitiveness of Ethical Human Conduct.
- Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order.
- Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
- Case studies of typical holistic technologies, management models and production systems.
- Strategy for transition from the present state to Universal Human Order:
  - a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers.
  - b. At the level of society: as mutually enriching institutions and organizations.

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc.

**Mode of Conduct (L-T-P-C 2-1-0-3)**

- Lecture hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them. Tutorial hours are to be used for practice sessions.
- While analysing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.
- In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection and self- exploration.
- Scenarios may be used to initiate discussion. The student is encouraged to take up "ordinary" situations rather than "extra-ordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting.
- Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practicals are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignments and/or activities are included.
- The practice sessions (tutorials) would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.

**Assessment:**

This is a compulsory credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self-

assessment, peer assessment etc. will be used in evaluation.

Example:

Assessment by faculty mentor: 10 marks

Self-assessment/Assessment by peers: 10 M

Socially relevant project/Group Activities/Assignments: 20 marks

Semester End Examination: 60 marks

The overall pass percentage is 40%. In case the student fails, he/she must repeat the course.

#### Text Books:

1. R R Gaur, R Asthana, G P Bagaria, "A Foundation Course in Human Values and Professional Ethics", 2<sup>nd</sup> Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1 The teacher's manual
2. R R Gaur, R Asthana, G P Bagaria, "Teachers' Manual for A Foundation Course in Human Values and Professional Ethics", 2<sup>nd</sup> Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

#### Reference Books:

1. A Nagaraj Jeevan Vidya: Ek Parichaya, Jeevan Vidya Prakashan, Amar kantak, 1999.
2. N. Tripathi, "Human Values", New Age Intl. Publishers, New Delhi, 2004.
3. Cecile Andrews, Slow is Beautiful
4. Gandhi - Romain Rolland (English)
5. Dharampal, "Rediscovering India"
6. E. F Schumacher. "Small is Beautiful."
7. J. C. Kumarappa "Economy of Permanence"
8. Pandit Sunderlal "Bharat Mein Angreji Raj"
9. Mohandas Karamchand Gandhi "The Story of My Experiments with Truth"
10. Mohandas K. Gandhi, "Hind Swaraj or Indian Home Rule"
11. Maulana Abdul Kalam Azad, India Wins Freedom -
12. Vivekananda - Romain Rolland (English)
13. The Story of Stuff (Book).

  
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20CEM01

**ENVIRONMENTAL SCIENCE**

Instruction	2 L Hours per Week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	0 Marks
Credits	0

**Objectives:** To enable the student

1. Identify environmental problems arising due to over utilization of natural resources and understand the importance of use of renewable energy sources
2. Become aware about the importance of eco system and interlinking of food chain.
3. Identify the importance of biodiversity in maintaining ecological balance.
4. Learn about various attributes of pollution management and waste management practices.
5. Contribute for capacity building of nation for arresting and/or managing environmental disasters.

**Outcomes:** At the end of the course, student is able to

1. Identify the natural resources and realize the importance of water, food, forest, mineral, energy, land resources and affects of over utilization.
2. Understand the concept of ecosystems and realize the importance of interlinking of food chains.
3. Contribute for the conservation of bio-diversity.
4. Suggest suitable remedial measure for the problems of environmental pollution and contribute for the framing of legislation for protection of environment.
5. Follow the environmental ethics and contribute to the mitigation and management of environmental disasters.

**UNIT- I:****Environmental Studies:** Definition, Scope and importance, Need for public awareness.**Natural resources:** Use and over utilization of natural resources, Water resources, Food resources, Forest resources, Mineral resources, Energy resources, Land resources.**UNIT – II:****Ecosystems:** Concept of an ecosystem, Structure and function of an ecosystem, Role of producers, Consumers and decomposers, Energy flow in an ecosystem, Food chains, Food webs, Ecological pyramids, Nutrient cycling, Bio-geo chemical cycles, Terrestrial and aquatic ecosystems.**UNIT – III:****Biodiversity:** Genetic, Species and ecosystem biodiversity, Bio-geographical classification of India, India as a mega diversity nation, Values of biodiversity, Hot-spots of biodiversity, Threats to biodiversity, Endangered and endemic species of India, Methods of conservation of biodiversity.

  
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**UNIT – IV:**

**Environmental Pollution:** Cause, Effects and control measures of air pollution, Water pollution, Marine pollution, Soil pollution, Noise pollution, Solid waste management, Nuclear hazards.

**Environmental Legislations:** Environment protection Act, Air, Water, Forest & Wild life Acts, Issues involved in enforcement of environmental legislation, Responsibilities of state and central pollution control boards

**UNIT – V:**

**Social Issues and the Environment:** Water conservation methods, Rain water harvesting and watershed management, Environmental ethics, Sustainable development and Climate change, Global warming, Ozone layer depletion, Forest fires and Contemporary issues.

**Text Books:**

1. Y. Anjaneyulu, Introduction to Environmental Science, B S Publications, 2004.
2. Suresh K. Dhameja, Environmental Studies, S. K. Kataria & Sons, 2009.

**Suggested Reading:**

1. C. S. Rao, Environmental Pollution Control Engineering, Wiley, 1991.
2. S. S. Dara, A Text Book of Environmental Chemistry & Pollution Control, S. Chand Limited, 2006

  
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20MEC07

**MATERIAL SCIENCE AND METALLURGY LAB**

Instruction	2 L Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

**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 Heat treatment operations.
4. Understand differences between different heat treatment methods.
5. Understand the relation between micro structure and properties.

**Outcomes:** At the end of the course, a student 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. Correlate the heat treatment methods and the mechanical properties obtained

**List of the experiments**

1. Study of metallurgical microscope.
2. Observing the microstructure of low carbon steel, medium carbon steel and high carbon steel specimens.
3. Observing the microstructure of austenitic stainless steel, high speed steel and case carburized steel specimens.
4. Observing the microstructure of grey cast iron, white cast iron and spheroidal cast iron specimens.
5. Observing the microstructure of Al-Si alloy, and malleable cast iron specimens.
6. Preparation of  $\alpha$ - $\beta$  brass and normalized steel specimens for micro structural observation.
7. Preparation of medium carbon steel and mild steel specimens for micro structural observation.
8. Preparation of nodular cast iron and grey cast iron specimens for micro structural observation.
9. Determination of grain size using image analyzer.
10. Annealing and preparation of the given Steel specimen for microstructural observation.
11. Normalizing and preparation of the given Steel specimen for microstructural observation.
12. Hardening and preparation of the given Steel specimen for microstructural observation.
13. Comparative study on the influence of heat treatments (annealing, normalizing and hardening) on the microstructure and hardness of the given Steel specimen.

  
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**Note: A minimum of 12 experiments need to be conducted.**

**Suggested Reading:**

1. V. Raghavan, Materials Science and Engineering, 4<sup>th</sup> edition, Prentice Hall of India Ltd., New Delhi, 2005.
2. S. H. Avner, Introduction to Physical Metallurgy, 2<sup>nd</sup> edition, Tata McGraw Hill Publishers, New Delhi, 2005.
3. Virtual labs – Physical Metallurgy Lab, NITK SURATHKAL.

  
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20MEC08

**STRENGTH OF MATERIALS LAB**

Instruction	2 L Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

**Objectives:** Students will

1. Demonstrate an understanding of tension, and the relationship between stress, strain and application of Hooke's law.
2. Demonstrate an understanding of types of beams, deflections and measurement of material property through deflections.
3. Demonstrate an understanding of torsion and deformations resulting from torsion.
4. Demonstrate the understanding of hardness and its measurement using different scales like Brinell and Rockwell.
4. Demonstrate an understanding of measurement of shear modulus and young's modulus for machine members like helical and leaf springs through loading respectively.

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

1. Draw stress-strain curve for an isotropic material and understand the salient features of it.
2. Determine the Young's modulus of various beam materials and leaf spring by conducting load-deflection test.
3. Rigidity modulus of a given shaft specimen by torsion test and shear modulus of closely coiled helical spring.
4. Evaluate hardness of different materials using different scales
5. Find the compressive and crushing strengths of concrete cubes and bricks.

**List of the experiments:**

1. Tension test on mild steel.
2. Compression test on mild steel.
3. Tension test on cast iron.
4. Compression test on cast iron.
5. Brinell's and Rockwell's hardness tests.
6. Izod Impact test.
7. Load-deflection test on a leaf spring to find out the Young's modulus of leaf material.
8. Deflection test on a helical spring to determine the rigidity modulus.
9. Torsion of shaft to determine the rigidity modulus of shaft material.
10. Deflection test on a cantilever beam to determine the Young's modulus.
11. Deflection test on a simply supported beam to determine the Young's modulus.
12. Deflection test on propped cantilever to determine the Young's modulus.



13. Deflection test on continuous beam to determine the Young's modulus.
14. Crushing and compression test on bricks and concrete cubes.
15. Look at each component (arm, leg, seat, back, etc.) of a chair in a classroom and decide what type of familiar structure it is and what type of loads act on it during normal use. List each component, state where and how the load acts and select the theory which you would have to consider when analyzing the stresses in the chair.

**Note: A minimum of 12 experiments need to be conducted.**

**Suggested Reading:**

1. S.S. Rattan., Strength of Materials, 3<sup>rd</sup> edition, Tata Mc-Graw Hill, 2017.
2. R. C. Hibbler, Mechanics of Mechanics of Materials, 9<sup>th</sup> Pearson, 2018.
3. Virtual labs – Strength of Materials Lab, NITK Surathkal.



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20MEC09

**MANUFACTURING PROCESSES LAB**

Instruction	2 L Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

**Objectives:** To enable the students to

1. Test the moulding sand and analyze the same.
2. Test the bead geometry and correlate the results to the input parameters.
3. Use TIG, MIG and Spot welding machines and experiment with them.
4. Test the formability characteristics of a given sheet metal and study different types of dies.
5. Understand the various type of sheet metal forming dies

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

1. Test the moulding sand and analyze the same.
2. Test the bead geometry and correlate the results to the input parameters.
3. Use TIG, MIG and spot welding machines and experiment with them.
4. Test the formability characteristics of a given sheet metal.
5. Demonstrate the understanding of various types of dies

**List of the Experiments:****Casting:**

1. Design of a simple pattern with various allowances.
2. Moulding sand testing: GCS, GSS, DCS and DSS
3. Moulding sand testing: Permeability and shatter index.
4. Finding out the GFN and Moisture content for a given sand sample.
5. Melting and Pouring of Aluminum.

**Welding:**

1. Study of Arc welding process, comparison of the bead geometry with DCSP, DCRP and A.C.
2. Study of resistance welding process and spot welding of MS Sheets.
3. Study of TIG welding process and plotting cooling curve in TIG welding process
4. Study of SAW Welding process and finding out deposition efficiency of the process.
5. Study of MIG welding process and testing of weld bead formed by MIG welding.

**Metal Forming:**

1. Evaluation of Formability of a given sheet material using Erichsen cupping test.
2. Study of Progressive die design and manufacturing of washer components using the same on a fly press (capacity 6 Tons) and estimation of forces.
3. 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.
4. 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.
5. Study of extrusion dies and demonstration of extruding lead material
6. 3 D Printing of a simple component.



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**Note:** A minimum of 12 experiments need to be conducted.

**Suggested Reading:**

1. P.N. Rao., Manufacturing Technology, Vol.1, 3<sup>rd</sup> edition, Tata McGraw Hill Publ., 2011.
2. Amitabh Ghosh and Mallick., Manufacturing Science, 4<sup>th</sup> edition, Assoc. East West Press Pvt. Ltd., 2011.
3. Metal Forming Virtual Simulation Lab, Dayalbagh Educational Institute, Agra



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20CSC07

**Basics of Data Structures Lab**  
(Common for all Programmes except CSE & IT)

Instruction	2 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	50 Marks
Credits	1

**Pre-requisites: Any Programming Language**

**Course Objectives:**

1. Design and construct simple programs by using the concepts of Data structures as abstract data type.
2. To have a broad idea about how efficiently pointers can be used in the implement of data structures.
3. To enhance programming skills while improving their practical knowledge in data structures.
4. To strengthen the practical ability to apply suitable data structure for real time applications.

**Course Outcomes:** The students will be able to

1. Implement the abstract data type.
2. Demonstrate the operations on stacks, queues using arrays and linked lists
3. Apply the suitable data structures including stacks, queues to solve problems
4. Analyze various searching and sorting techniques.
5. Choose proper data structures, sorting and searching techniques to solve real world problems

**List of Experiments**

1. Implementation of operations on arrays
2. Implementation of Stack.
3. Implementation of Queue.
4. Implementation of basic operations on Single Linked List.
5. Implementation of Searching techniques.
6. Implementation of Sorting Techniques
7. Case study like Banking System, Students Marks Management, Canteen Management, Library Management etc
8. Open Ended questions

**Text Books**

1. Brian W Kernighan, Dennis Ritchie, C Programming Language, PH PTR, 2nd Edition.
2. Richard M Reese, Understanding and Using C Pointers, O'Reily , 2013.

**WebLinks**

<https://nptel.ac.in/courses/106102064/>

<https://www.udemy.com/algorithms-and-data-structures-in-python/>



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20MEC10

**KINEMATICS OF MACHINES**

Instruction	3 L+1T Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

**Objectives:** At the end of the course, student will be able to understand

1. Basic elements of mechanisms and their motion characteristics, DOF
2. Velocity and Acceleration analysis of various mechanisms.
3. Principles involved in functioning of pivots, collars, clutches, belts, brakes and dynamometers
4. Drawing displacement diagrams and cam profile diagram for followers executing different types of motions and various configurations of followers.
5. Selecting gear and gear train depending on application.

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

1. Understand basic elements of mechanisms and their motion characteristics, DOF.
2. Analyze Velocity and Acceleration of various mechanisms.
3. Understand and Evaluate Principles involved in functioning of pivots, collars, clutches, belts, brakes and dynamometers.
4. Design displacement diagrams and cam profile diagram for followers executing different types of motions and various configurations of followers.
5. Select gear and gear train depending on application.

**UNIT - I**

**Basics of Mechanisms:** Definition of kinematic link, Pair, Kinematic chain, Mechanism and machine, Degrees of freedom, Grubler's criterion, Inversions of four bar mechanism, 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**

**Velocity and Acceleration of Mechanisms:** Velocities of mechanisms by instantaneous centre, Body centrode, Space centrode, Kennedy's theorem, Determination of velocity and acceleration of different mechanisms by relative velocity method including Coriolis component of acceleration, Freudenstein's method for synthesis of four bar linkage.

**UNIT- III**

**Friction:** Friction in pivots, Collars. Clutches - Single and Multi plate, Cone and centrifugal clutches.

**Brakes and Dynamometers:** Block or shoe, Band and block, Internal expanding shoe brake, Prony brake, 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 cycloidal tooth profile.

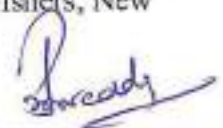
**Gear Trains:** Gear trains, Simple, Compound, Reverted and epicyclic gear trains, Differential of an automobile.

**Text Books:**

1. Thomas Bevan., Theory of Machines, CBS Publishers, 2009.
2. S.S. Rattan., Theory of Machines, 4<sup>th</sup> edition, Tata McGraw Hill Publishers, 2017.

**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, 3<sup>rd</sup> edition, East West Publications, 2009.
3. J.E. Shigley, Theory of Machines, 3<sup>rd</sup> edition, Tata Mc.Graw Hill Publishers, New Delhi, 2014.



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20MEEC11

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## THERMODYNAMICS

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** Students 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 principles associated with second law of thermodynamics.
4. Properties of pure substances and use of Mollier diagram.
5. Various air standard cycles, vapour power cycles and their importance.

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

1. Understand the concepts of system, thermodynamic properties, thermodynamic equilibrium and various methods of pressure and temperature measurements.
2. Apply the first law of thermodynamics to various thermodynamic processes along with the applications of steady flow energy equation.
3. Apply the Second law of thermodynamics to analyze heat pumps, refrigerators, heat engines and to evaluate entropy changes.
4. Evaluate the properties of pure substances and analyze the performance of steam power cycles.
5. Evaluate performance of air standard cycles and analyze the properties of gas mixtures.

### 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

**Energy Interactions and 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, Diffuser, Throttling device, Turbine, Compressor and heat exchanger.

### 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, Introduction to available and unavailable energy, Third law of thermodynamics, Helmholtz and Gibb's functions.

#### UNIT - IV

**Pure Substances:** 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, Clapeyron equation.

**Vapour Power Cycles:** Vapour power cycles - Carnot cycle, Simple Rankine cycle, Representation on p-v, T-s and h-s diagrams, Evaluation of performance parameters, Efficiency, Work ratio, Specific steam consumption and heat rate.

#### 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.

**Non-reactive Ideal Gas Mixtures:** Mole fraction, Mass fraction, Partial pressure, Dalton's law of partial pressures, Amagat-Leduc law of partial volumes, Relation between partial pressures, Mole fraction and volume fraction, Gas constant, Molecular mass, Specific heats of gas mixtures, Relation between volumetric and gravimetric analysis, Determination of theoretical air fuel ratio and equivalence ratio for various fuels,

#### Text Books:

1. P.K. Nag., Engineering Thermodynamics, 6<sup>th</sup> edition, Tata McGraw Hill Publishing, 2017
2. Yunus Cengel and Michael Boles., Thermodynamics: An Engineering Approach, 8<sup>th</sup> edition, McGraw Hill Education, 2017.

#### Suggested Reading:

1. R.K. Rajput., Engineering Thermodynamics, 4<sup>th</sup> Edition, Laxmi Publications, 2016.
2. Mahesh M Rathore., Thermal Engineering, Tata McGraw Hill Publishers, 2013.
3. D.S. Kumar., Engineering Thermodynamics, S.K. Kataria and Sons, 2014.



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20MEC12

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## FLUID PRINCIPLES AND HYDRAULIC MACHINES

Instruction	3 L + 1T Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

**Objectives:** Students will

1. Learn properties of fluids, laws related to fluid flow and their applications.
2. Understand the principles and problems associated with impact force of jet on the vanes
3. Understand various principles and performance characteristics related to Reciprocating pumps.
4. Come to know the working principles and performance characteristics of Centrifugal pumps.
5. Learn the working principle and efficiencies of hydraulic turbines.

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

1. Determine the various properties of fluid and their applications
2. Understand the methodology in calculation of impact force exerted by the jet on the vanes
3. Acquire the knowledge of the functionality and performance of reciprocating pumps.
4. Estimate the performance and testing of centrifugal pumps.
5. Acquire knowledge in the functionality, performance and testing of hydraulic turbines.

### UNIT - I

**Properties and Laws of Fluid Flow:** Fluids, Properties, Density, Specific weight, Specific gravity, Viscosity, Newton's law of viscosity, Pressure, Laws of fluid flow, Continuity theorem, Bernoulli's theorem, Pitot tube, Venturimeter, Notches, Darcy Weisbach equation, Hydraulic machines, Impulse-momentum equation and applications.

### UNIT - II

**Impact of Jet on Vanes:** Layout of hydraulic power plant, Working principle, Velocity triangles, Impact force exerted, Power developed and efficiency of jet impinging on a fixed flat vertical vane, A single and series of flat moving vertical vanes, At the center and at one end of a fixed symmetrical and unsymmetrical curved vane, At the center and at one end of a single and series of symmetrical and unsymmetrical moving curved vanes.

### UNIT- III

**Reciprocating Pumps:** Classification and working principle, Discharge, Slip, Coefficient of discharge, Power required to drive the pump and efficiency, Variation of pressure head due to acceleration of piston and pipe friction, Ideal and actual indicator diagrams, Separation, Safe speed to avoid separation, Air vessels, Work saved, Quantity of water entering into or coming out of air vessels and performance characteristic curves.



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**UNIT - IV**

**Centrifugal Pumps:** Classification and working principle, Comparison over reciprocating pumps, Velocity triangles, Head equivalent of workdone, Efficiencies, Pressure rise, Minimum starting speed, Specific speed, Physical significance, Model testing, Conditions of similarity, Priming, Performance characteristic curves, Common operational problems (troubles), reasons and remedies.

**UNIT - V**

**Hydraulic Turbines:** Classification and working, Velocity triangles, Power developed and efficiencies of Pelton wheel, Francis turbine and Kaplan turbines, Design of hydraulic turbines, Specific speed, Physical significance, Unit testing, Unit quantities, Model testing, Conditions for similarity and performance characteristic curves.

**Text Books:**

1. P.N. Modi and S.M. Seth., Hydraulics and Fluid Mechanics Including Hydraulic Machines, 22<sup>nd</sup> edition, Standard Book House, New Delhi, 2019.
2. R.K. Bansal., A Text Book of Fluid Mechanics and Hydraulic Machines, 9<sup>th</sup> edition, Laxmi Publications (P) Ltd., New Delhi, 2015.

**Suggested Reading:**

1. R.S. Khurmi and N. Khurmi., Hydraulics, Fluid Mechanics and Hydraulic Machines, 20<sup>th</sup> edition, S.Chand publishing, 2014
2. S. Ramamrutham., Hydraulics, Fluid Mechanics and Fluid Machines, Dhanpat Rai and Sons, New Delhi, 2004.
3. Madan Mohan Das., Fluid Mechanics and Turbomachines, PHI Learning Private Limited, New Delhi, 2009.



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20MEEC13

**METAL CUTTING AND MACHINE TOOL ENGINEERING**

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:**

1. Various cutting tool materials and tool geometry.
2. Factors effecting tool life and thermal aspects of metal cutting.
3. The working principles of various of types of lathes, drilling machine and milling machines ,
4. The working principles of boring machines, grinding machines and thread production
5. Working principles of non-conventional machines and jigs and fixtures

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

1. Describe tool geometry, select tool material for machining of various material and identify the types of chips.
2. Calculate cutting forces, MRR, power consumption under different cutting conditions.
3. Classify the mechanisms of tool wear, estimate tool life using Taylor's equation under various cutting conditions
4. Identify the basic parts, specifications, operations of various machine tools and understand jigs & fixtures
5. Classify methods of unconventional machining and identify suitable method for a given component.

**Unit-I**

**Cutting Tool Materials:** High carbon steel, HSS, Stellite, Carbides, Coated carbides and diamond.

**Tool Geometry:** Nomenclature of single point cutting tool by ASA and ORS, Geometry of drills, Milling cutters and broaches, Recommended Tool angles.

**Chip Formation:** Basic chip formation process, Types of chips, BUE, Chip breakers.

**Machining:** Orthogonal and oblique cutting, Mechanics of metal cutting, Merchant's 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, Tool Life & Machinability:** Types of wear, Mechanism of tool wear, Tool life & machinability, Effects of process parameters on tool life, Taylor's tool life equation.

**Economics of machining:** Tool life for maximum production and minimum cost.

**Unit-III**

**Constructional Features and Specifications of Machine Tools:** Various operations on lathe, Types of lathes and special attachments on a centre lathe, Drilling, Milling operations, Indexing methods, Shaper, Planer, Slotter and their differences, Quick return mechanisms,



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Automatic feed devices. Jig boring machines, Differences between horizontal and vertical jig boring machines

#### Unit- IV

**Grinding Machines:** Types of grinding, Abrasives and bonds used for grinding wheels. Specification and selection of wheels. Principles of broaching, Lapping, Honing, Polishing, Buffing, Super finishing and burnishing.

**Screws and Gear Manufacturing:** Screw making by tapping, Chasers, Thread rolling, Thread milling, Thread grinding. Gear shaping, Gear hobbing, Gear shaving and grinding.

#### Unit-V

**Jigs and Fixtures:** Design principles for location and clamping. Tool holding and work holding devices, Quick clamping devices, Types of Jigs and fixtures.

**Unconventional Machining:** Principles of working and applications of USM, AJM, WJM, EDM, ECM, LBM and EBM.

#### Text Books:

1. B.L. Juneja, G.S. Shekhon and Seth Nitin., Fundamentals of metal cutting & Machine tools, New Age Publishers, 2003.
2. P.N. Rao., Manufacturing Technology – Metal Cutting & Machine Tools, Vol. 2, Tata McGraw Hill Education Pvt. Ltd, 2010.

#### Suggested Reading:

1. David A. Stephenson and John S. Agapiou., Metal Cutting Theory and Practice, 3rd edition, CRC Press, March 2016
2. Amitabha Ghosh and Ashok Kumar Mallik., Manufacturing Science, 2nd Edition, Affiliated East-West Press Pvt. Ltd, 2010.
3. M.C. Shaw., “Metal Cutting Principles”, Clarendon Press, Oxford 1984.

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CBIT (A)

With Effect from the Academic Year 2021-22

20EGM01

**INDIAN CONSTITUTION AND FUNDAMENTAL PRINCIPLES**

Instruction	2 L Hours per Week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	0 Marks
Credits	0 Non Credit Course

**Objectives:** The course will introduce the students to:

1. History of Indian Constitution and how it reflects the social, political and economic perspectives of the Indian society.
2. Growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. Various Organs of Governance and Local Administration.

**Outcomes:** After successful completion of the course the students will be able to:

1. Understand the making of the Indian Constitution and its features.
2. Identify the difference among Right To equality, Right To freedom and Right to Liberty.
3. Analyze the structuring of the Indian Union and differentiate the powers between Union and States.
4. Distinguish between the functioning of Lok Sabha and Rajya Sabha while appreciating the importance of Judiciary.
5. Differentiate between the functions underlying Municipalities, Panchayats and Co-operative Societies.

**UNIT - I**

**Constitution of India:** Constitutional history, Govt of India Act 1909, 1919 and 1935, Constitution making and salient features. Directive principles of state policy, Its importance and implementation.

**UNIT - II**

**Scheme of the Fundamental Rights & Duties:** The Fundamental Rights, Equality, Certain freedom under Article 19, Life and personal liberty under Article 21, Fundamental Duties and the legal status.

**UNIT - III**

**Union Government and its Administration** - Structure of the Indian union, Federalism, Distribution of legislative and financial powers between the union and the states, Parliamentary form of government in India, Executive, President's role, Power and position.

**UNIT - IV**

**Legislature and Judiciary:** Central Legislature, Powers and functions of Lok Sabha and Rajya Sabha.

**Judiciary:** Supreme court, Functions, Judicial review and judicial activism

**UNIT - V**

**Local Self Government** - District's administration head (Collector), Role and importance.

**Municipalities:** Introduction, Mayor and role of elected representative, CEO of municipal corporation.

**Panchayati Raj:** Introduction, Zilla panchayat, Elected officials and their roles, CEO zilla

**Panchayat:** Position and role, Block level, Organizational hierarchy (different departments).

**Village level:** Role of elected and officials.

**Text Books:**

1. Ed Prof V Ravindra Sastry, Indian Government & Politics, 2nd edition, Telugu Akademy, 2018.
2. Indian Constitution at Work, NCERT, First edition 2006, Reprinted- January 2020.

**Suggested Reading:**

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar, Framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edition, Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

**Online Resources:**

1. <http://www.nptel.ac.in/courses/103107084/Script.pdf>



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With Effect from the Academic Year 2021-22

20EGM02

**INDIAN TRADITIONAL KNOWLEDGE**

Instruction	2 L Hours per Week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	2 MID Sem assignments (Optional)
Credits	0 Non Credit Course

**Objectives:**

1. To get a knowledge in Indian Culture
2. To Know Indian Languages and Literature and the fine arts in India
3. To explore the Science and Scientists of Medieval and Modern India

**Outcomes:** After completion of this course, students will be able to:

1. Understand philosophy of Indian culture
2. Distinguish the Indian languages and literature
3. Learn the philosophy of ancient, medieval and modern India
4. Acquire the information about the fine arts in India
5. Know the contribution of scientists of different eras.

**UNIT-I**

**Culture and Civilization:** Culture, Civilization and heritage, General characteristics of culture, Importance of culture in human literature, Cultural diversity, Aesthetics, Women seers, Indus culture, Indian cuisine, Martial arts

**UNIT-II**

**Education System:** Education in ancient, Medieval and modern India, Aims of education, Subjects, Languages, Science and scientists of ancient India, Science and scientists of medieval India, Scientists of modern India

**UNIT-III**

**Linguistic Wealth:** Indian Languages and Literature, The role of Sanskrit, Paleography, Significance of scriptures to current society, Indian semantics and lexicography, Bhakti literature, Darsanas

**UNIT-IV**

**Art, Technology & Engineering:** Sculpture, Painting and handicrafts, Indian music, Dance drama and theatre, Introduction to mayamatam, Iron and steel technology, Use of metals in medicinal preparations

**UNIT-V**


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**Science and Logic:** Helio-centric system, Sulbasutras, Katapayadi, Hindu calendar, 6 pramanas in Indian logic, Scientific method applied to therapeutics, Fallacies, Tarka – Induction & Deduction, Ayurvedic biology, Definition of health

**Essential Readings:**

1. Kapil Kapoor, Text and Interpretation: The Indian Tradition, ISBN: 81246033375, 2005
2. Samskrita Bharati, Science in Samskrit, ISBN-13: 978-8187276333, 2007
4. Satya Prakash, Founders of sciences in Ancient India, Govindram Hasanand, ISBN-10: 8170770009, 1989
5. Brajendranath Seal, The Positive Sciences of the Ancient Hindus, Motilal Banarasidass, ISBN-10: 8120809254, 1915

**Suggested Readings:**

1. Swami Vivekananda, *Caste, Culture and Socialism*, Advaita Ashrama, Kolkata ISBN-9788175050280
2. Swami Lokeshwarananda, *Religion and Culture*, Advaita Ashrama, Kolkata ISBN-9788185843384
3. Kapil Kapoor, *Language, Linguistics and Literature: The Indian Perspective*, ISBN-10: 8171880649, 1994.
4. Karan Singh, *A Treasury of Indian Wisdom: An Anthology of Spiritual Learn*, ISBN: 978-0143426158, 2016
5. Swami Vivekananda, *The East and the West*, Advaita Ashrama, Kolkata 9788185301860
6. Srivastava R.N., *Studies in Languages and Linguistics*, Kalinga Publications ISBN-13: 978-8185163475
7. Subhash Kak and T.R.N. Rao, *Computation in Ancient India*, Mount Meru Publishing ISBN-1988207126
8. R.N Misra, *Outlines of Indian Arts Architecture, Painting, Sculpture, Dance and Drama*, IAS, Shimla & Aryan Books International, ISBN 8173055149
9. S. Narain, *Examinations in ancient India*, Arya Book Depot, 1993
10. M. Hiriyanna, *Essentials of Indian Philosophy*, Motilal Banarsidass Publishers, ISBN-13: 978-8120810990, 2014
11. Ravi Prakash Arya, *Engineering and Technology in Ancient India*, Indian Foundation for Vedic Science, ISBN-10: 1947593072020

**SWAYAM/Nptel:**

1. History of Indian Science and Technology - [https://onlinecourses.swayam2.ac.in/arp20\\_ap35/preview](https://onlinecourses.swayam2.ac.in/arp20_ap35/preview)
2. Introduction to Ancient Indian Technology – [https://onlinecourses.nptel.ac.in/noc19\\_ae07/preview](https://onlinecourses.nptel.ac.in/noc19_ae07/preview)
3. Indian Culture & Heritage - [https://onlinecourses.swayam2.ac.in/nos21\\_sc11/preview](https://onlinecourses.swayam2.ac.in/nos21_sc11/preview)
4. Language and Society - <https://nptel.ac.in/courses/109/106/109106091/>
5. Science, Technology & Society - <https://nptel.ac.in/courses/109/103/109103024/>
6. Introduction to Indian Philosophy - <https://nptel.ac.in/courses/109/106/109106059/>
7. Introduction to Indian Art - An appreciation - [https://onlinecourses.nptel.ac.in/noc20\\_hs09/preview](https://onlinecourses.nptel.ac.in/noc20_hs09/preview)



CBIT (A)  
20MEE01

With Effect from the Academic Year 2021-22

**POWER PLANT ENGINEERING**  
(Professional Elective - I)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:**

1. Different types of power plants and their site selection criteria
2. Operation of thermal power plant
3. About hydraulic power plants, 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, environmental and safety aspects of power plant operation.

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

1. Identify different handling equipment used in steam plant.
2. Understand various coal combustion methods.
3. Recognize different types of dams, spill ways and hydro electric power plants.
4. Classify nuclear power plants based on moderator and coolant.
5. Analyze economics related to power plants and effect of pollutants.

**UNIT - I**

**Introduction:** Energy and power, Sources of energy, Classification of power plants, Power development in India.

**Steam power plant:** Plant Layout, Site selection factors, Types of coal, Requirements of good coal handling plant, Coal and ash handling systems, Removal of dust and dust collectors.

**UNIT II**

**Coal Combustion and Firing Methods:** Overfeed stoker, Chain grate and spreader stokers, Underfeed stoker, Multi-retort stoker, Unit system, Central bin system, Pulverized fuel burners, Cyclone burner, Fluidized bed combustion.

**UNIT III**

**Hydro Electric Power Plant:** Hydrological cycle, Recording and non recording rain gauges, Run-off flow measurement, Flow and mass duration curves, Site selection, Components and layout of hydro power plant, Types of dams and spillways, Classification of hydro electric plants.

**UNIT - IV**

**Nuclear Power Plant:** Breeding and fertile materials, Comparison of fission and fusion

processes, Essential components of a nuclear reactor, Pressurized water reactor, Boiling water reactor, Gas cooled reactor, Liquid metal cooled reactors, Breeder reactor, Radioactive waste disposal.

#### UNIT - V

**Power Plant Economics:** Terms and definitions, Types of loads, Load curve, Load duration curve, Fixed and operating costs, methods to find depreciation cost, Various types of tariffs.

**Environmental considerations:** Effluents from power plants and impact on environment.

#### Text Books:

1. R.K. Rajput, A Text Book of Power Plant Engineering, 5<sup>th</sup> edition, Laxmi Publications (P) Ltd, New Delhi, 2016.
2. P.K. Nag, Power Plant Engineering, 4<sup>th</sup> edition, McGra Hill Education (India) Private Limited, New Delhi, 2014.

#### 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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CBIT (A)  
20MEE02

With Effect from the Academic Year 2021-22

**PRODUCTION AND OPERATIONS MANAGEMENT**  
(Professional Elective-I)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:**

1. Understand plant layout design to facilitate material flow and processing of a product in the most efficient manner
2. 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.
3. Understand how Materials Requirement Planning and MRPII systems are used in managing operations
4. Recognize the importance of Inventory control to ensure their availability with minimum capital lock up.
5. Evaluate the quality processes in manufacturing and service sector to improve the operational performance

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

1. Understand the role of production system and its design in production and operations management.
2. Apply forecasting techniques for predicting demand
3. Use aggregate planning, master scheduling and materials requirement planning in a production system
4. Compare various inventory control techniques used in production system.
5. Apply the quality control tools to improve performance of production system.

**UNIT-I**

**Introduction:** Production systems, Classification and characterisation

**Plant Location and Layout:** Factors affecting plant location, Objectives of plant layout, Types of layouts, Merits and demerits.

**Work Study:** Productivity, Introduction to method study and work measurement, Standard time calculations, Work sampling.

**UNIT-II**

**Forecasting:** Introduction, Forecasting objectives and uses, Demand patterns, Qualitative models, Market survey, Delphi method, Quantitative models, Moving average, Weighted

moving average, Simple exponential smoothing, Trend adjusted exponential smoothing, Simple regression.

**Forecast Errors:** Mean absolute deviation, Mean square error, Mean forecast error, Mean absolute percentage error

### 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:** Importance, MRP system, Inputs and outputs, Bill of materials.

### UNIT-IV

**Inventory Control:** Importance, Inventory control systems, Types of Inventories, Inventory costs, Deterministic Inventory models, Basic purchase model, Purchase model with instantaneous replenishment and with shortages, Basic production model, Production model with shortages, Inventory model with price breaks, Just-in-time system evolution and its characteristics.

### UNIT-V

**Quality Control:** Introduction, Quality gurus and their contributions, Quality tools, Process capability, Quality control by control charts, Sampling plans, Operating characteristic curve, Introduction to total quality management and six-sigma.

### Text Books:

1. Joseph G. Monks., Operations Management: Theory and Problems, 3<sup>rd</sup> edition, McGraw Hill International Edition, 1987.
2. William J. Stevenson., Operations Management, 8th edition, Tata McGraw Hill Edition, 2005.

### Suggested Reading:

1. Everette E. Adam and Ronald J. Ebert., Production & Operations Management, 5<sup>th</sup> edition, Prentice Hall of India, 2005.
2. R. Panneerselvam., Production and Operations Management, 2<sup>nd</sup> edition, PHI Learning Pvt. Ltd., New Delhi, 2006.
3. Elwood S. Buffa., Modern Production/Operations Management, 5<sup>th</sup> edition, John Wiley Publishers, Singapore, 2002



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CBIT (A)  
20MEE03

With Effect from the Academic Year 2021-22

**ENTREPRENEURSHIP**  
(Professional Elective - I)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:**

1. Concept and procedure of idea generation.
2. The nature of industry and related opportunities and challenges.
3. Elements of business plan and its procedure.
4. Project management and its techniques.
5. Behavioural issues and Time management.

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

1. Understand the concept and essence of entrepreneurship.
2. Identify business opportunities and nature of enterprise.
3. Analyze the feasibility of new business plan.
4. Apply project management techniques like PERT and CPM for effective planning and execution of projects.
5. Use behavioral, leadership and time management aspects in entrepreneurial journey.

**UNIT-I**

**Entrepreneurship:** Definition, Functions of entrepreneurs, Qualities of entrepreneurs, Entrepreneur vs intrapreneur, First generation entrepreneurs, Women entrepreneurs, Innovation, Creativity, Intellectual property in entrepreneurial journey, Conception and evaluation of ideas and their sources, Need and importance of startups and incubation centers.

**UNIT-II**

**Indian Industrial Environment:** Competence, Opportunities and challenges, Entrepreneurship and economic growth, Small scale industry in India, Objectives, Linkage among small, medium and large scale industries, Types of enterprises, Corporate social responsibility.

**UNIT-III**

**Formulation of Business Plan:** Introduction, Business model canvas, Elements of business plan and its salient features, Technical analysis, Profitability and financial analysis, Marketing analysis, Executive summary. Choice of technology and collaborative interactions, Sources of finance and Incentives for entrepreneurs. Business firm registration procedures.

**UNIT-IV**

**Project Management:** Meaning and definition of project, Project organization, Project planning, Execution and control using CPM and PERT techniques, Human aspects of project management, Assessment of tax burden, Environmental issues.

**UNIT-V**

**Behavioral Aspects of Entrepreneurs:** Personality determinants, Maslow's hierarchy of needs, Leadership concepts and models, Values and attitudes, Motivation aspects, Change behavior.

**Time Management:** Approaches of time management, Strengths and weaknesses, Time management matrix and the urgency addiction

**Text Books:**

1. Vasant Desai., Dynamics of Entrepreneurial Development and Management, 6<sup>th</sup> edition, Himalaya Publishing House, Mumbai, 1997.
2. Prasanna Chandra., Projects: Planning, Analysis, Selection, Implementation and Review, 8<sup>th</sup> edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1995.

**Suggested Reading:**

1. Robert D. Hisrich and Michael P. Peters., Entrepreneurship, 5<sup>th</sup> edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2005.
2. Stephen R. Covey., First Things First, 1<sup>st</sup> edition, Free press, New York, 2003.
3. S.S. Khanka., Entrepreneurial Development, 4<sup>th</sup> edition, S. Chand & Co. Pvt. Ltd., New Delhi, 2012.



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20MEE04

With Effect from the Academic Year 2021-22

**MECHATRONICS AND AUTOMATION**  
(Professional Elective-I)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:**

1. To understand the electrical and mechanical systems and their interconnection to perform a task.
2. Apply mechanical, electronics, control, and computer engineering in the design of mechatronics systems to specific applications.
3. Design of mechatronics systems to specific applications.
4. Interfacing and actuation of a microprocessor and compare the performance of various controllers
5. Design, development, and working of various automated systems.
6. Automation principles for various industrial applications

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

1. Apply the concept of mechatronics and analyze electrical and mechanical systems and their interconnection for a given application.
2. Apply mechanical, electronics, control, and computer engineering in the design of mechatronics systems to specific applications.
3. Analyze the design, interfacing, and actuation of a microprocessor and Compare the performance of various controllers (P, PD, PI and PID)
4. To design, develop automated systems for various applications.
5. To design and develop automated and autonomous robotic systems using AI and IOT for various industrial applications.

**UNIT - I**

**Introduction to Mechatronics Systems:** Need of interface of electrical & electronic devices with mechanical elements, 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.

**Sensors and Transducers:** Sensors for displacement, Position and proximity, Velocity, Motion, Force, Fluid pressure, Liquid flow, Liquid level, Temperature, (thermistor, thermocouple), Light sensors and selection of sensors.

**UNIT – II**

**Pneumatic and Hydraulic Actuation Systems:** Valves, Pumps and accessories, Hydraulic circuits, Mechanical servo control circuits, Electro-hydraulic servo control and hydro pneumatic circuits with examples.

**Mechanical Actuation Systems:** Cams, Gear trains, Ratchet and pawl.

**Electrical Actuation Systems:** Mechanical switches, Solenoids, DC motors, AC motors, Stepper motors and servo motors.

#### UNIT - III

**Microprocessor Technology:** Introduction, Architecture, Configuration, Programming and using of 8051 controller with 'C' language, Interfacing input and output devices for various applications.

**Process Controllers:** Controllers, Uses of controllers, Open loop and closed loop control, Proportional, PD, PI, PID controllers, Analog and digital methods of control.

#### UNIT - IV

**Introduction to Automation:** Importance of automation, Use of mechatronics, Systems required, Purpose of automatic control, Implementation of industrial control system, Introduction to automatic control theory

**Design of an Automated System:** Building blocks of an automated system, Working principle, Selection of various components of an automated system, Specifications of various elements, Use of design data books and catalogues.

#### UNIT - V

**Case Studies of Mechatronics Systems:** Pick and place robot, Automatic car park systems, Automatic washing machine and engine management systems.

**Introduction to robotic automation:** Artificial Intelligence (AI) based systems, IOT in manufacturing industries.

#### Text Books:

1. William Bolton., Mechatronics: Electronic control systems in mechanical and electrical engineering, 6<sup>th</sup> edition, Pearson Education, 2015
2. Ronald P. Hunter., Automated process control systems – concepts and Hardware, 2<sup>nd</sup> edition, PHI, 1987.

#### Suggested Reading:

1. Devdas Shetty and Richard A. Kolk., Mechatronics System Design, Cengage Learning, 2010.
2. HMT Ltd., Mechatronics, Tata McGraw Hill Publishing Company Limited, New Delhi, 1998.
3. A.K Sawhney., A course on Electrical and Electronic Measurements and Instrumentation, Dhanapatirai & co, 2015

  
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With Effect from the Academic Year 2021-22

20MEC14

**FLUID PRINCIPLES AND HYDRAULIC MACHINES LAB**

Instruction	2 L Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

**Objectives:** Students will

1. Determine discharge of fluid flow.
2. Verify fluid laws like Bernoulli's equation and determine losses through pipes.
3. Determine impact force of jet on the vanes
4. Demonstrate knowledge in evaluating performance characteristics of pumps.
5. Evaluate the performance characteristics of turbines

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

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

**List of the Experiments:**

1. Verification of Bernoulli's equation.
2. Determination of Darcy's friction factor and nature of water flow through pipes
3. Determination of coefficient of discharge for venturimeter
4. Determination of coefficient of discharge for rectangular notch
5. Determination of coefficient of discharge for V- notch
6. Determination of impact force of jet on fixed flat and fixed curved vanes
7. Performance and characteristic curves of reciprocating pump
8. Performance and characteristic curves of centrifugal pump
9. Performance and characteristic curves of self priming pump.
10. Performance and characteristic curves of gear pump.
11. Performance and characteristic curves of Pelton wheel
12. Performance and characteristic curves of Francis Turbine under constant speed and variable speed conditions
13. Performance and characteristic curves of Kaplan turbine under constant speed and variable speed conditions

**Note: A minimum of 12 experiments need to be conducted.****Suggested Reading:**

1. P.N. Modi and S.M. Seth., Hydraulics and Fluid Mechanics Including Hydraulic Machines, 22<sup>nd</sup> edition, Standard Book House, New Delhi, 2019.
2. R.K. Bansal., A Text Book of Fluid Mechanics and Hydraulic Machines, 9<sup>th</sup> edition, Laxmi Publications (P) Ltd., New Delhi, 2015.
3. Virtual labs – Fluid Machinery Lab, NITK SURATHKAL

  
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With Effect from the Academic Year 2021-22

20MEC15

**METAL CUTTING AND MACHINE TOOL ENGINEERING LAB**

Instruction	2 L Hours per Week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

**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. Work shop practice on lathe drilling and milling machines
4. Measure cutting forces during machining on Lathe machine, milling
5. Unconventional machining operations like EDM & ECM

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

1. Identify tool geometry and grind to a given tool signature
2. Perform various machining operations to produce components of different shapes and also using jigs & fixtures.
3. Determine the shear angle at various cutting conditions.
4. Evaluate cutting forces using dynamometer, estimate MRR & power consumption under different cutting conditions
5. Plan and create components of utility using various manufacturing facilities in the laboratory.

**List of the experiments:**

1. Facing and plain turning operations on lathe.
2. Step turning and knurling on lathe machine.
3. Taper turning on lathe.
4. Drilling and boring on lathe.
5. Thread cutting on lathe.
6. Influence of process parameters on MRR in turning operation.
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 during machining on lathe machine and milling machine.
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).
13. Design utility component, pre/pare process sheet for the manufacturing of the same and produce the component in the lab.

**Note:** A minimum of 12 experiments need to be conducted.

  
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**Suggested Reading:**

1. B.L. Juneja., G.S. Shekhon and Seth Nitin, Fundamentals of Metal Cutting & Machine tools, New Age Publishers, 2003.
2. P.N. Rao, Manufacturing Technology – Metal Cutting & Machine Tools, Vol. 2, Tata McGraw Hill Education Pvt. Ltd, 2010.
3. Virtual labs – Machine Tools Lab, IITB MUMBAI



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20ME C16

With effect from the Academic year 2022-23

## DYNAMICS OF MACHINES

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

### Objectives:

1. To understand force analysis of single slider crank mechanism and turning moment Diagrams for Flywheels
2. To understand the Gyroscopic effect and the performances of Governors
3. To know the Balancing of rotating and reciprocating masses.
4. To determine natural frequencies of undamped, damped and forced vibrating systems of single degree freedom systems.
5. To understand the modes of vibrations, Two degree of Freedom and Torsional Vibrations

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

1. Apply the concept of dynamically equivalent link and determine the fluctuation of energy for flywheel applications in engines and punching presses.
2. Understand the gyroscopic effects in ships, aero planes and road vehicles.
3. Analyze the characteristics of various centrifugal governors.
4. Analyze balancing problems in rotating and reciprocating machinery.
5. Understand free and forced vibrations of single degree freedom systems and two-degree freedom linear systems.

### UNIT- I

**Force analysis:** Dynamic force analysis of single slider crank mechanism, concept of dynamically equivalent link and correction couple.

**Flywheels:** Working principle of flywheel, turning moment on the crank shaft, turning moment diagrams, maximum fluctuation of energy and its determination of coefficient of fluctuation of speed. Applications of flywheels in engines and punching presses.

### UNIT- II

**Gyroscope:** Principle of gyroscope, roll, yaw and pitch motions, gyroscopic effect in a two-wheeler, car, ship and aeroplane.

**Governors:** Necessity of governor, different types of governors, working principle of centrifugal governors, characteristics of Watt, Porter governor, Hartnell governor, controlling force diagram, Sensitivity, stability and hunting of governor, concept of isochronism of governors. Effort and power of governor.

### UNIT- III

**Balancing of Rotating masses:** Balancing and its types, rotor balancing, single plane and two plane balancing, unbalanced forces and couples, static and dynamic balancing, balancing of rotors by analytical and graphical methods.

  
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**Balancing of reciprocating machines:** Primary and secondary unbalanced forces, balancing of in line and radial engines.

#### UNIT - IV

**Vibrations:** Vibrations of single degree freedom system (axial, transverse and torsional). Natural frequency of equivalent system of combination of springs.

**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 and three degree freedom systems:** Natural frequencies of two degree freedom linear systems. Torsionally equivalent shafts. Whirling speed of shafts. Nodes in two and three rotor systems, modes of vibration. Dunkerley's and Rayleigh's approximate methods. Matrix iteration method, Jacobi's method.

#### Text Books:

1. S.S. Rattan, Theory of Machines, 4<sup>th</sup> edition, Tata-Mc Graw Hill, 2014
2. John J. Vicker, Gordon R. Pennock, Joseph E. Shigley, Theory of Machines & Mechanisms, Oxford University press, 2003.
3. William T. Thomson, Theory of Vibration with Application, 5<sup>th</sup> edition, Pearson education 2008

#### Suggested Reading:

1. A. Ghosh and Mallick, Theory of mechanisms and machines, Affiliated to E-W Press, 1988.
2. J.S. Rao and Gupta, Theory and Practice of Mechanical Vibrations, PHI, 1984



**PROFESSOR & HEAD**  
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**APPLIED THERMODYNAMICS AND HEAT TRANSFER**

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

**Objectives:** To understand

1. The working principle of single stage and multi stage reciprocating air compressor.
2. The working principle of diesel and petrol engines.
3. The combustion phenomena in IC Engines, parameters leading to abnormal combustion; cooling, lubrication and ignition systems.
4. The principles of conductive and convective heat transfer.
5. The principles of heat exchanger, concepts of radiation, phase change heat transfer.

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

1. Estimate the power required and efficiency of reciprocating air compressor using the principles of thermodynamics.
2. Understand the working principle of I.C engines and evaluate the performance of I.C. engines.
3. Understand the concepts of normal, abnormal combustion and the functioning of engine systems like cooling, lubrication and ignition.
4. Estimate the heat transfer through composite slabs, composite cylinders and understand the dimensionless numbers used in convection.
5. Understand the basic principles of heat exchangers, radiation, boiling and condensation.

**UNIT - I**

**Reciprocating Air Compressors:** Classification of compressors, advantages of reciprocating compressors over rotary compressors, applications of compressed air, working principle of reciprocating compressors - single stage and multi stage compressors with and without clearance, concept of optimum pressure ratio, minimum work input, various efficiencies of multi stage compressors, simple problems on reciprocating compressors.

**UNIT - II**

**Internal Combustion Engines:** Classification, working principles of 2 stroke, 4 stroke SI and CI engines, valve and port timing diagrams, performance of IC engines, Morse test, various methods of determining frictional power, various efficiencies, heat balance sheet.

**UNIT - III**

**Combustion Phenomena:** Stages of combustion in SI and CI engines, factors affecting, normal and abnormal combustion phenomenon in SI and CI engines, methods to control the abnormal combustion, octane and cetane number, types of combustion chambers, cooling systems, lubrication systems, battery and magneto ignition systems of IC engines, working principle of simple carburetor and fuel injector.

**UNIT - IV**

**Modes of Heat Transfer:** Conduction-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:** Basic concepts of free and forced convection, dimensionless numbers and their physical significance, simple problems on free and forced convection.

#### UNIT - V

**Radiation:** Concept of black-body Laws of radiation – Planck's Law, Wien's displacement law, Stefan Boltzmann Law, Kirchoff's Law.

**Heat Exchangers:** Classification, concept of LMTD, effectiveness, simple problems.

**Boiling and Condensation:** Basic concepts of boiling and condensation, pool boiling curve.

#### 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,

#### Data Book:

1. C.P.Kothandaraman, Heat Transfer Data Book, TMH

#### Suggested Reading:

1. R.K. Rajput., Thermal Engineering, Laxmi Publishers, New Delhi, 2014
2. Ozisik, Heat Transfer, TMH, 2004



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**DESIGN OF MACHINE ELEMENTS**

(Use of data book is permitted)

Instruction	3 L + 1T	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	4	

**Objectives:**

1. To understand the principles of machine design and design of components for static loads.
2. To design machine members for fluctuating loads and impact loads
3. Learn the design principles of shafts, keys, couplings, belt drives and pulleys.
4. Understand the principles of design of permanent joints such as riveted and welded joints.
5. Understand the principles of design of bolted joints, power screws and gasket joints.

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

1. Understand the standards, codes, various design considerations, failure criteria of members and design for static loads.
2. Design machine members subjected to fluctuating and impact loads.
3. Recommend suitable shafts, couplings and belt drives for a given application.
4. Design and suggest permanent joints for a given application.
5. Design of temporary fasteners.

**UNIT – I**

**Introduction:** Materials used in machine components and their specifications to Indian standards. Codes and standards used in design. Reliability, Principles of Ergonomics and Manufacturing considerations, preferred numbers, Types of loads and corresponding stresses. 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 shafts:** Solid, hollow and splined shafts under torsion and bending loads.

**Design of Keys & Couplings:** Keys, 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 riveted joints, efficiency of the joint. Design of joints subjected to direct and eccentric loads.

**Welded Joints:** Types of joints, Design of welded joints subjected to direct and eccentric loading.



## UNIT – V

Design of temporary fasteners: 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, Design Machine Elements, McGraw Hill Publication, 2017.
2. J.E. Shigley, C.R. Mischne, Mechanical Engineering Design, Tata McGraw Hill Publications, 2015.
3. R.S.Khurmi and J.K.Gupta, Machine design, 34<sup>th</sup> edition, S Chand publications, 2018.

### Suggested Reading:

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

### Machine Design Data Books:

1. K. Mahadevan, K. Balaveera Reddy., Design Data Hand book for Mechanical Engineers, 3<sup>rd</sup> edition, CBSPublisher,
2. PSG College, Design Data book, 2012
3. V.B. Bhandari, Machine Design Data Book, McGraw Hill Education, 2015



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20ME C19

With Effect from the Academic Year 2022 – 23

**CAD/CAM**

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

**Objectives:**

1. To teach the basic design process and the importance and types of geometric modelling techniques
2. To teach the theory for modelling of surface and solid modelling techniques
3. To impart the basic skill in writing CNC part programming
4. To teach basic configurations of robot Manipulator
5. To teach concepts of part classification coding, computer aided process planning, automated inspection methods

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

1. Understand the applications of computer in design, manufacturing, and geometric transformation techniques
2. Demonstrate the knowledge of mathematical representation of various curves and surfaces and to model engineering components using solid modelling techniques.
3. Distinguish various NC systems and write the CNC part program for simple components
4. Demonstrate the fundamentals knowledge of robotics
5. Understand the elements of a modern manufacturing environment

**UNIT-I**

**Introduction:** Introduction to CAD, Product cycle, Design Process, Design criteria, Alternative solutions, Hardware integration and networking, Data Exchange Formats (IGES, STEP).

**Geometric Transformations:** Introduction, Translation, Rotation, Scaling, Reflection Transformations, Homogenous Representation, Concatenated Transformation, Transformations about fixed point.

**UNIT-II**


**Wire frame Modeling:** Wire frame entities and their definition, interpolation and approximation curves. parametric and non-parametric representation- line, 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 non-uniform rational B-splines.

**Surface Modeling:** Surface representation Analytic surfaces: definition of Plane surface, Ruled surface, Surface of revolution, Tabulated cylinder, Synthetic Surfaces- Hermite cubic and Bezier surfaces.

**Solid Modeling:** Solid entities, Boolean operations, B – rep and CSG approaches, feature based modelling, Assembly modelling and mating conditions.

**UNIT-III**

**Numerical Control of Machine Tools:** Features and elements of NC, Types of NC systems: PTP, straight Cut and Contouring, definition of axes, definition of interpolation, post-processor, preparatory and miscellaneous functions, canned cycles, tool length and cutter radius compensation. Manual part programming and computer aided part programming for simple components (APT).

  
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#### UNIT-IV

**CNC:** Introduction to CNC, Typical configurations, Machining centres

**DNC:** Typical configurations, CNC vs DNC.

**Adaptive Control Systems:** ACO and ACC.

**Industrial Robots:** Robot anatomy, configurations, control systems, drivers, accuracy and repeatability, end effectors, sensors in robotics, programming methods. Robot industrial applications: material handling, processing and assembly and inspection.

#### UNIT-V

**GT:** Part families, layout, part classification and coding system- OPITZ, MICLASS.

**CAPP:** Variant and Generative process planning.

**FMS and CIM:** FMS 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).

**Additive Manufacturing:** Process chain, Introduction to slicing

#### Text books:

1. Ibrahim Zeid, CAD/ CAM Theory and Practice, McGraw Hill Inc, New York, 2011.
2. Mikell P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson Publication, 4<sup>th</sup> edition, 2016.
3. P.N. Rao, CAD/CAM - Principles and Applications, 2nd edition, Tata McGraw Hill, New Delhi, 2004.

#### Suggested Reading:

1. Yoram Koren, Computer Control of Manufacturing Systems, McGraw Hill Int, New York, 1994.
2. C. Elanchezian, T. Sunder Selwyn, G. Shannuga Sunder, Computer Aided manufacturing, 2<sup>nd</sup> edition, Laxmi Publications (P) Ltd, New Delhi 2007.

  
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**REFRIGERATION AND AIR CONDITIONING**

(Professional Elective-II)

(Use of data book is permitted)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

**Objectives:**

1. Acquire the basic knowledge about refrigeration, its applications for aircrafts.
2. Demonstrate basic knowledge of vapor compression refrigeration system, cascade and compound refrigeration.
3. Understand various types of refrigeration systems – absorption, steam-jet and non-conventional.
4. Acquire the basic knowledge of various psychrometric processes and comfort air conditioning.
5. Acquire knowledge in estimating air conditioning loads.

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

1. Distinguish different types of refrigerants and evaluate the performance of different aircraft refrigeration systems.
2. Analyze the performance of vapour compression refrigeration systems and improvement methods.
3. Understand the Vapour absorption, steam-jet and non-conventional refrigeration systems.
4. Analyze air-conditioning processes using the principles of Psychrometry.
5. Evaluate heating and cooling loads in air-conditioning systems.

**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.**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.**Thermoelectric refrigeration systems:** Seebeck effect, Peltier effect and Thompson effect, Analysis of the thermoelectric refrigeration systems using Peltier effect, Expression for COP, Vortex tube refrigeration – principle and working.

#### 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 Airconditioning 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, 2017.
2. Stoecker, W.F., and J.W. Jones, Refrigeration and Air-Conditioning, Mc.Graw Hill, New Delhi, 2014.
3. R.K. Rajput, Refrigeration and Air Conditioning, Laxmi Publications, New Delhi, 2013.

#### Suggested Reading:

1. V.K. Jain, Refrigeration and Air Conditioning, S Chand & Company, New Delhi, 2019.
2. Manohar Prasad, Refrigeration and Air Conditioning, New Age International, Allahabad, 2015.

#### Refrigeration and air conditioning data books:

1. Manohar Prasad, Refrigeration and Air-conditioning Data Book, New Age International Publishers, 2010.

  
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**ROBOTIC ENGINEERING**  
(Professional Elective-III)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

**Objectives:**

1. Principle of working of a robot, types and specifications, configuration, work envelop and motion controls and applications
2. Transformations, kinematics and dynamics of robotic systems
3. Singularities, Jacobian and trajectory planning of a robot to prepare the robot for various tasks
4. Design of end effectors, drives, working of sensors and controllers for finding position and orientation.
5. Robot vision for image acquisition and processing and plan for various tasks and various Languages and Programming methods of robot.

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

1. Understand the basic components and specifications of the Robots
2. Solve the problems of transformations, direct and inverse kinematics of robots
3. Analyze forces in links and joints of a robot and find the singularities, Jacobian and trajectory planning of a robot for various tasks
4. Recommend sensors and controllers for finding position and orientation to take corrective action based on feedback
5. Design an intelligent robot using machine vision and sensors to perform an assigned task.

**UNIT - I**

**Overview of Robots and Subsystems:** Brief History, Types of robots, resolution, repeatability and accuracy, degrees of freedom of robots, Robot configurations, 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.

**UNIT – II**

**Direct Kinematics:** 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.

**UNIT - III**

**Inverse Kinematics:** inverse orientation, inverse locations, Singularities, Jacobian, **Trajectory Planning:** joint interpolation, task space interpolation, executing user specified tasks, sensor based motion planning, micro controllers to control servomotors.

**UNIT - IV**

**Analysis of RP and RR Type Robots:** 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.

  
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**Controllers** : Independent joint control, PD and PID feedback, actuator models, nonlinearity of manipulator models, force feedback, hybrid control

#### UNIT - V

**Sensors** : 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. Object recognition by image matching and based on features, Animatronics – Introduction.

#### Text Books:

1. Nagrath and Mittal, Robotics and Control, Tata McGraw-Hill, 2003.
2. Spong and Vidyasagar, Robot Dynamics and Control, John Wiley and sons, 2008.
3. Mikell P. Groover, Industrial Robotics, McGraw-Hill, 2008.

#### Suggested Reading:

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 Algorithms, Cambridge Univ. Press, New York, 2006.

  
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20MEE07

With Effect from the Academic Year 2022 – 23

**RESEARCH METHODOLOGY AND INNOVATION**  
(Professional Elective-II)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

**Objectives:**

1. To make the students to formulate the research problem
2. To identify various sources for literature review and data collection.
3. To prepare the research design
4. To equip the students with good methods to analyze the collected data
5. To enable students use creative thinking and innovative skills for problem solving

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

1. Define research problem
2. Review and assess the quality of literature from various sources.
3. Understand and develop various research designs.
4. Collect and analyze the data using statistical techniques
5. Apply creative thinking and innovative skills in research

**UNIT – I:**

**Research Methodology:** Objectives, Motivation and Significance of Research, Types of Research, Research Methods versus Methodology, Research process, Criteria of Good Research, Problems Encountered by Researchers in India, Technique involved in defining a problem.

**UNIT-II**

**Literature Survey:** Importance of Literature Survey, Sources of Information - Primary, Secondary and tertiary, Assessment of Quality of Journals and Articles, Information through Internet

**Research writing:** Format of the Research report, Writing a Synopsis, Dissertation, Research Proposal and Research Report

**UNIT – III**

**Research Design:** Meaning and Need of Research Design, Terminology used in Research Design, Features of a Good Research Design, Formulation of hypothesis, Operationalizing the research question, Different Research Designs – exploratory, descriptive, diagnostic and hypothesis-testing research studies, Basic Principles of Experimental Design, Steps in Sample design

**UNIT – IV**

**Data Collection and Analysis:** Collection of primary data-Observation, Interview and Questionnaire methods, Secondary data, Measures of central tendency, Measures of dispersion, Measures of asymmetry, Important parametric tests-z, t, F, Chi-Square, ANOVA significance.

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## UNIT - V

**Innovation:** Creativity, Innovation and its difference, Blocks for creativity and innovation, overcoming obstacles, Examples of innovation, Being innovative, Steps for Innovation, right climate for innovation, Design led innovation, Grass root innovation, Frugal and flexible approach to innovation.

### Text Books:

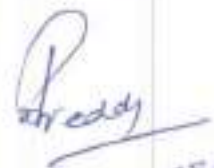
1. C.R Kothari, "Research Methodology Methods & Technique", New Age International Publishers, 2004.
2. R. Ganesan, "Research Methodology for Engineers", MJP Publishers, 2011
3. The Art of Innovation, Tom Kelley & Jonathan Littman, Profile Books Ltd, UK, 2008

### Suggested Reading:

1. Vijay Upagade and Aravind Shende, "Research Methodology", S. Chand & Company Ltd., New Delhi, 2009.
2. JUGAAD Innovation, Navi Radjou, Jaideep Prabhu, Simone Ahuja Random house India, Noida, 2012.

### NPTEL Reference:

1. Prof. Soumitro Banerjee, Research Methodology, IISER Kolkata - <https://archive.nptel.ac.in/courses/127/106/127106227/>
2. Prof. B. K. Chakravarthy, Design, Technology and Innovation, IIT Bombay - <https://archive.nptel.ac.in/courses/107/101/107101088/>



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20ME E08

**PRODUCT DESIGN AND PROCESS PLANNING**  
(Professional Elective-II)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

**Objectives:**

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

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

1. Define the needs of the customer while designing a new product or modifying existing product in the competitive environment.
2. Understand creativity, brainstorming and ergonomic concepts.
3. Apply the concept of design for manufacture, assembly, maintenance, reliability and product life cycle in developing a product.
4. Implement the Intellectual Property Rights to a new product or a process.
5. Evaluate and recommend an effective Process Plan and principles of value engineering to new product development.

**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, market research and identifying market opportunities.

**UNIT - II**

**Product Selection and Evaluation:** Need for creativity and innovation. Techniques of innovation like brainstorming 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, Preparing patent disclosure. International code for patents, Trademark, Trade Secret and Copy Rights.

**Process Planning:** Need and significance of process planning, Process capability studies, Process sheets, Benefits and Types of Computer Aided process planning.

## UNIT - V

**Process Selection and Planning:** Selection of manufacturing process, co selection of materials and processes, estimation of machining time in various cutting operations, Estimation of costs for manufacture, value engineering in product design, Group technology, and concepts of concurrent engineering, startups, innovation and its importance, quality function deployment and quality engineering.

### Text Books:

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

### Suggested Reading:

1. A.K. Chitale & R.C. Gupta, Product Design & Manufacturing, PHI, 1997.
2. Karl T. Ulrich, Stephen Eppinger, Product Design and Development, McGrawHill Publication,

  
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20ITO01

With Effect from the Academic Year 2022 – 23

**OBJECT ORIENTED PROGRAMMING USING JAVA**  
(Open Elective-I)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

**Course Objectives:**

1. To familiarize with fundamentals of object-oriented programming paradigm.
2. To impart the knowledge of string handling, interfaces, packages and inner classes.
3. To acquaint with Exception handling mechanisms and Multithreading.
4. To gain knowledge on collection framework, stream classes.
5. To familiarize web application environment using Servlets and JSP

**Course Outcomes:**

Upon completing this course, students will be able to:

1. To understand fundamentals of object-oriented programming paradigm.
2. To apply knowledge of string handling, interfaces, packages and inner classes.
3. To implement Exception handling mechanisms and Multithreading.
4. To demonstrate knowledge on collection framework, stream classes.
5. To develop web applications using Servlets and JSP. \

**UNIT-I**

**OOP concepts:** Data abstraction, encapsulation, inheritance, benefits of inheritance, polymorphism, classes and objects, Procedural and object oriented programming paradigms.

**Introduction to Java:** Java's Magic: The Byte code, The Java Buzzwords, Simple Java Programs, Java Primitive Types, Arrays: How to create and define arrays, Basic Operators, Control statements.

**Introducing Classes:** Declaring objects, methods, Constructors, this keyword, Method Overloading and Constructor Overloading, Objects as parameters, Returning objects, Use of static and final keywords.

**UNIT-II**

**Inheritance:** super and subclasses, Member access rules ,super keyword, Method overriding, Dynamic method dispatch , Abstract classes, using final with inheritance , Introduction to Object class.

**Packages:** Defining, Creating and Accessing a Package, Understanding CLASSPATH, importing packages.


**Interfaces :**Defining and implementing interfaces, Nested Interfaces. **Strings Handling:** String & StringBuffer classes, StringTokenizer class and Wrapper classes and conversion between Objects and primitives.

**Inner classes in Java:** Types of inner classes, Creating static / non-static inner classes, Local and anonymous inner classes.

**UNIT-III**

**Exception Handling in Java:** what are Exceptions? Exception types, Usage of try, catch, throw, throws and finally clauses, writing your own exception classes. **Multi-threading in Java:** The java Thread Model, How to create threads, Thread class in java, Thread priorities, Thread synchronization.

**Generics:** What are Generics? Generic classes, bounded types, Generic methods and interfaces.

  
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## UNIT-IV

**Collections Framework:** Overview of Collection Framework, Commonly used Collection classes – Array List, Linked List, Hash Set, Linked Hash Set, Tree Set, Collection Interfaces –Collection, List, Set, Sorted Set, Accessing a collection via an Iteration, Storing user-defined classes in collections, Map Interfaces and Classes, using a comparator. Legacy classes – Vector, Hash table, The Enumeration interface.

**Input/Output :** How to read user input (from keyboard) using scanner class, Stream classes, Input Stream, Output Stream, File Input Stream, File Output Stream, Reader and Writer, File Reader, File Writer classes, File class.

## UNIT-V

**Java Servlets:** Overview of Java Servlet API, Servlet Implementation, Servlet Configuration, Servlet Exceptions, Servlet Life cycle, Request and Response methods, Approaches to Session tracking, Servlet Context, Servlet Collaboration.

**JSP Basics:** Introduction to JSP, Directives, Scripting Elements, Standard Actions.

**Databases:** Connect servlet to MySQL, Connect JSP to MySQL.

### Text Books:

1. Herbert Schildt, "Java: The Complete Reference", 8th Edition, Tata McGraw Hill Publications, 2011.
2. Kathy Sierra, Bryan Basham, Bert Bates, —Head First Servlets and JSP, 2<sup>nd</sup> Edition, O'Reilly Media, Inc, 2008.

### Suggested Reading:

1. E Balagurusamy "Programming with JAVA", 6th Edition, Tata McGraw-Hill Publishing company Ltd, 2019.
2. Sachin Malhotra & Saurabh Choudhary, "Programming in Java", 2<sup>nd</sup> Edition, Oxford University Press, 2014.
3. C. Thomas Wu, "An introduction to Object-oriented programming with Java", 4th Edition, Tata McGraw-Hill Publishing company Ltd., 2010.
4. Kathy Sierra, Bert Bates, "Head First Java: A Brain-Friendly Guide", 2nd Edition, O'Reilly, 2005

### Web Resources:

1. [https://www.cse.iitb.ac.in/~nlp-ai/javalect\\_august2004.html](https://www.cse.iitb.ac.in/~nlp-ai/javalect_august2004.html).
2. <http://nptel.ac.in/courses/106106147/>
3. <https://ocw.mit.edu/courses/electrical-engineering-and-computerscience/6-092-introduction-to-programming-in-java-january-jap-2010/lecture-notes/>

  
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20CSO09

With Effect from the Academic Year 2022 – 23

**FUNDAMENTALS OF DATABASE MANAGEMENT SYSTEMS**  
(Open Elective-I)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

**Course Objectives:** The objectives of this course are,

1. To learn data models, conceptualize and depict a database system using E-R diagrams.
2. To understand the internal storage structures in a physical DB design.
3. To learn the fundamental concepts of transaction processing techniques.

**Course Outcomes:** On Successful completion of this course, student will be able to,

1. Classify the difference between FMS and DBMS; describe the roles of different users and the structure of the DBMS. Design the database logically using ER modeling
2. Outline the schema of the relational database and key constraints. Develop queries using DDL, DML and DCL of SQL.
3. Identify the inference rules for functional dependencies and apply the principles of normal forms to decompose the relations in a database.
4. Summarize the concepts of dense, sparse, ISAM and B+ tree indexing and get familiar with states and properties of transactions.
5. Interpret the locking, time stamp, graph and validation-based protocols for concurrency control.
6. Summarize log-based recovery techniques to increase the robustness of the database, identify to resolve the deadlocks in the transactions.

**UNIT - I**

**Introduction:** Database System Applications, Purpose of Database Systems, View of Data, Database Languages, Database Users and Administrators Database System Architecture, Application Architectures.

**Database Design and E-R Model:** Basic concepts, Constraints, E-R Diagrams, E-R Design Issues, Extended E-R Features, Specialization and Generalization.

**UNIT - II**

**Relational Model:** Structure of Relational Databases, Database Schema, Keys.

**Structured Query Language:** Overviews, SQL Data Types, SQL Queries, Data Manipulation Language Set Operations, Aggregate Functions, Data Definition Language, Integrity Constraints, Null Values, Views, Join Expression. Index Definition in SQL.

**UNIT - III**

**Relational Database Design:** Undesirable Properties in Relational Database Design, Functional Dependencies, Trivial and Nontrivial Dependencies, Closure of Set of Functional Dependencies, Closure of Set of Attributes, Irreducible Set of Functional Dependencies, Normalization – 1NF, 2NF, and 3NF, Dependency Preservation, BCNF, Comparison of BCNF and 3NF.

**UNIT - IV**

**Indexing:** Basic concepts, Dense and Sparse Indices, Secondary Indices, Tree-Structured Indexing, Indexed Sequential Access Method (ISAM), B+ Tree Index Files.

  
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**Transaction Management:** Transaction Concept – ACID Properties, States of Transaction, Implementation of Atomicity and Durability, Serializability, Recoverability.

#### UNIT - V

**Concurrency Control:** Lock-Based Protocols, Timestamp-Based Protocols, Validation-Based Protocols.

**Deadlocks Handling:** Deadlock Prevention, Deadlock Detection and Recovery.

**Recovery System:** Failure Classification, Storage Structure, Recovery and Atomicity, Log-Based Recovery.

#### Text Books:

1. Abraham Silberschatz, Henry F Korth, S Sudarshan, "Database System Concepts", Sixth Edition, McGraw-Hill International Edition, 2011.
2. Date CJ, Kannan A, Swamynathan S, "An Introduction to Database Systems", Eight Edition, Pearson Education, 2006.

#### Suggested Reading:

1. Raghu Ramakrishnan, Johannes Gehrke, "Database Management Systems", Third Edition, McGraw Hill, 2003.
2. Ramez Elmasri, Durvasul VLN Somayazulu, Shamkant B Navathe, Shyam K Gupta, "Fundamentals of Database Systems", Fourth Edition, Pearson Education, 2006.



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20EEO03

With Effect from the Academic Year 2022 – 23

**ENERGY AUDITING**  
(Open Elective-I)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

**Prerequisites:** Students should have prior knowledge on different Electrical Energy Generation systems, measuring instruments and basics of power systems

**Course objectives:**

1. To know the concept of Energy auditing
2. To understand the formulation of efficiency for various engineering systems
3. To explore the different ways to design various technologies for efficient engineering systems.

**Course Outcomes:** After completion of this course, students will be able to:

1. Know the current energy scenario and various energy sources
2. Understand the concepts of energy auditing.
3. Evaluate the performance of existing engineering systems
4. Explore the methods of improving energy efficiency in different engineering systems
5. Design different energy efficient appliances.

**UNIT-I**

**Basics of Energy and its various forms:** Overview of Engineering, elements Solar energy, electricity generation methods using solar energy, PV cell, elements of wind energy, electricity generation using wind energy, elements of Bio energy, Bio mass energy conservation, elements of Geothermal energy, sources of Geo thermal energy, sources of Chemical energy, fuel cells, Energy Scenario in India

**UNIT-II**

**Energy Auditing-I:** Introduction, Need for energy audit, types of energy audit: Preliminary audit, General/mini Audit, Investment-grade/ Comprehensive audit. Major energy consuming equipment and systems, Energy audit team, energy Auditing methodology: preliminary and detailed. Process flow diagram, Energy Audit report format

**UNIT-III**

**Energy Auditing-II: For buildings:** Energy Auditing Instruments, Energy Efficiency, Energy Auditing for buildings- stages in programs, surveying, measurements, and model analysis. Energy audit form of commercial buildings such as Hotel, checklist for Energy saving measures.



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#### UNIT -IV

**Energy Efficient Technologies-I: Energy Efficient Technology in Mechanical Engineering:** Heating, ventilation, and air-conditioning; Evaporative coolers, Air conditioners -types such as Portable; Central AC, Window AC and Split AC

**Energy Efficient Technology in Electrical Engineering:** Electricity billing, Power Factor Improvement-Regenerated Energy in Lifts and Escalators

#### UNIT-V

**Energy Efficient Technologies-II: Energy Efficient Technology in Civil Engineering:** Green building-features- concept of Embodied energy -Building design-Green construction-Net Zero Energy Building - **Energy Efficient Technology in Chemical Engineering:** Green chemistry, - Battery Managementsystems – concept and salient features -topologies

#### Text Books:

1. Umesh Rathore, 'energy management', Kataria publications, 2nd editon, 2014.
2. G.Hari hara Iyer : Green Building – Fundamentals , Notion Press .com2022
3. Hargroves, K., Gockowiak, K., Wilson, K., Lawry, N., and Desha, C. (2014) An Overview of Energy Efficiency Opportunities in Mechanical/civil/electrical/chemical Engineering, The University of Adelaide and Queensland University of Technology.

#### Suggested reading:

1. Success stories of Energy Conservation by BEE, New Delhi ([www.bee-india.org](http://www.bee-india.org))
2. Guide books for National Certification Examination for Energy Manager / Energy AuditorsBook-1, General Aspects



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20BTO01

With Effect from the Academic Year 2022 – 23

**BIOLOGY FOR ENGINEERS**  
(Open Elective-I)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

**Prerequisites:** The school level basic knowledge in Fundamental science is required.

**Course Objectives:** The objectives of this course are

1. Understand the milestones reached by human in the field of biology.
2. Understand the human body and its parts.
3. Understand the human anatomy and medical devices.
4. Understand types of advanced therapies.
5. Understand the treatment of toxic pollutants in the environment.
6. Understand genome sequencing and NGS.

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

1. Appraise the values of Biology in classical and modern time
2. Develop modern instruments related to skeletal, nervous, and circulatory system
3. Apply concept of respiratory, excretory, and assisted reproductive process for developing related instruments
4. Illustrate the modern interdisciplinary tools related to medical biotechnology and bioremediation
5. Summarize the basic knowledge about nucleic acids, proteins and their sequencing

**UNIT-I**

**Introduction to Biology:** Classical Vs Modern Biology; Importance of Biological Science and Historical developments; Origin of Life, Urey Miller Experiment, Spontaneous Generation Theory; Three Domains of Life; Principle and Applications of Microscope (Light and Electron Microscope), Prokaryotic and Eukaryotic Cell- Structure and their differences.

**UNIT-II**

**Human Anatomy and Functions-I:** Human organ systems and their functions; Skeletal System-Bones, Tendon, Ligaments, principle and applications in knee replacement; Nervous System - Structure of Brain, Spinal Cord, Neuron, Neurotransmitters, Synapse, Alzheimer's - a case study, principle and applications of Imaging Techniques (CT & MRI scans); Circulatory System - Heart structure and functions, principle and applications of cardiac devices (Stent and Pacemaker), Artificial heart, blood components and typing, haemocytometer.

**UNIT-III**

**Human Anatomy and Functions-II:** Respiratory Systems - Lung structure and function, principle and applications of Peak Flow Meter, ECMO (Extra Corporeal Membrane Oxygenation); Excretory Systems- Kidney structure and function, principle and applications of Dialysis; Prenatal diagnosis; Assisted reproductive techniques- IVF, Surrogacy.

  
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#### UNIT-IV

**Medical Biotechnology and Bioremediation:** Cells of Immune System, Etiology of cancer, Cancer treatment (Radiation Therapy); Stem Cells and its Clinical applications; Scaffolds and 3D printing of organs; Bio sensors and their applications; Parts of bioreactor and its types; Bioremediation.

#### UNIT - V

**Bioinformatics:** Nucleic acid composition, Genetic Code, Amino acid, Polypeptide, Levels of protein structure, Homolog, Ortholog and Paralog, Phylogenetics, Genome Sequencing, Human Genome Project, Next generation sequencing.

#### Text Books:

1. Campbell, N.A., Reece, J.B., Urry, Lisa, Cain, M.L., Wasserman, S.A., Minorsky, P.V., Jackson, R.B., "Biology: A global approach", Pearson Education Ltd, Edition 11, 2017.
2. Shier, David, Butler, Jackie, Lewis, Ricki., "Hole's Human Anatomy & Physiology", McGraw Hill 2012.

#### Suggested Reading:

1. Bernard R. Glick, T. L. Delovitch, Cheryl L. Patten, "Medical Biotechnology", ASM Press, 2014.

  
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20MT004B

With Effect from the Academic Year 2022 – 23

## NUMERICAL METHODS

(Open Elective-I)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

### Course Objectives:

1. Solve algebraic and transcendental equations.
2. Solve simultaneous equations when the number of unknown increases by iterative methods
3. Learn interpolation and extrapolation techniques to fit the numerical tabulated data.
4. Solve numerical integration to get approximate solution of given data using Simpson's  $1/3^{rd}$ ,  $3/8^{th}$  Weddle's rules.
5. Solve ODE using Taylor, Picard's, Euler's, modified Euler's, Rungekutta methods.

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

1. Apply numerical methods to find roots of algebraic and transcendental equations.
2. Derive the solutions when system of equations has more than two unknowns and learn to reduce the instability of equations.
3. Apply interpolation and extrapolation techniques to fit the numerical tabulated data.
4. Find numerical integration by using Simpson's  $1/3^{rd}$ ,  $3/8^{th}$  and Weddle's rules
5. Apply numerical methods to Solve ODE using Taylor, Picard's, Euler's, modified Euler's, Rungakutta methods.

### UNIT-I:

#### SOLUTIONS OF ALGEBRAIC AND TRANSCENDENTAL EQUATIONS

Bisection Method, Regulae Falsi Method (method of false position); Newton Raphson Method, Approximate solution of equations by Horner's method.

### UNIT-II:

#### SOLUTIONS OF SIMULTANEOUS EQUATIONS

Gauss elimination method, Jacobi's Iteration Method, Gauss Seidel Iteration Method, Solutions of Non-Linear simultaneous equations by Newton Raphson method.

### UNIT III:

#### FINITE DIFFERENCES AND INTERPOLATION

Finite difference operators, Newton's forward and backward interpolation formulas, Interpolation for unequal intervals, Lagrange's interpolation, Newton's divided difference formulas, inverse interpolation.

### UNIT IV:

#### NUMERICAL DIFFERENTIATION AND INTEGRATION

Numerical derivatives using Newton's forward difference formula, Numerical derivatives using Newton's backward interpolation formulas, Numerical integration: Simpson's  $1/3^{rd}$ ,  $3/8^{th}$  rules. Weddle's rule.

  
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**UNIT V:**

**NUMERICAL SOLUTIONS FOR DIFFERENTIAL EQUATIONS**

Solution of differential equation: Picard's method, Taylor's method, Euler's method, modified Euler's method, Rungakutta fourth order method.

**Text Books:**

1. S. S. Shastri Introductory methods of Numerical Analysis, PHI Learning PVT LTD 2012
2. B.S. Grewal, Numerical Methods in Engineering & Science with Programs in C, C++ & MATLAB", Khanna Publishers, 19th Edition, 2013.

**Suggested Reading:**

1. R.K. Jain and S.R.K. Iyengar," Numerical methods for Scientific and Engineering Computation", New Age.
2. N.M. Kapoor, "Fundamentals of Mathematical Statistics", Pitambar Publications.

  
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20MEC20

**DYNAMICS AND VIBRATIONS LAB**

Instruction	2	Hours per week
Duration of SEE	3	Hours
SEE	50	Marks
CIE	50	Marks
Credits	1	

**Objectives:**

1. To demonstrate basic principle and exposure to evaluate CAM Follower Motion and Gyroscopic effects.
2. The importance of static and dynamic balancing.
3. The methods of controlling speeds of prime movers
4. To acquire the knowledge in evaluating the stability of vehicles
5. Frequency response of spring mass system with damping and without damping - Undamped torsional vibrations of single and double rotor systems

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

1. Analyze the cam profile for different motion characteristics.
2. Examine the performance of governors and the gyroscopic effect on vehicles.
3. Evaluate the static and dynamic balancing masses in a rotating mass system.
4. Determine the natural frequency of different single degree freedom vibrating systems.
5. Determine the natural frequency of two degree freedom vibrating systems

**List of the Experiments**

1. To study the motion of follower with the given profile of the cam. To plot the follower displacement vs. angle of rotation curves for different cam follower pairs.
2. To study the gyroscopic effect on a rotating disc.
3. Study the effect of varying mass on the centre of sleeve in Porter governor.
4. Study the effect of varying the initial spring compression in Hartnell governor.
5. Static and Dynamic balancing in a rotating mass system.
6. To study the longitudinal vibrations of helical coiled spring.
7. To find damping by logarithmic decrement on spring mass system.
8. Determination of the frequency of single rotor torsional vibrations.
9. Determination of the frequency of double rotor system torsional vibrations.
10. To verify the Dunkerley's principle for lateral vibration of beam.
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.
13. Determine the equivalent link parameters and centre of mass of connecting rod theoretically and validate the result by experiment by choosing suitable methods and devices.

**NOTE:** Students should complete a minimum of 10 experiments including experiment 13 which is compulsory.

**Text Books:**

1. S.S. Rattan, Theory of Machines, Fourth edition Tata-Mc Graw Hill, 2014
2. John.J.Vicker, Gordon R. Pennock, Joseph E. Shigley, Theory of Machines & Mechanisms, Oxford University Press, 2003.
3. William T.Thomson, Theory of Vibration with Application, 5<sup>th</sup> edition, Pearson education 2008

**Suggested Reading:**

1. Robert L. Norton, Design of Machinery, Tata Mc Graw Hill, 2005.
2. Benson H. Tague, Principles of Vibration, 2<sup>nd</sup> edition, Oxford University Press, 2007



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20ME C21

**APPLIED THERMODYNAMICS AND HEAT TRANSFER LAB**

Instruction	2	Hours per week
Duration of SEE	3	Hours
SEE	50	Marks
CIE	50	Marks
Credits	1	

**Objectives:**

1. To demonstrate basic knowledge related to performance of petrol and diesel engines.
2. To understand the importance of heat balance sheet in IC engine.
3. To evaluate the performance of multi-stage reciprocating air compressor.
4. To demonstrate knowledge in evaluating thermal conductivity and heat transfer coefficient under natural and forced convection phenomena.
5. To understand the basic concepts of radiation heat transfer and evaluation of overall heat transfer coefficient in a heat exchanger.

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

1. Evaluate the performance of petrol and diesel engines.
2. Estimate the conversion of heat supplied by the fuel to various other forms of energy in an IC engine.
3. Determine the performance of multi stage reciprocating air compressor.
4. Estimate the thermal conductivity of a material and the value of convection heat transfer coefficient under natural/forced convection.
5. Determine the Stefan - Boltzmann constant, emissivity of grey plate and overall heat transfer coefficient of heat exchanger.

**List of the Experiments:****Applied Thermodynamics**

1. Determination of Valve timing diagram and Port timing 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.
8. Determination of Fuel properties like Flash point, Fire point, Viscosity and Calorific value of fuel.

**Heat Transfer**

9. Determination of thermal conductivity of composite wall.
10. Determination of convective heat transfer coefficient under Natural and Forced convection phenomena using pin-fin apparatus.
11. Determination of Emissivity of a given plate.
12. Determination of the value of Stefan-Boltzmann constant.
13. Determination of Heat transfer coefficient in parallel and counter flow heat exchanger.
14. Evaluate the performance parameters and pollution levels of an alternative fuel on a four stroke single cylinder diesel engine.

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**Note: Students should perform a minimum of 10 experiments including experiment 14 which is compulsory.**

**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, 2009

**Suggested Reading:**

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

  
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20ME C22

**CAD/CAM LAB**

Instruction	2	Hours per week
Duration of SEE	3	Hours
SEE	50	Marks
CIE	50	Marks
Credits	1	

**Objectives:**

1. To teach the basic design process and the importance and types of geometric modeling techniques
2. To teach Assembly modelling by applying suitable assembly constraints
3. To generate orthographic views of components and assemblies.
4. To demonstrate the Indication of size, form, and positional tolerances on the drawing sheets
5. To demonstrate the working of CNC machines and write part programs for different operations

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

1. Make use of appropriate features to generate 3D model using CAD software
2. Apply constraints to assemble the components
3. Demonstrate the knowledge splines and surface modelling
4. Select tools required for performing specific job on CNC mill and CNC lathe
5. Write CNC part program to generate tool path for different machining operations

**List of the Exercises:**

1. Introduction and Working with Splines
2. Surface Modeling
3. Part modeling of simple parts using various features
4. Assembly of simple machine components (couplings)
5. Implementation of Geometric Transformations and Bezier curves using MATLAB
6. Contouring on CNC Milling Machine
7. Rectangular Pocketing and Circular Pocketing on CNC Milling Machine
8. Step Turning on CNC Lathe Machine and Taper Turning on CNC Lathe Machine
9. Multiple Turning on CNC Lathe Machine
10. Generation of STL files , Part orientation, support and Tool path generation using any RP software
11. Demonstration of FDM technology using 3D printer.
12. Develop a product using 3D Printing / generate CNC toolpath for its component it

**Note:** Student should complete a minimum of 10 exercises including exercise number 14 which is compulsory.

**Text books:**

1. P.N.Rao, -CAD/CAM:Principles and Application, TataMcGraw-Hill,July 2017
2. N Mehta,-Machine Tool Design and Numerical Control, McGrawHill Education, 3<sup>rd</sup> edition, 2017
3. Dassault Systems,-SOLIDWORKS Essentials: Training, SolidWorkscorp., 2011

**Suggested Reading:**

1. [https://my.solidworks.com/solidworks/guide/SOLIDWORKS\\_Introduction\\_EN.pdf](https://my.solidworks.com/solidworks/guide/SOLIDWORKS_Introduction_EN.pdf)
2. <https://help.solidworks.com>

20MEC23

### METROLOGY AND INSTRUMENTATION

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

#### Objectives:

1. To familiarize with limits, fits & tolerances and fundamental concepts of measurements.
2. To have adequate skill in the usage of various precision measuring instruments and the concepts of Limit gauges.
3. To learn the importance of Geometric form and how to measure form errors.
4. To have knowledge in the concepts of classification of instrument errors and their characteristics.
5. To understand the working principles of various instruments used for the measurement of displacement, pressure and temperature.

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

1. Understand the need, accuracy and associated concepts of linear and angular measurements.
2. Select appropriate gauges for inspection and design.
3. Calculate surface roughness by using appropriate instruments.
4. Analyze and interpret the types of errors, strain measurement and instrument characteristics.
5. Evaluate measuring methods and devices for displacement, pressure & temperature.

#### UNIT-I

**Limits, Fits and Tolerances:** nominal size, limits, tolerances, allowance, fundamental deviation, unilateral and bilateral tolerances, impact of tolerances on the manufacturing processes, types of fits, alpha numeric designation of limits/fits, hole and shaft basis systems, interchangeability and selective assembly


**Linear and angular measurement:** Line and end standards, slip gauges, Tomlinson gauges and sine bar, 3D Coordinate measuring machine

#### UNIT-II

**Design of limit gauges:** Taylor's Principle for plan limit gauges, design of GO and NO GO gauges, use of plug, ring and snap gauges.

**Comparators:** Introduction, dial indicator, sigma mechanical comparator, back pressure type pneumatic comparator.

**Optical measuring instruments:** Optical projector principle and its uses, tool maker's microscope principle and its uses, interferometry.

  
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### UNIT-III

**Straightness, Flatness and Roundness Measurement:** Definitions, measurement by beam comparator, straight edge, spirit level, and bench centers.

**Surface roughness measurements:** Need for surface roughness measurement, Roughness and waviness, numerical assessment of surface roughness, surface roughness measurement by profilometer, Taylor Hobson Talysurf, ISI symbols for indication of surface finish.

### UNIT-IV

**Screw thread metrology:** Basic terminology of screw thread, measurement of effective diameter by 2 wire and 3 wire methods, best wire size.

**Gear tooth metrology:** Spur gear nomenclature, gear tooth thickness measurement by gear tooth vernier.

**Instrumentation:** Static and dynamic characteristics of instruments, types of errors, strain measurement with strain gauges, gauge factor, rosette Gauges.

### UNIT-V

**Transducers:** Displacement measurement by L.V.D.T, pressure measurement by bourdon pressure gauge, bulk modulus pressure gauge, pirani gauge, temperature measurement by thermo couples, laws of thermo electricity, types of materials used in thermocouples.

#### Text Books:

1. R.K. Jain, Engineering Metrology, Khanna Publications, 1996.
2. Doebelin, Measurement Systems Application and Design, TMH, 5<sup>th</sup> edition, 2004.
3. Beckwith, Buck, Lienhard, Mechanical Measurements, PEA, 3<sup>rd</sup> Indian Reprint, 2001.

#### Suggested Reading:

1. Rega Rajendra, Principles of Engineering Metrology, Jaico Publishing House, Mumbai, 2008.
2. B.C. Nakra & K.K. Chaudhary, Instrumentation Measurement and Analysis, 3<sup>rd</sup> edition, McGrawhill, 2014



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**MACHINE DESIGN**

(Use of design data handbook is permitted)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

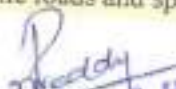
**Objectives:**

1. Understand the materials used for helical and leaf springs, learn design principles of closely coiled helical and leaf springs.
2. To become familiar with the design principles of gear drives for power transmission.
3. To become familiar with design principles of sliding contact bearings and selection of rolling contact bearings.
4. Design principles of IC engine components such as piston, connecting rod, crank shaft.
5. Analyze the curved beams and selection of chain drives used in power transmission.

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

1. Understand the design procedure of helical, leaf springs under static and fluctuating loads.
2. Design the spur, helical and bevel gears based on beam strength and wear strength.
3. Demonstrate the ability in designing sliding contact bearings & selection of rolling contact bearings.
4. Design of IC engine piston, connecting rod and crank shaft.
5. Analyze the curved beams and selection of chain drives for a given application.

**UNIT-I****Mechanical Springs:** Introduction, types of springs, Materials used for springs.**Helical Springs:** stresses in springs, Wahl's factor, deflection and energy stored in spring. Design for static and fluctuating loads.**Leaf Springs:** modeling of 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, Design of Spur, Helical and Bevel 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:** Hydrodynamic bearings: journal bearing and thrust 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 overhang 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**.

**Selection of chain drives:** Power rating of roller chains, Strength of roller chains.

#### Text Books:

1. V.B. Bhandari, Design Machine Elements, Mc Graw Hill Publication, 2017.
2. J.E. Shigley, C.R. Mischne, Mechanical Engineering Design, Tata Mc Graw Hill Publications, 2015.
3. R.S.Khurmi and J.K.Gupta, Machine design, 34<sup>th</sup> edition, S Chand publications, 2018.

#### Suggested Reading:

1. P. Kanniah, Machine Design, Sci-Tech Publications, 2010
2. M.F. Spotts, Design of Machine Elements, Prentice Hall of India, 2013.

#### Machine Design Data Books:

1. K. Mahadevan, K.Balaveera Reddy., Design Data Hand book for Mechanical Engineers, 3<sup>rd</sup> edition, CBS Publisher, 2018
2. PSG College, Design Data book,2012



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20MEEC25

With Effect from the Academic Year 2022 – 23

## THERMAL TURBO MACHINES

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

### Objectives:

1. To acquire basic knowledge of functioning of nozzles and diffusers.
2. To understand the design of ducts with frictional flow.
3. To know the working principles of various rotary compressors.
4. To understand the working of steam turbines.
5. To acquire basic knowledge in the functioning of gas turbines.

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

1. Design various configurations of nozzles and diffusers with the principles of Gas Dynamics.
2. Design the ducts for friction with the principles of Fanno Flow.
3. Estimate the power required for various types of rotary compressors.
4. Determine the various efficiencies related to Steam Turbines.
5. Determine the power output of the Gas Turbine and understand the working principle of jet and rocket propulsion.

### UNIT-I

**Introduction to Compressible Flows:** Speed of propagation of pressure waves, Mach number, Acoustic velocity and Mach cone, compressibility factor for compressible and incompressible flows, pressure field due to a moving source of disturbance, one dimensional compressible flow. Isentropic flow with variable area, Static and Stagnation properties, Mach number variation, Area ratio as function of Mach number, flow through different types of nozzles and diffusers Flow with Normal Shocks, 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 and Stagnation pressure ratio across shock.

### UNIT-III

**Rotodynamic Compressors:** Introduction to Turbomachines, classification and applications. 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, Degree of reaction of rotary compressors, Chocking, Surging and Stalling.

### UNIT-IV

**Steam Turbines:** Study of Steam nozzles; 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, Governing of Turbines.

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## 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, simple problems, Ramjet engines, Pulse jet engines.

**Rocket Propulsion:** Types of Propellants, types of Rocket engines, Rocket propulsion theory and its 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, 2014

### Suggested Reading:

1. V. Ganeshan, Gas Turbines, Tata Mc Graw Hills, New Delhi, 2010.
2. R Yadav, Steam and Gas Turbines, Central Publishing House Ltd, Allahabad, 2003.

  
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## FINITE ELEMENT ANALYSIS

Instruction	3 L + 1T	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	4	

**Objectives:**

1. Equip the students with the Finite Element Analysis fundamentals and formulations.
2. Enable the students to formulate the axial, truss, beam and circular shaft problems.
3. Enable the students to formulate 2D problems with special cases.
4. Enable the students to formulate quadrilateral element, use of numerical integration, Gaussian quadrature and one dimensional dynamic problems.
5. Enable the students to understand the convergence requirements, heat transfer, formulate 3D problems and perform engineering simulations using Finite Element Analysis software (ANSYS)

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

1. Understand FE method for solving field problems using energy formulations.
2. Analyze bars, trusses, beams and circular shafts for static and dynamic analysis.
3. Formulate 2D structural components using triangular element for plane stress, plane strain and axisymmetric problems.
4. Derive stiffness matrix for 4 node quadrilateral isoparametric element for static analysis and 3 D elements.
5. Solve heat transfer problems and apply finite element analysis software 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 problem: Finite element modeling co-ordinates and shape 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, analysis of circular shaft subjected to torsion.

**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 axisymmetric solids subjected to axisymmetric loading with triangular elements.

#### UNIT - IV

**Quadrilateral elements and Numerical Integration:** Two dimensional four noded isoparametric elements, Numerical integration and Gauss quadrature.

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

#### UNIT - V

**Heat transfer analysis:** Steady state heat transfer analysis, one dimensional analysis of a fin and two dimensional analysis of thin plate, formulation of time dependent field problems, applications 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.

**Introduction to finite element analysis software:** Modelling, Analysis and Post processing.

#### Text Books:

1. G. Ramamurthy, 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, Prentice Hall of India, 1997
3. Daryl L. Logan, A First Course in the Finite Element Method, Cengage Learning, 2011.

#### Suggested Reading:

1. S.S. Rao, The Finite Element Method in Engineering, Pergamon Press, 1989.
2. L. J. Segerlind, Applied Finite Element Analysis, Wiley Eastern, 1984.



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20MEE09

With Effect from the Academic Year 2022 – 23

**COMPUTATIONAL FLUID DYNAMICS**  
(Professional Elective-III)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

**Objectives:**

1. To understand governing equations of fluid flow
2. To understand turbulence and how to model them.
3. To know how to discretize governing equations of fluid flow by FDM and their stability.
4. To learn various iterative methods to solve N-S equation.
5. To understand FVM to solve fluid flow equations.

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

1. Describe and develop mathematical models for flow phenomena.
2. Apply Finite Difference Method for fluid flow and heat transfer problems Classify PDE for fluid flow and heat transfer applications.
3. Use different solvers based on applications
4. Solve fluid flow and heat transfer problems using commercial CFD tools for turbulence models
5. Formulate numerical equations by Finite Volume Method for fluid flow and heat transfer problems

**UNIT-I**

**Governing Equations of Fluid Dynamics and Heat Transfer:**

Introduction to CFD, Models of Flow – Conservation and Non-conservation form - Continuity, Momentum and Energy Equation in conservation and non-conservation form (differential equations only)

**UNIT-II**

**Classifications of Partial Differential Equations:** Elliptic, parabolic and hyperbolic equations, Initial and boundary value problems.

**Discretization and Finite Difference method:** Forward, Backward and Central difference schemes, Transient one and two dimensional conduction - Explicit, implicit, semi-implicit and ADI methods - Stability analysis and error estimation.

**UNIT-III**

**Elliptic Partial Differential Equations:** Jacobi, Gauss Seidel methods, TDMA,  
**Viscous incompressible flow, Vorticity Stream function method.**

**UNIT-IV**

**Turbulence Modeling:**

Types of Turbulence modeling-Reynolds and Favre averaged N-S equations, mixing length model, k-epsilon turbulence model.

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## 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. Ghoshdastidar, Computational Fluid Dynamics & Heat Transfer, Cengage Pub., 2018.
2. J.D. Anderson, Jr., Computational Fluid Dynamics: The Basic with Applications, McGraw Hill, Inc., 2012.
3. H. Versteeg and W. Malalasekera, An Introduction to Computational Fluid Dynamics : The Finite Volume Method, 3<sup>rd</sup> edition, Pearson, , 2016

### 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.

  
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20MEE10

With Effect from the Academic Year 2022 – 23

**ADDITIVE MANUFACTURING**  
(Professional Elective-II)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

**Objectives:**

1. To introduce students the basics of additive manufacturing, its advantages and limitations and concept of mass customization.
2. To familiarize students with different additive manufacturing techniques.
3. To teach students about STL file issues and familiarize them with various RP softwares.
4. To demonstrate various post processing techniques and rapid tooling concept.
5. To demonstrate the applications of rapid prototyping in various fields

**Outcomes:**

1. Understand the fundamental concepts of Additive manufacturing
2. Demonstrate the knowledge of various Additive Manufacturing Processes.
3. Analyze preprocessing and identify different post processing techniques in AM
4. Demonstrate the design rules for product development through Additive manufacturing.
5. Create awareness of Additive manufacturing in various applications,

**UNIT-I**

**Overview:** Traditional Manufacturing Vs Additive Manufacturing, Mass Customization, Reverse Engineering, fundamental fabrication process, AM Process chain, Classification of AM process, Advantages and Limitations of AM.

**UNIT-II**

**AM Technologies: Vat Photopolymerization:** Stereolithography (SL), Materials, SL resin curing process, Process Benefits and Drawbacks, Applications of Photo polymerization Processes.  
**Extrusion-Based AM Processes:** Fused Deposition Modeling (FDM), Principles, Materials, and Plotting and path control, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes.  
**Sheet Lamination AM Processes:** Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications.  
**Powder Bed Fusion AM Processes:** Selective laser Sintering (SLS), Selective Laser Melting (SLM), Materials, Powder fusion mechanism, SLS Metal and ceramic part creation, Electron Beam melting (EBM) Process

**UNIT-III**

**Pre-processing in AM:** STL Format, STL File Problems, STL file Repairs

**Post Processing of AM Parts:** Support Material Removal, Surface Texture Improvement, Accuracy Improvement, Aesthetic Improvement, Preparation for use as a Pattern, Property Enhancements using Non-thermal and Thermal Techniques.

**AM Softwares:** Features of various AM software's like Magics, Mimics, Solid Viewrt, 3 D Rhino,

  
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#### UNIT-IV

**Design for Additive Manufacturing (DFAM):** DFAM Concepts and Objectives: Complex Geometry, Customized Geometry, Integrated Assemblies and Elimination of Conventional design for manufacture (DFM) Constraints, Rapid Manufacturing (RM), Unique Capabilities, Exploring Design Freedoms and Design Tools for AM.

**Guidelines for process selection:** Introduction, selection methods for a part, challenges of selection, example system for preliminary selection, production planning and control.

#### UNIT-5

**Rapid Tooling :** Conventional tooling vs Rapid tooling , Classification of rapid tooling.

**Indirect Rapid Tooling Methods:** Spray Arc Metal deposition , Investment casting , 3D Keltool Process

**Direct Rapid Tooling Methods:** Direct AIM , LOM tools , EOS direct tool Process


**AM Applications:** Applications in Design Industry, Analysis and Planning, Application in Aerospace, Automobile Sectors, Bio-medical Applications.

#### Text Books:

1. Chua Chee Kai, Leong Kah Fai, 3D Printing and Additive Manufacturing: Principles & Applications, 4th Edition, World Scientific, 2015.
2. Ian Gibson, David W Rosen, Brent Stucker., Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, 2nd Edition, Springer, 2015
3. K. Venuvinod and Weiyin Ma, Rapid Prototyping: Laser-based and Other Technologies, Springer, 2004.

#### Suggested Reading:

1. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 2001.
2. Rafiq Noorani, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006.

  
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20MEE11

With Effect from the Academic Year 2022 – 23

**OPERATIONS RESEARCH**  
(Professional Elective-III)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

**Objectives:**

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

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

1. Understand the concepts of linear programming problems and Solve
2. Solve the given transportation problem.
3. Develop optimum pair of operations and resources by using Assignment technique.
4. Analyze project management techniques like CPM and PERT to plan and execute projects successfully.
5. Apply sequencing and queuing theory concepts for 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**

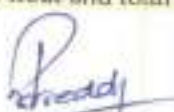
**Transportation models:** Finding an initial feasible solution - north west corner method, least cost method, Vogel's approximation method, finding the optimal solution, special cases in transportation problems - unbalanced transportation problem, degeneracy in transportation, profit maximization in 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, Kendall's notation, single channel - Poisson arrivals-exponential service times.

#### Text Books:

1. Hamdy A. Taha, Operations Research-An Introduction, 10<sup>th</sup> edition, Pearson education India, 2017.
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. R. PaneerSelvam, Operations Research, 2<sup>nd</sup> edition, PHI Learning Pvt. Ltd., New Delhi, 2008.
2. Nita H. Shah, Ravi M. Gor, HarlikSoni, Operations Research, PHI Learning Private Limited, 2013.



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20MEE12

With Effect from the Academic Year 2022 – 23

**INDUSTRIAL SAFETY AND MAINTENANCE**  
(Professional Elective-III)

Instruction	3	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

**Objectives:** The students will be able to understand

1. Causes for industrial accidents and preventive steps to be taken.
2. Fundamental concepts of Maintenance Engineering.
3. About wear and corrosion along with preventive steps to be taken
4. The basic concepts and importance of fault tracing.
5. The steps involved in carrying out periodic and preventive maintenance of various equipments used in industry

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

1. Identify the causes for industrial accidents and suggest preventive measures.
2. Identify the basic tools and requirements of different maintenance procedures.
3. Apply different techniques to reduce and prevent Wear and corrosion in Industry.
4. Identify different types of faults present in various equipments like machine tools, IC Engines, boilers etc.
5. Apply periodic and preventive maintenance techniques as required for industrial equipments like motors, pumps and air compressors and machine tools etc.

**UNIT – I**

**Industrial safety:** Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes, Fire prevention and firefighting, equipment and methods.

**UNIT – II**

**Fundamentals of Maintenance Engineering:** Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

**UNIT – III**

**Wear and Corrosion and their Prevention:** Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications of Screw down grease cup, Pressure grease gun, Splash lubrication, Gravity lubrication, Wick feed lubrication, Side feed lubrication, Ring lubrication, Definition of corrosion, principle and factors affecting the corrosion, Types of corrosion, corrosion prevention methods.

  
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#### UNIT-IV

**Fault Tracing:** Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like machine tool, Pump, Air compressor, Internal combustion engine, Boiler, Electrical motors, Types of faults in machine tools and their general causes.

#### UNIT - V

**Periodic and Preventive Maintenance:** Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of Machine tools, Pumps, Air compressors, Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment.

**Condition monitoring and Basic concepts of Proactive maintenance for Industry 4.0.**

#### Text Books:

1. H. P. Garg, "Industrial Maintenance", S. Chand and Company, may 1987
2. Das Akhil Kumar, Principles of Industrial Safety Management Understanding the Ws of Safety at Work, Second edition, PHI Learning Pvt Ltd, Jan 2020
3. M.P. Poonia, S.C. Sharma, Khanna Publishing House - Technology & Engineering, year 2019.

#### Suggested Readings:

1. Parth B. Shah, Industrial Safety and Maintenance Engineering, Technical publications, 2021
2. Higgins & Morrow, "Maintenance Engineering Handbook", McGraw-Hill Education Eighth Edition, February 2014

  
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## METROLOGY AND INSTRUMENTATION LAB

Instruction	2	Hours per week
Duration of SEE	3	Hours
SEE	50	Marks
CIE	50	Marks
Credits	1	

### Objectives:

1. To choose the proper measuring instrument for the precise measurement of length, height and diameter.
2. To classify the different measuring instruments used for the angular measurement.
3. To develop gear & screw thread parameters using optical projector and tool maker's microscope.
4. To analyze the limits, fits and tolerances for selection and design of gauges.
5. To determine the working principles in the measurement of Flatness, Roundness and Surface roughness.

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

1. Measure the linear dimension by using appropriate method & device.
2. Demonstrate the knowledge of angular measurements and use measuring instruments as per requirements.
3. Determine the gear and screw thread parameters using profile projector and tool makers' microscope.
4. Design and test plain limit gauges for a given specimen.
5. Evaluate and estimate the measurement of flatness, roundness and surface roughness.

### Experiments:

1. Measurement with inside, outside and depth micrometers.
2. Measurement with height gauges, height masters.
3. Measurement of linear and angular dimensions with Tool maker's microscope – diameter of thin wire and single point cutting tool angle.
4. Measurement with dial indicator and its calibration.
5. Measurement of angles with sine bar and clinometers.
6. Comparison of roundness errors with bench centers and 3D scanner.
7. Measurement of flatness errors of a surface plate with precision spirit level.
8. Measurement with optical profile projector.
9. Design of plug and snap gauges for a given component.
10. Surface roughness measurement by Taylor Hobson -Talysurf.
11. Measurement of gear tooth thickness by gear tooth vernier.
12. Displacement measurement with LVDT.
13. Analyze, assess, measure and document all Measuring attributes of a selected component by using appropriate methods and devices.

  
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**Note: Student should complete a minimum of 10 experiments including experiment number 13 which is compulsory.**

**Text Books:**

1. R.K. Jain, Engineering Metrology, Khanna Publications, 1996.
2. Doebelin, Measurement Systems Application and Design, TMH, 5<sup>th</sup> edition, 2004.
3. Beckwith, Buck, Lienhard, "Mechanical Measurements", PEA, 3rd Indian Reprint, 2001.

**Suggested Reading:**

1. Rega Rajendra, Principles of Engineering Metrology, Jaico Publishing House, Mumbai, 2008.
2. B.C. Nakra & K.K. Chaudhary, Instrumentation Measurement and Analysis, 3<sup>rd</sup> edition, McGraw-Hill, 2014.

  
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20MEC28

With Effect from the Academic Year 2022 – 23

### MACHINE DRAWING LAB

Instruction	2	Hours per week
Duration of SEE	3	Hours
SEE	50	Marks
CIE	50	Marks
Credits	1	

**Objectives:** Students will learn

1. The importance of machine drawing in industries
2. The usage of solid modeling software
3. Various drawing and feature commands
4. Orthographic and isometric views
5. The assembly of various industrial components

**Outcomes:** Students are able to

1. Understand the importance and need of machine drawing in industries.
2. Model different machine components using CAD software.
3. Draw a detailed dra
4. wing of a component to facilitate its manufacture.
5. Analyze aspects of orthographic views in the preparation of the part/assembly drawings.
6. Identify the sequence of steps to assemble the machine/system components

**List of Experiments/Exercises:**

1. Introduction to machine drawing: importance and need in industries of automobile, aero and manufacturing, classifications of drawings.
2. Study of various commands/ tool bars using solid modelling package (solid works).
3. Part modelling of a components using feature commands Extrude Boss, Extrude Cut, Fillet, Chamfer with mass properties
4. Part modelling using feature commands Revolve, Rib with mass properties
5. Part modelling of a components using feature commands loft, sweep with mass properties
6. Drawing the view from the front, top and left of the objects.
7. Drawing the sectional views of a components
8. Creation of Stuffing box assembly model from parts and views of the assembly
9. Creation of Screw Jack assembly model from parts and views of the assembly
10. Creation of Piston of a petrol engine assembly model from parts and views of the assembly
11. Creation of Lathe tail-stock assembly model from parts and views of the assembly
12. Creation of Revolving centre assembly model from parts and views of the assembly

**Note :** Students should prepare a minimum of 10 drawings

  
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**Suggested Reading:**

1. K.L. Narayana, P. Kanniah, K. Venkata Reddy, Machine drawing Published by New Age International (P) Limited, 5<sup>th</sup> edition, 2018.
2. N. D. Bhatt, V. M. Panchal Machine drawing [including computer aided drafting first-angle projection method], Charotar publishing house, 50<sup>th</sup> edition, 2016.



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**PRODUCTION DRAWING LAB**

Instruction	2	Hours per week
Duration of SEE	3	Hours
SEE	50	Marks
CIE	50	Marks
Credits	1	

**Objectives:** Students will learn to

1. Construct production drawings to enable produce the components in the shop floor and assemble them to meet the final functional requirements.
2. Create drawings for visualization using any modelling packages Solid works, CATIA etc.
3. Choose the Fits, Limits and Tolerances of parts for manufacturing and assembly.
4. Use the Conventions like surface finish, roughness, concentricity
5. Prepare Bill of materials for assembly and process sheet in manufacturing industry.

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

1. Interpret the working drawing/ industrial blueprint of various components.
2. Identify the different parts of the object with dimensional tolerances
3. Create the various part drawings using solid modelling package
4. Use the various functions of modelling soft ware: annotations, sheet making etc.
5. Prepare Bill of materials for assembly and process sheet in manufacturing industry.

**List of Exercises/Experiments:**

1. Introduction to production drawing: importance and need in industries
2. Conventional representation of Materials and machine components
3. Study of the terms used in the limit system and types of fits
4. To learn the need of geometrical tolerances, form and positional tolerances
5. Understanding surface roughness and its indication
6. Study the importance of process sheet preparation

Study the following assembly drawings and draw the component drawings with suitable tolerances and fits, surface roughness, bill of materials etc., Prepare the process sheet using any one of the modelling software tools: solid works/solid edge/CATIA/ProE/Auto CAD-MDT/Nx.

7. Stuffing box
8. I.C engine connecting rod
9. Revolving centre
10. Square tool post
11. Universal coupling
12. Steam Engine Cross Head
13. Drill Jig (Plate Type)
14. Non Return Valve
15. Blow off Cock

**Note :** Students should prepare a minimum of 6 drawings

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Gandipet, Hyderabad-500 075, Telangana

**Suggested Reading:**

1. K. Venkata Reddy, K.L. Narayana, P. Kanniah, Production drawing, 4th edition, New Age International (P) Limited, 2018.
2. P.Narasimha Reddy, T.A. Janardhan Reddy and C. Srinivas Rao, Production Drawing Practice, Hi-Tech Publishers, 2001.



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20MEC30

With Effect from the Academic Year 2022 – 23

### THERMAL ENGINEERING LAB

Instruction	2	Hours per week
Duration of SEE	3	Hours
SEE	50	Marks
CIE	50	Marks
Credits	1	

#### Objectives:

1. To demonstrate knowledge in evaluating thermal conductivity of a metal rod and critical heat flux of a material.
2. To know about the phase change heat transfer and performance of cross flow heat exchanger.
3. To understand the working of principle of axial flow fan and centrifugal blower.
4. To evaluate the COP of Refrigeration tutor and AC tutor.
5. To determine the pressure distribution in nozzle; drag and lift coefficients for contoured bodies.

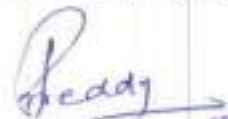
**Outcomes:** At the end of the course, the students will be able to

1. Determine thermal conductivity of a metal rod and critical heat flux of a copper wire.
2. Estimate the convective heat transfer coefficients for phase change heat transfer and effectiveness of cross flow heat exchanger.
3. Determine the overall efficiency of centrifugal/axial-flow compressor.
4. Study of COP of refrigeration/air conditioning tutor.
5. Determine the - pressure distribution in a nozzle/cylinder/aero-foil; lift and drag forces for different geometrical profiles.

#### List of the Experiments

1. Study of Thermal conductivity of metal rod.
2. Determination of critical heat flux for copper wire in water.
3. Evaluate the convective heat transfer coefficient of dropwise and filmwise condensation.
4. Evaluate the effectiveness of cross flow heat exchanger.
5. Determination of overall efficiency of centrifugal blower
6. Study of overall efficiency of axial flow fan
7. Study of COP of refrigerating tutor
8. Study of COP of air conditioning tutor
9. Determination of pressure distribution for convergent and divergent nozzle
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
13. Determination of Sensible and Latent heat loads for a class room and validating the data with RAC software.

**Note:** Student should complete a minimum of 10 experiments including experiment number 13 which is compulsory.



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**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, 2014

**Suggested Reading:**

1. V. Ganeshan, Gas Turbines, Tata Mc Graw Hills, New Delhi, 2010.
2. R.K. Rajput, Heat Transfer, Laxmi Publication, 2014



**PROFESSOR & HEAD**  
Department of Mechanical Engineering  
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20MEC31

With Effect from the Academic Year 2022 – 23

### FINITE ELEMENT ANALYSIS LAB

Instruction	2	Hours per week
Duration of SEE	3	Hours
SEE	50	Marks
CIE	50	Marks
Credits	1	

#### Objectives:

1. Trusses , Bars of constant cross section area, tapered cross section area and stepped bar.
2. Beams -Simply supported, cantilever, beams with UDL, and beams with varying load etc.
3. Stress analysis of a rectangular plate with a circular hole, axisymmetric problems.
4. Buckling analysis and Dynamic Analysis.
5. Steady state and Transient heat transfer analysis.

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

1. Apply basics of Theory of Elasticity to continuum problems.
2. Analyze finite elements like 1D, 2D and 3D structures for linear static analysis.
3. Solve heat transfer problems.
4. Examine problems of limited complexity in buckling and dynamic analysis.
5. Evaluate solutions to practical problems by finite element software.

#### List of Exercises:

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 casting.
11. Non linear analysis of cantilever beam.
12. Coupled field analysis.
13. Static/Buckling/Modal/Harmonic/Transient/Non-Linear/ heat transfer analysis of a selected component.

#### Note:

1. Students should complete a minimum of 10 exercises including exercise number 13 which is compulsory.
2. Students may use any or combination of FEA software (ANSYS/ABAQUS/NASTRAN/NISA/CAEFEM/ADINA).

  
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**Suggested Reading:**

1. Tadeusz, A. Stolarski, Y. Nakasone, S. Yoshimoto, Engineering Analysis with ANSYS Software, 1<sup>st</sup> edition, Elsevier Butterworth-Heinemann publications, 2007.
2. ANSYS Inc., User Manuals for Release 15.0.

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Code : 20EGCO3

**EMPLOYABILITY SKILLS**  
(BE/BTech V & VI semester - Common to all Branches)

Instruction	2	Hours per week
Duration of SEE	3	Hours
SEE	50	Marks
CIE	50	Marks
Credits	1	

**Course Objectives:** To help the students

1. Learn the art of communication, participate in group discussions and case studies with confidence and to make effective presentations.
2. With- resume packaging, preparing them to face interviews.
3. Build an impressive personality through effective time management, leadership qualities, self-confidence and assertiveness.
4. Understand professional etiquette and to make them learn academic ethics and value system.
5. To be competent in verbal aptitude.

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

1. Become effective communicators, participate in group discussions with confidence and 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, learn to manage time effectively and deal with stress.
4. Make the transition smoothly from campus to work, use media with etiquette and understand the academic ethics.
5. Enrich their vocabulary, frame accurate sentences and comprehend passages confidently.

**UNIT 1**

**Verbal Aptitude:** Error Detection, Articles, Prepositions, Tenses, Concord and Transformation of Sentences-Jumbled Words/Sentences- Vocabulary, Synonyms, Antonyms, One Word Substitutes, Idioms and Phrases, Word/Sentence/Text Completion- Reading Comprehension.

**UNIT 2**

**Group Discussion & Presentation Skills:** Dynamics of Group Discussion-Case Studies- Intervention, Summarizing, Modulation of Voice, Body Language, Relevance, Fluency and Accuracy, Coherence, Elements of Effective Presentation – Structure of a Presentation – Presentation tools – Body language - Preparing an Effective PPT

**UNIT 3**

**Behavioural Skills:** Personal strength analysis-Effective Time Management- Goal Setting- Stress management-

**Corporate Culture** – Grooming and etiquette-Statement of Purpose (SOP).

  
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#### UNIT 4

Mini Project: Research-Hypothesis-Developing a Questionnaire-Data Collection-Analysis-General and Technical Report - Writing an Abstract - Technical Report Writing-Plagiarism-Project Seminar.

#### UNIT 5

**Interview Skills:** Cover Letter and Résumé writing – Structure and Presentation, Planning, Defining the Career Objective, Projecting ones Strengths and Skill-sets – Interviews: Concept and Process, Pre-Interview Planning, Opening Strategies, Answering Strategies, Mock Interviews.

#### Suggested Reading:

1. Leena Sen, "Communication Skills", Prentice-Hall of India, 2005
2. Dr. Shalini Verma, "Body Language - Your Success Mantra", S Chand, 2006
3. Edgar Thorpe and Showick Thorpe, "Objective English", 2<sup>nd</sup> edition, Pearson Education, 2007
4. Ramesh, Gopalswamy, and Mahadevan Ramesh, "The ACE of Soft Skills", New Delhi: Pearson, 2010
5. Gulati and Sarvesh, "Corporate Soft Skills", New Delhi: Rupa and Co., 2006
6. Van Emden, Joan, and Lucinda Becker, "Presentation Skills for Students", New York: Palgrave Macmillan, 2004
7. A Modern Approach to Verbal & Non-Verbal Reasoning by R S Aggarwal, 2018
8. Covey and Stephen R, "The Habits of Highly Effective People", New York: Free Press, 1989

  
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18ME C22

## METROLOGY AND INSTRUMENTATION

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

**Objectives:**

1. To familiarize with limits, fits & tolerances and fundamental concepts of linear and angular measurements.
2. To have adequate skill in the usage of various precision measuring instruments and the concepts of limit gauges.
3. To learn the importance of Geometric form and how to measure form errors.
4. To have knowledge in the concepts of classification of instrument errors and their characteristics.
5. To understand the working principles of various instruments used for the measurement of displacement, pressure and temperature.

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

1. Understand the need, accuracy and associated concepts of measurements. (BL-2)
2. Select appropriate gauges for inspection and design. (BL-3)
3. Calculate surface roughness by using appropriate instruments. (BL-3)
4. Analyze and interpret the types of errors, strain measurement and instrument characteristics. (BL-4)
5. Evaluate measuring methods and devices for displacement, pressure & temperature. (BL-5)

**UNIT-I**

**Limits, Fits and Tolerances:** Interchangeability, nominal size, limits, tolerances, allowance, fundamental deviation, unilateral and bilateral tolerances, types of fits, alpha numeric designation of limits/fits, hole and shaft basis systems, selective assembly.

**Linear and angular measurement:** Line and end standards, slip gauges, Tomlinson gauges and sine bar.

**UNIT-II**

**Design of limit gauges:** Taylor's Principle for plan limit gauges, design of GO and NO GO gauges, use of plug, ring and snap gauges.

**Comparators:** Introduction, dial indicator, sigma-mechanical comparator, back pressure type pneumatic comparator.

**Optical measuring instruments:** Optical projector principle and its uses, tool maker's microscope principle and its uses, interferometry.

**UNIT-III**

**Straightness, Flatness and Roundness Measurement:** Definitions, measurement by beam comparator, straight edge, spirit level, and bench centers.

**Surface roughness measurements:** Roughness and waviness, numerical assessment of surface roughness, surface roughness measurement by profilometer, Taylor Hobson Talysurf, ISI symbols for indication of surface finish.

**UNIT-IV**

**Screw thread metrology:** Basic terminology of screw thread, measurement of effective diameter by 2 wire and 3 wire methods, best wire size.

**Gear tooth metrology:** Spur gear nomenclature, gear tooth thickness measurement by gear tooth vernier.

  
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**Instrumentation:** Static and dynamic characteristics of instruments, types of errors, strain measurement with strain gauges, gauge factor, rosette Gauges.

**UNIT-V**

**Transducers:** Displacement measurement by L.V.D.T, pressure measurement by bourdon pressure gauge, bulk modulus pressure gauge, pirani gauge, temperature measurement by thermo couples, laws of thermo electricity, types of materials used in thermocouples.

**Text Books:**

1. R.K. Jain, "Engineering Metrology", Khanna Publications, 1996.
2. Doebelin, "Measurement Systems Application and Design", TMH, 5/e., 2004.
3. Beckwith, Buck, Lienhard, "Mechanical Measurements", PEA, 3rd Indian Reprint, 2001.

**Suggested Reading:**

1. RegaRajendra, "Principles of Engineering Metrology", Jaico Publishing House, Mumbai, 2008.
2. B.C. Nakra & K.K. Chaudhary, "Instrumentation Measurement and Analysis", 3/e, McGrawhill, 2014.

  
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18ME C23

## OPERATIONS RESEARCH

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

### Objectives:

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

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

1. Understand the concepts of linear programming problems. (BL-2)
2. Solve the given transportation problem. (BL-3)
3. Develop optimum pair of operations and resources by using Assignment technique. (BL-3)
4. Analyze project management techniques like CPM and PERT to plan and execute projects successfully. (BL-4)
5. Apply sequencing and queuing theory concepts for industry applications. (BL-3)

### 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.

### UNIT-V

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

  
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Queuing theory: Introduction, Kendall's notation, single channel - Poisson arrivals-exponential service times.

**Text Books:**

1. Hamdy A. Taha, "Operations Research-An Introduction", 10/e, Pearson education India, 2017.
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. R. PanerSelvam, "Operations Research", 2/e, PHI Learning Pvt. Ltd., New Delhi, 2008.
2. Nita H. Shah, Ravi M. Gor, HardikSoni, "Operations Research", PHI Learning Private Limited, 2013.

  
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18ME C24

**FINITE ELEMENT ANALYSIS**

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 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 circular shaft problems.
3. Enable the students to formulate 2D problems with special cases.
4. Enable the students to formulate quadrilateral element, use of numerical integration, Gaussian quadrature and one dimensional dynamic problems.
5. Enable the students to understand the convergence requirements, heat transfer, formulate 3D problems and perform engineering simulations using Finite Element Analysis software (ANSYS).

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

1. Understand FE method for solving field problems using energy formulations. (BL-2)
2. Analyze bars, trusses, beams and circular shafts for static and dynamic analysis. (BL-4)
3. Formulate 2D structural components using triangular element for plane stress, plane strain and axi-symmetric problems. (BL-4)
4. Derive stiffness matrix for 4 node quadrilateral isoparametric element for static analysis and 3 D elements. (BL-6)
5. Solve heat transfer problems and apply finite element analysis software for engineering solutions. (BL-3)

**UNIT - I**

**Fundamental concepts:** Introduction to finite element method, stresses and equilibrium, boundary conditions, strain –displacement and stress – strain relationship.

**One dimensional problem:** Finite element modeling co-ordinates and shape 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, analysis of circular shaft subjected to torsion.

**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 axisymmetric solids subjected to axisymmetric loading with triangular elements.

**UNIT - IV**

**Quadrilateral elements and numerical integration:** Two dimensional four nodedisoparametric elements, numerical integration and gauss quadrature.

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

**UNIT - V**

**Heat transfer analysis:** Steady state heat transfer analysis, one dimensional analysis of a fin and two dimensional analysis of thin plate, formulation of time dependent field problems, applications 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.

**Introduction to finite element analysis software:** Modeling, analysis and post processing.

**Text Books:**

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

**Suggested Reading:**

1. S.S. Rao, "The Finite Element Method in Engineering", Pergamon Press, 1989.
2. L. J. Segerlind, "Applied Finite Element Analysis", Wiley Eastern, 1984.

  
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18ME E21

**POWER PLANT ENGINEERING**

(Core Elective - VI)

Instruction	3	Hours Per Week
Duration of SEE	3	Hours
SEE	70	Marks
CIE	30	Marks
Credits	3	

**Objectives:**

1. Different types of power plants and their site selection criteria
2. Operation of thermal power plant
3. About hydraulic power plants, 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, environmental and safety aspects of power plant operation.

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

1. Select the suitability of site for a power plant in the context of environment. (BL-4)
2. Discuss ash handling and coal handling methods in thermal power plants. (BL-2)
3. Understand the importance of site selection for a hydro-power plant in the context of societal and environment. (BL-2)
4. Explain the safety aspects of nuclear waste disposal. (BL-2)
5. Estimate the economic factors and pollutant formation from power plants. (BL-3)

**UNIT - I**

**Introduction:** Power plant, classification of power plants, conventional and non-conventional power plants, merits and demerits of conventional and non-conventional power plants.

**Steam power plant:** Selection of site for steam power plant, plant layout, formation and types of coal, stages in coal handling, working of coal handling equipment - belt conveyors, screw conveyors, bucket elevators and grab bucket conveyors, general layout of ash handling and dust collection system, uses of ash and dust, ash handling systems - mechanical, pneumatic, steam jet and hydraulic systems of ash handling.

**UNIT - II**

**Combustion process in steam power plant:** Stoker firing, overfeed stokers - travelling grate stokers and spreader stokers, underfeed stokers - single retort and multi-retort underfeed stokers, elements of pulverized fuel burning system, advantages and disadvantages of pulverized fuel burning system, pulverized fuel burners - long flame, short flame, tangential and cyclone burners, fluidized bed combustion (FBC), benefits and disadvantages of FBC.

**UNIT - III**

**Hydro electric power plant:** Hydrological cycle, hydrograph, flow/mass duration curve, selection of site for hydro-electric plant, advantages and disadvantages of hydro-electric plants, elements (flow-sheet) of hydro-electric power plant, types and working of hydroelectric power plants, storage and pondage, parts and terminology of a dam.

selection of site for dams, classification and working of different types of dams, spillways, necessity and location of spillways, classification and working of different types of spillways.

#### UNIT - IV

**Nuclear power plant:** Nuclear fuel, breeding and fertile materials, distinction between fissionable, fissile and fertile materials, advantages and disadvantages of nuclear power, components of nuclear reactor, types of nuclear reactors, working of pressurized water reactor, boiling water reactor, sodium-graphite reactor, fast breeder reactor and gas cooled reactors – radioactive (nuclear) waste disposal methods.

#### UNIT - V


**Power plant economics and environmental considerations:** Definition and related exercises on connected load, demand (load), maximum demand (peak load), demand factor, average load, load factor, diversity factor, utilization factor, plant capacity factor and plant use factor, fixed cost and variable cost, methods to find depreciation cost and related numerical problems, economics in plant selection, effluents from power plants and impact on environment, pollutants, pollution control.

#### Text Books:

1. R.K. Rajput, "A Text Book of Power Plant Engineering", 4/e, Laxmi Publications (P) Ltd., New Delhi, 2015.
2. P.K. Nag, "Power Plant Engineering", 4/e, McGraw-Hill Education (India) Private Limited, New Delhi, 2014.
3. P.C. Sharma, "A Text Book of Power Plant Engineering", S.K. Kataria & sons, 2019

#### Suggested Reading:

1. R. Yadav, "Fundamentals of Power Plant Engineering", Central Publishing House, Allahabad, 2012.
2. S.C. Arora and S. Domkundwar, "A Course in Power Plant Engineering", Dhanpat Rai & Sons, New Delhi, 2005.

  
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18ME E22

## ENGINEERING RESEARCH METHODOLOGY

(Core Elective - VI)

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

### Objectives:

1. To make the students to formulate the research problem.
2. To identify various sources for literature review and data collection.
3. To prepare the research design.
4. To equip the students with good methods to analyze the collected data.
5. To explain how to interpret the results and report writing.

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

1. Define research problem. (BL-1)
2. Review and assess the quality of literature from various sources. (BL-2)
3. Understand and develop various research designs. (BL-2)
4. Analyze problem by statistical techniques: ANOVA, F-test, Chi-square. (BL-4)
5. Improve the style and format of writing a report for technical paper/ Journal report. (BL-4)

### UNIT – I

**Research methodology:** Objectives and motivation of research, types of research- descriptive vs. analytical, applied vs. fundamental, quantitative vs. qualitative, conceptual vs. empirical, research approaches, significance of research, research methods vs. methodology, research process, criteria of good research, problems encountered by researchers in India, technique involved in defining a problem.

### UNIT-II

**Literature survey:** Importance of literature survey, sources of information-primary, secondary, tertiary, assessment of quality of journals and articles, information through internet.

### UNIT – III

**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, steps in sample design.

### UNIT – IV

**Data collection:** Collection of primary data, Secondary data, measures of central tendency-mean, mode, median, measures of dispersion- range, mean deviation, standard deviation, measures of asymmetry (skewness), important parametric tests -z, t, F, Chi-Square, ANOVA significance.

### UNIT – V

**Research report formulation and presentation:** Synopsis, dissertation, technical paper and journal paper, writing research grant proposal, making presentation with the use of visual aids, writing a proposal for research grant.

### Text Books:

1. C.R Kothari, "Research Methodology Methods & Technique", New Age International publishers, 2004.
2. R. Ganesan, "Research Methodology for Engineers", MJP Publishers, 2011.
3. Vijay Upagade and Aravind Shende, "Research Methodology", S. Chand & Company Ltd., New Delhi, 2009.

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**Suggested Reading:**

1. G. Nageswara Rao, "Research Methodology and Quantitative methods", BS Publications, Hyderabad, 2012.
2. Naval Bajaj, "Business Research Methods", Pearson Education, 2011.

18ME E23

**DATA ANALYTICS**  
(Core Elective - VI)

Instruction	3 Hours per Week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

**Objectives:**

1. To familiarise the students with the concept of descriptive and inferential statistics.
2. To make the students to understand the concept of machine learning.
3. To make the students to understand various techniques of supervised learning.
4. To make the students to learn the concepts of unsupervised learning.
5. To make the students to learn the prescriptive analytics.

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

1. Solve the problems using statistics, regression analysis and ANOVA. (BL-3)
2. Understand the concept of machine learning. (BL-2)
3. Apply various supervised learning techniques to a given problem. (BL-3)
4. Understand unsupervised learning and problems in big data analysis. (BL-2)
5. Demonstrate prescriptive analytics methods to the given data. (BL-2)

**UNIT-I**

**Introduction:** Introduction to data and analytics, taxonomy of data analytics, typical data challenges (data quality, enrichment, integration of ERP & PLM data), preparing data for analytics (techniques to improve data quality, integration - ETL).

**Descriptive and inferential statistics:** Descriptive statistics: introduction, probability distributions, inferential statistics, inferential statistics through hypothesis tests permutation & randomization test, regression & ANOVA.

**UNIT-II**

**Machine Learning:** Introduction and concepts, differentiating algorithmic and model based frameworks, regression, ordinary least squares, K nearest neighbours regression & classification.

**UNIT-III**

**Supervised learning with regression and classification techniques:** Model validation approaches, discriminant analysis, quadratic discriminant analysis, regression and classification trees, support vector machine.

**Ensemble Methods:** Neural networks, deep learning.

**UNIT-IV**

**Unsupervised learning and challenges for big data analytics:** Clustering, associative rule mining, challenges for big data analytics.

**UNIT-V**

**Prescriptive analytics:** Creating data for analytics through designed experiments, creating data for analytics through active learning, creating data for analytics through reinforcement learning.

  
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**Text Books:**

1. Hastie, Trevor, "The elements of statistical learning", Vol. 2, No.1. New York, Springer, 2009.
2. Montgomery, Douglas C., and George C. "Ranger. Applied statistics and probability for engineers", John Wiley & Sons, 2010
3. Christopher Tong and D. Sriram, "Artificial Intelligence in Engineering Design: Knowledge acquisition, commercial systems, and integrated environments", Boston : Academic Press, 1992.

**Suggested Reading:**

1. Anil Maheswari, "Data Analytics", McGraw-Hill, 2017.
2. V.K.Jain "Data Science and Analytics (with Python, R and SPSS Programming)", Khanna Publishers, 2018.

  
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18ME E24

**INNOVATION AND INTELLECTUAL PROPERTY RIGHTS**  
(Core Elective - VI)

Instruction 3 Hours per Week	3 Hours
Duration of SEE	70 Marks
SEE	30 Marks
CIE	3
Credits	

**Objectives:**

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 and techno-business aspects of IPR.

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

1. Understand the evolution of Intellectual property, working of organization's at global level to protect and promote intellectual property. (BL-2)
2. Apply the patent filing process at national and international level. (BL-3)
3. Derive logical conclusion of research, innovation and patent filing. (BL-4)
4. Compare different kinds of Intellectual property and their patenting system. (BL-2)
5. Understand the techno-legal-business angle of Intellectual property, infringement and enforcement Mechanisms for protection. (BL-2)

**UNIT-I**

**Overview of IPR:** Introduction and the need for intellectual property rights (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 licensors 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, protection of industrial design, kind of protection available, term of protection of industrial design and need for protection.

**UNIT-III**

**Trademarks:** Definition of trademarks, types of trademarks and functions of a trademark, registration of Trademark, benefits of registration of trademark, procedure for registration of trademark and term of validity of trademark, infringement and passing off.

**UNIT-IV**

**Copyright:** What is copyright, what is covered by copyright, term of enforcement of copyright and need for copyright protection, copyright and related rights, copyrights in computer programming.

**UNIT-V**

**Geographical indications:** Introduction, definition, difference between GI and trademark, difference between GI and appellation of origin, GI as factors of rural development, developing a geographical indication and protection

**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.R, "Intellectual Property; Patents, copyright, Trademarks and allied rights", Sweet & Maxwell, 1993.
2. P. Narayanan, "Intellectual Property Law", Eastern Law Edn, 1997.

  
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18PE E12

**SUPPLY CHAIN MANAGEMENT**  
(Core Elective - VI)

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

**Objectives:**

1. The awareness about transportation and warehouse management systems.
2. The designing supply chain networks.
3. The concept of demand and supply and integrating it with supply chain management.
4. The planning and managing inventories.
5. The pricing and revenue management.

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

1. Understand fundamentals of supply chain and its key concepts. (BL-2)
2. Design an effective supply chain network. (BL-4)
3. Understand the essence of demand and supply and associated gaps. (BL-2)
4. Apply inventory management techniques. (BL-3)
5. Evaluate pricing and revenue management systems. (BL-5)

**UNIT-I**

**Concept of SCM:** Supply chain definition, stages of supply chain, objectives, drivers of SCM-facilities, inventory, transportation, information, sourcing and pricing, decision phases in Supply chain, pull and push processes introduction to logistics management.

**UNIT-II**

**Designing the supply chain network:** Role of distribution in supply chain and factors influencing its network design and decisions, types of distribution networks - manufacturer storage with direct shipping, manufacturer storage with direct shipping and in transit merge, distributor storage with package carrier delivery, distributor storage with last mile delivery, manufacturer/distributor storage with customer pickup, retail storage with customer pick up, framework for network design decisions-supply chain strategy, regional facility configuration, desirable sites and location choices.

**UNIT-III**

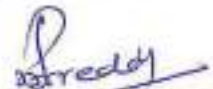
**Planning supply and demand:** Planning demand & supply in a supply chain, demand forecasting- moving averages, exponential smoothing, trend and seasonality, aggregate planning, master scheduling, materials requirement planning, time phased order plan, critical ratio, product tree structures.

**UNIT-IV**

**Planning & managing inventories in a supply chain:** Inventory control, objectives of inventory management in supply chain, deterministic inventory and probabilistic inventory control, economic order quantity, quantity discounts, Reorder point, basics of ABC analysis, FNSD analysis, VED analysis.

**UNIT-V**

**Sourcing, pricing, coordination and IT in supply chain:** Sourcing decisions, key sourcing related processes, In-house or outsource, pricing & revenue management, differential pricing strategies, coordination in supply chain, bullwhip effect, information technology and supply chain, supply chain macro processes- CRM, ISCM, SRM, TMF.



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**Text Books:**

1. Sunil Chopra & Peter Meindl, "Supply Chain Management – Strategy, Planning and Operation", Pearson Education, Inc., Upper Saddle River, New Jersey, 2003.
2. N. J. Kumar & Mukesh Bhatia, "Supply Chain Management", Neha publishers & Distributors, 2010.
3. Michael H. Hugos, "Essentials of Supply Chain Management", 3/e, John Wiley & Sons, Inc, Hoboken, New Jersey, 2011.

**Suggested Reading:**

1. Martin Christopher, "Logistics & Supply Chain Management", 5/e, Financial Times Series, 2010.
2. Dobler Donald. W, David.N.Burt, "Purchasing & supply Management Text & Cases", McGraw-Hill, 1996.

  
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18IT 001

## OBJECT ORIENTED PROGRAMMING USING JAVA

(Open Elective)

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

### Course Objectives:

1. To familiarize with fundamentals of object-oriented programming paradigm.
2. To impart the knowledge of string handling, interfaces, packages and inner classes.
3. To facilitate learning Exception handling and Multithreading mechanisms.
4. To gain knowledge on collection framework, stream classes.
5. To familiarize with event driven GUI programming and Database connectivity.

**Outcomes:** Upon completing this course, students are able to:

1. Understand Object-Oriented concepts.
2. Create Java applications using sound OOP practices e.g. Inheritance, Interfaces, Packages, and Inner Classes.
3. Implement Exception Handling and Multithreading concepts in java programs.
4. Develop programs using the Java Collection API and Stream classes.
5. Design and Develop GUI applications with the integration of event handling, JDBC.

### Modified Course Outcomes:

1. Understand the concepts of Object-Oriented Programming and class concept in Java.
2. Apply concepts of OOP such as Inheritance, Interfaces, Packages and Inner classes.
3. Handle exceptions and demonstrate the concepts of Multithreading and Generic classes.
4. Develop programs using Java Collection API and Stream classes.
5. Design and Develop GUI applications with JDBC.

### UNIT-I

**OOP concepts** - Data abstraction, encapsulation, inheritance, benefits of inheritance, polymorphism, classes and objects, Procedural and object oriented programming paradigms.

**Introduction to Java:** Java's Magic: The Byte code, The Java Buzzwords, Simple Java Programs, Java Primitive Types, Arrays: How to create and define arrays, Basic Operators, Control statements.

**Introducing Classes:** Declaring objects, methods, Constructors, this keyword, Method Overloading and Constructor Overloading, Objects as parameters, Returning objects, Use of static and final keywords.

### UNIT-II

**Inheritance:** super and subclasses, Member access rules, super keyword, Method overriding, Dynamic method dispatch, Abstract classes, using final with inheritance, Introduction to Object class.

**Packages:** Defining, Creating and Accessing a Package, Understanding CLASSPATH, importing packages.

**Interfaces:** Defining and implementing interfaces, Nested Interfaces.

**Strings Handling:** String & StringBuffer classes, StringTokenizer class and Wrapper classes and conversion between Objects and primitives.

  
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**Inner classes in Java:** Types of inner classes, Creating static / non-static inner classes, Local and anonymous inner classes.

#### UNIT-III

**Exception Handling in Java:** what are Exceptions? Exception types, Usage of try, catch, throw, throws and finally clauses, writing your own exception classes.

**Multithreading in Java:** The java Thread Model, How to create threads, Thread class in java, Thread priorities, Thread synchronization.

**Generics:** What are Generics? Generic classes, bounded types, Generic methods and interfaces.

#### UNIT-IV

**Collections Framework:** Overview of Collection Framework, Commonly used Collection classes – ArrayList, LinkedList, HashSet, LinkedHashSet, TreeSet, Collection Interfaces –Collection, List, Set, SortedSet, Accessing a collection via an Iteration, Storing user-defined classes in collections, Map Interfaces and Classes, Using a comparator. Legacy classes – Vector, Hashtable, The Enumeration interface.

**Input/Output :** How to read user input (from keyboard) using scanner class, Stream classes, InputStream, OutputStream, FileInputStream, FileOutputStream, Reader and Writer, FileReader, FileWriter classes. File class.

#### UNIT-V

**GUI Design and Event Handling:** Component, Container, window, Frame classes. Working with Frame window GUI Controls, Layout Managers, Introduction to Swings, Delegation Event Model, Event Classes, Source of Events, Event Listener Interfaces, Handling button click events, Adapter classes. Writing GUI Based applications.

**Database Handling in Java:** Java Database Connectivity (JDBC) using MySQL.

#### Text Books:

1. Herbert Schildt, "Java: The Complete Reference", 8<sup>th</sup> Edition, Tata McGraw Hill Publications, 2011.
2. Cay S. Horstmann, Gary Cornell, "Core Java, Volume I, Fundamentals", 8<sup>th</sup> Edition, Prentice Hall, 2008.

#### Suggested Reading:

1. E Balagurusamy "Programming with JAVA", 6th Edition . Tata McGraw-Hill Publishing company Ltd, 2019.
2. Sachin Malhotra & Saurabh Choudhary, "Programming in Java", 2<sup>nd</sup> Edition, Oxford University Press, 2014.
3. C. Thomas Wu, "An introduction to Object-oriented programming with Java", 4<sup>th</sup> Edition, Tata McGraw-Hill Publishing company Ltd., 2010.
4. Kathy Sierra, Bert Bates, "Head First Java: A Brain-Friendly Guide" 2<sup>nd</sup> Edition, O'Reilly, 2005

#### Web Resources:

1. [https://www.cse.iitb.ac.in/~nlp-ai/javalect\\_august2004.html](https://www.cse.iitb.ac.in/~nlp-ai/javalect_august2004.html).
2. <http://nptel.ac.in/courses/106106147/>
3. <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-092-introduction-to-programming-in-java-january-iap-2010/lecture-notes/>

  
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18 PY 001

## HISTORY OF SCIENCE AND TECHNOLOGY

(Open Elective)

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

**Course Objectives:** The objectives of the course is to make the student

1. Gains the knowledge about origin of science in the Stone Age and its progress during Antiquity period.
2. Familiar with scientific views in the Medieval period and during the Industrial revolution..
3. Aware of modern scientific developments from 19<sup>th</sup> century onwards.

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

1. Demonstrate the process of beginning of science and civilization, knowledge acquisition and philosophical approach of science and its advancements in the Stone Ages and Antiquity period.
2. Illustrate the advancements in science and technology in the medieval period across Asia and Arab countries and decline and revival of science in Europe.
3. Explain the scientific approach and its advances of the Europeans and how the role of engineer during the industrial revolution and the major advancements.
4. Make use of the advancements in the field of science and technology by adopting new philosophies of 19<sup>th</sup> and first half of 20<sup>th</sup> century in finding ethical solutions to the societal problems.
5. Interpret the changes in specializations of science and the technology and build the relation between information and society from second half of 20<sup>th</sup> century onwards.

### UNIT-I

**Science - The Beginning (through 599 BCE):** The Stone Ages, Knowledge among hunter gatherers, Agricultural Revolution and other revolutions. Civilization, Major advances.

**Science in Antiquity (600 BCE- 529 CE):** Philosophy- a precursor to science, Hellenistic world and the Roman Empire, Other cultures of the period, Major advances.

### UNIT-II

**Medieval Science (530 CE - 1452 CE):** The decline of science in Europe, Science in China, Science and mathematics in India, Arab science, Revival of science in Europe, Technology revolution of the Middle ages, Major advances.

**The Renaissance and the Scientific Revolution (1453 CE – 1659 CE):** Renaissance, Scientific Revolution, Technology, Major advances.

### UNIT-III

**Scientific Method: Measurement and Communication (1660 CE – 1734 CE):** European domination, The scientific method, Major advances.

**The Industrial Revolution (1735 CE – 1819 CE):** Industrial Revolution, Rise of the engineer, Major Advances.

  
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**UNIT-IV**

**Science and Technology in the 19th Century (1820 CE – 1894 CE):** Philosophical basis of 19th-century science, Science and the public, Science and technology, Major advances.

**Rise of Modern Science and Technology (1895 CE – 1945 CE):** The growth of 20<sup>th</sup> century science, New philosophies, Quantum reality, Energy sources, Electricity: a revolution in technology, Major advances.

**UNIT-V**

**Big Science and the Post-Industrial Society (1946 CE – 1972 CE):** Big science, Specialization and changing categories, Technology changes society, Major advances.

**The Information Age (1973 CE – 2015 CE):** Information and society, Globalization, The post-industrial society, Problems of the Information age, Major Advances

**Text Books:**

1. Bryan Bunch and Alexander Hellemans, "The History of Science and Technology", Houghton Mifflin Company (New York), 2004
2. JD Bernal, "Science in History", 4 Volumes, Eklavya Publishers, 2012

**Suggested Readings:**

1. "The 100 Most Influential Scientists of All Time", Edited by Kara Rogers, Britannica Educational Publishing, 2010
2. Alberto Hernandez, "A Visual History of Science and Technology", The Rosen Publishing Group, 2016



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18EG O 02

**GENDER SENSITIZATION**  
(Open Elective)

Instruction	3 Periods per week
Duration of SEE Examination	3 Hours
SEE Examination	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** This course will introduce the students to:

1. Sensibility regarding issues of gender in contemporary India.
2. A critical perspective on the socialization of men and women.
3. Popular debates on the politics and economics of work while helping them reflect critically on gender violence.

**Outcomes:** After completion of the course the students are able to

1. Understand the difference between "Sex" and "Gender" and be able to explain socially constructed theories of identity.
2. Recognize shifting definitions of "Man" and "Women" in relation to evolving notions of "Masculinity" and "Femininity".
3. Appreciate women's contributions to society historically, culturally and politically.
4. Analyze the contemporary system of privilege and oppressions, with special attention to the ways gender intersects with race, class, sexuality, ethnicity, ability, religion, and nationality.
5. Demonstrate an understanding of personal life, the workplace, the community and active civic engagement through classroom learning.

**UNIT - I**

**Understanding Gender:**

**Gender:** Why Should We Study It? (Towards a World of Equals: Unit -1)

**Socialization:** Making Women, Making Men (Towards a World of Equals: Unit -2) Introduction. Preparing for Womanhood. Growing up Male. First lessons in Caste. Different Masculinities.

**UNIT - II**

**Gender And Biology:**

**Missing Women:** Sex Selection and Its Consequences (Towards a World of Equals: Unit -4) Declining Sex Ratio. Demographic Consequences.

**Gender Spectrum:** Beyond the Binary (Towards a World of Equals: Unit -10) Two or Many? Struggles with Discrimination.

**UNIT - III**

**Gender and Labour:**

**Housework:** the Invisible Labour (Towards a World of Equals: Unit -3) "My Mother doesn't Work." "Share the Load."

**Women's Work:** Its Politics and Economics (Towards a World of Equals: Unit -7) Fact and Fiction. Unrecognized and Unaccounted work. Additional Reading: Wages and Conditions of Work.

**UNIT-IV**

**Issues Of Violence**

**Sexual Harassment:** Say No! (Towards a World of Equals: Unit -6) Sexual Harassment, not Eve-teasing- Coping with Everyday Harassment- Further Reading: "Chupulu".

**Domestic Violence: Speaking Out** (Towards a World of Equals: Unit -8) **Is Home a Safe Place?** -When Women Unite [Film]. **Rebuilding Lives.** Additional Reading: **New Forums for Justice.** **Thinking about Sexual Violence** (Towards a World of Equals: Unit -11) **Blaming the Victim-"I Fought for my Life...."** - Additional Reading: **The Caste Face of Violence.**

#### UNIT – V

**Gender: Co - Existence**

**Just Relationships: Being Together as Equals** (Towards a World of Equals: Unit -12) **Mary Kom and Onler.** **Love and Acid just do not Mix.** **Love Letters.** **Mothers and Fathers.** Additional Reading: **Rosa Parks-The Brave Heart.**

#### Textbook:

1. A. Suneetha, Uma Bhugubanda, Duggirala Vasanta, Rama Melkote, Vasudha Nagaraj, Asma Rasheed, Gogu Shyamala, Deepa Sreenivas and Susie Tharu **"Towards a World of Equals: A Bilingual Textbook on Gender"** published by Telugu Akademi, Hyderabad, Telangana State, 2015.

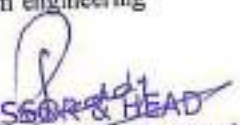
#### Suggested Reading:

1. Menon, Nivedita. **Seeing like a Feminist.** New Delhi: Zubaan-Penguin Books, 2012
2. Abdulali Sohails. **"I Fought For My Life...and Won."** Available online at:  
<http://www.thealternative.in/lifestyle/i-fought-for-my-lifeand-won-sohaila-abdulali/>

#### Web Resources:

1. <https://aifs.gov.au/publications/gender-equality-and-violence-against-women/introduction>
2. <https://theconversation.com/achieving-gender-equality-in-india>

**Note:** Since it is an Interdisciplinary Course, Resource Persons can be drawn from the fields of English Literature or Sociology or Political Science or any other qualified faculty who has expertise in this field from engineering departments.

  
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18ITO03

**PRINCIPLES OF INTERNET OF THINGS**  
(Open Elective)

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

**Course Objectives:**

1. To provide an overview of Internet of Things, building blocks of IoT and real-world applications.
2. To explore various IOT enabling technologies.
3. To facilitate students, understand Python scripts for IoT platform.
4. To identify steps in IOT design Methodology.
5. To introduce about the Raspberry Pi device, its interfaces and Django Framework.

**Outcomes:** Upon completing this course, students are able to:

1. Comprehend the terminology, protocols and communication model of IoT.
2. Define the various IoT enabling technologies and differentiate between M2M and IoT.
3. Acquire the basics of Python Scripting Language used in developing IoT applications.
4. Describe the steps involved in IoT system design methodology.
5. Design simple IoT systems using Raspberry Pi board and interfacing sensors with Raspberry Pi.

**Modified Course Outcomes:**

1. Outline the terminology, protocols, Communication models and Communication APIs of IoT.
2. Define the various IoT enabling technologies, Levels, Domain Specific applications and differentiation between M2M and IoT.
3. Make use the basics of Python Scripting Language for developing IoT applications.
4. Infer the steps involved in IoT system design methodology with Home Automation case study.
5. Examine IoT systems using the Raspberry Pi board and interfacing sensors.

**UNIT-I**

**Introduction & Concepts:** Introduction to Internet of Things- Definitions & Characteristics of IoT, Physical Design of IOT-Physical Layer, Network Layer, Transport Layer, Application Layer, Things in IoT, IoT Protocols, Logical Design of IOT-IoT Functional Blocks, IoT Communication Models-Request-reponse, Publisher-Subscriber, Push-Pull, Exclusive Pair, IoT Communication APIs-REST API, Websocket API,

**UNIT-II**

**IOT Enabling Technologies:** Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols, Embedded Systems, IOT Levels & Deployment Templates. Differences and similarities between IOT and M2M, Domain Specific IoT's – IoT applications for Home Automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, health and Lifestyle.

**UNIT-III**

**Introduction to Python**–Motivation for using Python for designing IoT systems, Language features of Python, Data types- Numbers, Strings, Lists, Tuples, Dictionaries, Type Conversions. Data Structures: Control of flow-if, for, while, range, break/continue, pass, functions, modules, packaging, file handling, database operations, classes, Exception handling.

  
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**UNIT-IV**

**IoT Platforms Design Methodology:** Introduction, IoT Design Methodology Steps-Purpose and Requirements Specification, Process Specification, Domain Model Specification, Information Model Specification, Service Specifications, IoT Level Specification, Functional View Specification, Operational View Specification, Device and Component Integration, Application Development, Case Study on IoT System for Weather Monitoring.

**UNIT-V**

**IoT Physical Devices and End Points:** Basic building blocks of an IoT device, Raspberry Pi about the Raspberry Pi board, Raspberry Pi interfaces-Serial, SPI, I2C, Other IoT Devices like Arduino, BeagleBone Black, Cubieboard. Python Web Application Framework: Django Framework-Roles of Model, Template and View.

**Text Books:**

1. Arshdeep Bahga and Vijay Madisetti, "Internet of Things - A Hands-on Approach, Universities Press, 2015.
2. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014.

  
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18CSO 09

## BASICS OF ARTIFICIAL INTELLIGENCE

(Open Elective)

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

**Pre-requisites:** Basic Mathematics.

**Course Objectives:** The main objectives of this course are:

1. To Provide fundamental concepts in Artificial Intelligence.
2. Discuss the various paradigms involved in solving an AI problems which involve perception, reasoning and learning
3. Apply the AI concepts to build an expert system to solve the real-world problems.

**Course Outcomes:** On Successful completion of this course, student will be able to

1. Identify various search strategies to solve problems.
2. Compare and contrast knowledge representation schemes.
3. Apply Bayesian Networks and Dempster Shafer theory for reasoning.
4. Explain the role of agents and interaction with the environment
5. Determine different learning paradigms.
6. Explain robotic architectures and expert systems.

### UNIT - I

Introduction: Definition, history, applications. Problem Solving: AI problems, AI Technique, Defining problem as a State-Space Search, Problem Characteristics, Heuristic Search Techniques: Generate-and-test, Hill Climbing, Constraint Satisfaction.

### UNIT - II

Knowledge Representation (Logic): Representing facts in logic, proposition logic, predicate logic, resolution and unification. Knowledge Representation (Structured): Declarative representation, Semantic nets, procedural representation, frames.

### UNIT - III

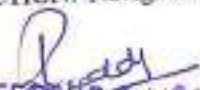
Reasoning: Probability and Bayes theorem, Certainty factors and Rule based systems, Bayesian Networks, Dempster-Shafer Theory. Planning: Components, goal stack planning, nonlinear planning, hierarchical planning.

### UNIT - IV

Learning: Introduction, Rote learning, learning by taking advice, learning in problem solving and learning from examples: Decision tree. Intelligent Agents: Classification, Working of an agent, single agent and multi agent systems, multi agent application.

### UNIT - V

Expert System: Representing and Using Domain Knowledge, Expert systems shells, Explanation, Knowledge Acquisition. Perception and Action: Real Time Search, Vision, Speech Recognition, ACTION: Navigation, Manipulation, Robot architectures.

  
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**Text Books:**

1. Elaine Rich, Kevin Night, Shivashankar B Nair, "Artificial Intelligence", 3rd Edition, 2008
2. Russell Norvig, "Artificial Intelligence-Modern Approach", 3rd edition, 2010.

**Suggested Reading:**

1. Saroj Kaushik, "Artificial Intelligence", Cengage Learning India, 2012.
2. Nelson M. Mattos, "An Approach to Knowledge Base Management", Springer Berlin Heidelberg, 1991.

**Online Resources:**

1. <http://nptel.ac.in/courses/106106126/>
2. <http://nptel.ac.in/courses/106105077/>

  
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18ME C25

**METROLOGY AND INSTRUMENTATION LAB**

Instruction	3Hours per week
Duration of SEE	3 Hours
SEE	50Marks
CIE	25 Marks
Credits	1.5

**Objectives:**

1. To choose the proper measuring instrument for the precise measurement of length, height and diameter.
2. To classify the different measuring instruments used for the angular measurement.
3. To develop gear & screw thread parameters using optical projector and tool maker's microscope.
4. To analyze the limits, fits and tolerances for selection and design of gauges.
5. To determine the working principles in the measurement of Flatness, Roundness and Surface roughness.

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

1. Measure the linear dimension by using appropriate method & device. (BL-3)
2. Demonstrate the knowledge of angular measurements and use measuring instruments as per requirements. (BL-2)
3. Determine the gear and screw thread parameters using profile projector and tool makers' microscope. (BL-3)
4. Design and test plain limit gauges for a given specimen. (BL-3)
5. Evaluate and estimate the measurement of flatness, roundness and surface roughness. (BL-5)

**Experiments:**

1. Measurement with inside, outside and depth micrometers.
2. Measurement with height gauges, height masters,
3. Measurement of linear and angular dimensions with Tool maker's microscope – diameter of thin wire and single point cutting tool angle.
4. Measurement with dial indicator and its calibration.
5. Measurement of angles with sine bar and clinometers.
6. Measurement of roundness errors with bench centers.
7. Measurement of flatness errors of a surface plate with precision spirit level.
8. Measurement with optical profile projector.
9. Design of plug and snap gauges for a given component.
10. Surface roughness measurement by Taylor Hobson -Talysurf.
11. Measurement of gear tooth thickness by gear tooth vernier.
12. Displacement measurement with LVDT.
13. Analyze, assess, measure and document all Measuring attributes of a selected component by using appropriate methods and devices.

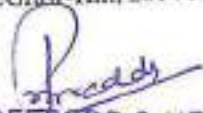
**Note:** Student should complete a minimum of 10 experiments including experiment number 13 which is compulsory.

**Text Books:**

1. R.K. Jain, "Engineering Metrology", Khanna Publications, 1996.
2. Doebelin, "Measurement Systems Application and Design", TMH, 5/e., 2004.
3. Beckwith, Buck, Lienhard, "Mechanical Measurements", PEA, 3rd Indian Reprint, 2001.

**Suggested Reading:**

1. RegaRajendra, "Principles of Engineering Metrology", Jaico Publishing House, Mumbai, 2008.
2. B.C. Nakra & K.K. Chaudhary, "Instrumentation Measurement and Analysis", 3/e, McGraw-Hill, 2014.

  
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18ME C26

COMPUTER AIDED ENGINEERING LAB

Instruction	3 Hours	3 Hours per week
Duration of SEE		50 Marks
SEE	25 Marks	
CIE		
Credits	1.5	

**Objectives:**

1. Trusses , Bars of constant cross section area, tapered cross section area and stepped bar.
2. Beams -Simply supported, cantilever, beams with UDL, and beams with varying load etc.
3. Stress analysis of a rectangular plate with a circular hole, axisymmetric problems.
4. Buckling analysis and Dynamic Analysis.
5. Steady state and Transient heat transfer analysis.

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

1. Apply basics of Theory of Elasticity to continuum problems.
2. Analyze finite elements like 1D, 2D and 3D structures for linear static analysis.
3. Solve heat transfer problems.
4. Examine problems of limited complexity in buckling and dynamic analysis.
5. Evaluate solutions to practical problems by finite element software.

(BL- 3)  
(BL-4)  
(BL- 3)  
(BL-4)  
(BL-5)

**List of Exercises:**


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 casting.
11. Non linear analysis of cantilever beam.
12. Coupled field analysis.
13. Static/Buckling/Modal/Harmonic/Transient/Non-Linear/ heat transfer analysis of a selected component.

**Note:**

1. Students should complete a minimum of 10 exercises including exercise number 13 which is compulsory.
2. Students may use any or combination of FEA software(ANSYS/ABAQUS/NASTRAN/NISA/CAEFEM/ADINA).

**Suggested Reading:**

1. Tadeusz, A. Stolarski, Y. Nakasone, S. Yoshimoto, "Engineering Analysis with ANSYS Software", I/e, Elsevier Butterworth-Heinemann publications, 2007.
2. ANSYS Inc., "User Manuals for Release 15.0".

  
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18ME C27

## PROJECT: PART - 1

Instruction	4 Hours per week
Duration of SEE	---
SEE	50 Marks
CIE	2
Credits	

**Objective:** The objective of Project Part -1 is to enable the student take up investigative study in the broad field of Engineering / Technology, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a supervisor. This is expected to provide a good initiation for the student(s) towards R&D.

- Outcomes:** At the end of the course, the students are able to
1. Identify a topic in advanced areas of Mechanical / Allied fields of Engineering. (BL-1)
  2. Review literature to identify the gaps, define the objectives and scope of the work. (BL-2)
  3. Generate innovative ideas for societal benefit and Nation building. (BL-6)
  4. Develop prototypes/models, experimental setup and software systems necessary to meet the objectives. (BL-6)
  5. Prepare a technical report and present before the departmental committee (BL-5)

**The work shall include:**

1. Survey and study of published literature on the assigned topic.
2. Working out a preliminary Approach to the Problem relating to the assigned topic.
3. Conducting preliminary Analysis/Modelling/Simulation/Experiment/Design/Feasibility.
4. Preparing a Written Report on the Study conducted for Presentation to the Department.
5. Final Seminar, as oral Presentation before a departmental Committee.

**Guidelines for the award of marks:**

Evaluation by	Maximum Marks	Evaluation Criteria / Parameter
Supervisor	20	Project Status / Review
	5	Report
Departmental Committee	5	Relevance of the Topic
	5	PPT Preparation
	5	Presentation
	5	Question and Answers
	5	Report Preparation

  
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18EC 001

**REMOTE SENSING AND GIS**  
(Open Elective)

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

**Course Objectives:**

This course aims to:

1. Explain the fundamental concepts of remote sensing and digital imaging techniques.
2. Make the students to understand the principles of thermal and microwave remote sensing.
3. Make the students understand the significance of GIS and the process of GIS.

**Course Outcomes:**

Upon completion of this course, students will be able to:

1. Demonstrate the understanding of basic concepts of remote sensing and interpret energy interactions.
2. Choose an appropriate technique for a given scenario by appreciating the types of remote sensing.
3. Distinguish the principle behind the working of microwave and LIDAR sensing.
4. Apply an appropriate data model from the acquired knowledge of the basics of GIS.
5. Explain the procedure for encoding data and geospatial data analysis.

**UNIT-I**

**Concept of Remote Sensing:** Remote sensing definition, data, process, EM bands used in remote sensing. Interactions and recording of energy: interaction with atmosphere, interaction with earth surface features (soil, water, vegetation), recording of energy by sensors, Transmission, reception and processing, Image interpretation and analysis, Applications, Advantages and limitations of Remote sensing, Orbits of Remote sensing satellites, Indian remote sensing satellites.

**UNIT-II**

**Digital Imaging:** Types of Remote sensing, Sensor resolutions, Digital Image, Sensor components, Principle of a long-track and across-track scanning, Hyperspectral Imaging, Thermal Remote Sensing.

**UNIT-III**

**Microwave Remote Sensing:** Active and Passive Microwave Remote Sensing, Radar Imaging: Key components of imaging radar, viewing geometry, spatial resolution, principle of RAR, SAR and their range resolution, Satellite Radar Imaging, LIDAR.

**UNIT-IV**

**Concept of Geographic Information Systems:** Key components of GIS, joining spatial and attribute data, functions, advantages and applications of GIS, Spatial data model, Raster data model, Vector data model.

**UNIT-V**


**Process of GIS and Geospatial analysis:** Data sources, encoding raster data, encoding vector data, encoding attribute data, linking spatial and attribute data, Geospatial data analysis methods database query, geospatial measurement, overlay operations, network analysis and surface analysis, Integration of GIS and remote sensing.

**Text Books:**

1. Basudeb Bhatta, "Remote Sensing and GIS", 2/e, Oxford University Press, 2012.
2. Lillesand T.M., and Kiefer R.W. "Remote Sensing and Image Interpretation", 6/e, John Wiley & Sons, 2000.

**Suggested Reading:**

1. James B. Campbell and Randolph H. Wynne, "Introduction to Remote Sensing", the Guilford Press, 2011.
2. Michael N DeMers, "Fundamentals of GIS", 2/e, John Wiley, 2008.

  
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18MTO 01

**DECISION THEORY  
(OPEN ELECTIVE)**

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

**Course Objectives:**

1. To explain procedure of LPP
2. To discuss various methods to get optimum solution.
3. To analyse the optimum solution by Hungarian method.
4. To demonstrate the algorithm for job sequencing.
5. To discuss method of finding solution of Dynamic programming problem.

**Course Outcomes:**

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

1. Calculate the optimum values for given objective function by LPP
2. Solve the solution for maximise the profit with minimum cost by Transportation problem.
3. Determine the optimum feasible solution for sequencing the Jobs
4. Arrange the jobs for different Machines to get optimum values
5. Measure the solution of dynamical system problems

**UNIT-I:** Introduction to Operations Research: Basics definition, scope, objectives, phases, models and limitations of Operations Research, Linear Programming Problem-Formulation of LPP, Graphical solution of LPP, Simplex Method, Artificial variables, big-M method.

**UNIT-II:** Transportation problems, Formulation, solution, unbalanced transportation problems, finding basic feasible solutions-Northwest corner rule, least cost method and Vogel's approximations method, Optimality test: the stepping stone method and MODI method.

**UNIT-III:** Assignment model, formulation, Hungarian method for optimal solution, solving unbalanced problem, Traveling salesman problem and assignment problem

**UNIT IV:** Sequencing models, solution of sequencing problem-processing n jobs through 2 Machines-processing n jobs through 3 Machines-processing 2 jobs through m machines-processing n jobs through m machines.

**UNIT-V:** Dynamic Programming, Characteristics of dynamic programming, Solution of LPP by dynamic programming and Network scheduling by PET/CPM.

**Text Books:**

1. P.Sankaralyer, "Operations Research", Tata McGraw-Hill, 2008.
2. A.M.Natarajan, P.Balasubramani, A.Tamilarasi, "Operations Research", Pearson Educairons, 2005.

**Suggested Reading:**

1. J K Sharma, "Operations Research Theory & Applications, 3e", Macmillan India Ltd, 2007.
2. P.K.Gupta and D.S.Hira, "Operations Research", S.Chand & Co, 2007.
3. Kranti Swarup , P.K.Gupta and Man Mohan "Operations Research", Sultan Chand & Sons, 2019.

18EE O 03

## ENERGY AUDITING

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

### Course objectives:

1. To know the concept of Energy auditing
2. To understand the formulation of efficiency for various engineering systems
3. To explore the different ways to design various technologies for efficient engineering systems.

**Outcomes:** After completion of this course, students are able to:

1. Know the current energy scenario and importance of energy auditing.
2. Understand the concepts of energy auditing.
3. Evaluate the performance of existing engineering systems
4. Explore the methods of improving energy efficiency in different engineering systems
5. Design different energy efficient devices.

### UNIT-I

**Basics of Energy and its various forms:** Overview of engineering, elements Solar energy, electricity generation methods using solar energy, PV cell, elements of wind energy, electricity generation using wind energy, elements of bio energy, bio mass energy conservation, elements of geothermal energy, sources of geothermal energy, sources of chemical energy, fuel cells, Energy Scenario in India

### UNIT-II

**Energy Auditing-1: Introduction :** Need for energy audit, directions for the study of energy auditing, inclusions for energy auditing, types of energy audit: preliminary audit, general/mini audit, investment-grade/comprehensive audit. Major energy consuming equipments and systems, energy audit team, energy auditing methodology: preliminary and detailed. Process flow diagram, energy audit report format

### UNIT-III

**Energy Auditing-2: For buildings:** Energy auditing instruments, energy efficiency, energy auditing for buildings: stages in programs, surveying, measurements and model analysis. Energy audit form of commercial buildings, checklist for energy saving measures

### UNIT-IV

**Energy Efficient Technologies-I:** Importance of energy efficiency for engineers, Energy efficient technology in mechanical engineering: Heating, ventilation and air-conditioning, boiler and steam distribution systems  
Energy efficient technology in civil engineering: future of roads, harnessing road and transport infrastructure:

### UNIT-V

**Energy Efficient Technologies-II :** Energy efficient technology in electrical engineering: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors; Energy efficient technology in chemical engineering: green chemistry, low carbon cements, recycling paper

### Text Books:

1. Umesh Rathore, 'energy management', Kataria publications, 2nd edition, 2014.
2. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects
3. Hargroves, K., Gockowiak, K., Wilson, K., Lawry, N., and Desha, C. (2014) An Overview of Energy Efficiency Opportunities in Mechanical/civil/electrical/chemical Engineering, The University of Adelaide and Queensland University of Technology.

### Suggested reading:

1. Success stories of Energy Conservation by BEE, New Delhi ([www.bec-india.org](http://www.bec-india.org))

  
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18CSO 07

## BASICS OF CYBER SECURITY

(Open Elective)

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

**Pre-requisites:** Operating System, Computer Network, Cryptography.

**Course Objectives:** The main objectives of this course are:

1. To Identify and present indicators that a cybercrime has occurred and understand methods and tools used in cybercrimes.
2. To collect, Process, Analyze and Present Computer Forensics Evidence.
3. To understand the legal perspectives and Organizational implications of Cyber Security

**Outcomes:** On Successful completion of this course, student will be able to

1. List the different types of cybercrimes and analyze legal frameworks to handle cybercrimes.
2. Identify the Tools and Methods used in cybercrimes.
3. Analyze and resolve cyber security issues and laws governing Cyberspace.
4. Describe the need of Digital Forensics and the importance of digital evidence in prosecution.
5. Interpret the commercial activities in the event of significant information security incidents in the Organization.
6. Discuss the vulnerabilities in networking protocols and their mitigation techniques.

### UNIT - I


Introduction to Cyber Crime: Cyber Crime: Definition and Origins of the Word, Cyber crime and Information Security, Classification of Cyber Crimes, Cyber Crime: The Legal Perspective, Cyber Crime: An Indian Perspective, A Global Perspective of Cyber Crime.

### UNIT - II

Cyber Offenses: Introduction, How Criminals plan the Attacks, Social Engineering, Cyber stalking, Cyber cafe and Cybercrimes, Botnets: The Fuel for Cybercrime, Attack Vector.  
Tools and Methods Used in Cybercrime: Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horse and Backdoors, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Overflow.

### UNIT - III

Cyber Security: The Legal Perspectives: Cyber Crime and the Legal Landscape around the World, Need of Cyber laws: the Indian Context, The Indian IT Act, Challenges to Indian Law and Cyber Crime Scenario in India, Digital Signatures and the Indian IT Act, Cyber Crime and Punishment, Cyber Law, Technology and Students: The Indian Scenario.

  
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**UNIT - IV**

Understanding Cyber Forensics: Introduction ,Digital Forensics Science, Need for Computer Forensics, Cyber Forensics and Digital Evidence, Forensics Analysis of Email, Digital Forensics Life Cycle, Chain of Custody Concept, Network Forensics, Approaching a Cyber Forensics Investigation, Challenges in Computer Forensics.

**UNIT - V**

Cyber Security: Organizational Implications: Introduction, Cost of Cybercrimes and IPR issues, Web threats for Organizations, Security and Privacy Implications, Social media marketing: Security Risks and Perils for Organizations, Social Computing and the associated challenges for Organizations.

**Text Books:**

1. Sunit Belpre and Nina Godbole, "Cyber Security: Understanding Cyber Crimes, Computer Forensics And Legal Perspectives", Wiley India Pvt.Ltd, 2011.
2. Kevin Mandia, Chris Proise, "Incident Response and computer forensics", Tata McGraw Hill, 2006.

**Suggested Reading:**

1. Alfred Basta, Nadine Basta, Mary Brown, Ravinder Kumar, "Cyber Security and Cyber Laws", Paperback – 2018.
2. Mark F Grady, Fransesco Parisi, "The Law and Economics of Cyber Security", Cambridge university press, 2006.

**Online Resources:**

1. <https://www.edx.org/learn/cybersecurity>
2. <https://www.coursera.org/courses?query=cyber%20security>
3. <https://swayam.gov.in/course/4002-cyber-law>

  
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18EC 005

## MEMS AND ITS APPLICATIONS

(Open Elective)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

### Course Objectives:

This course aims to:

1. Provide knowledge of semiconductors, various materials used for MEMS.
2. Introduce various Electrostatic and Thermal Sensors and Actuators.
3. Educate on the applications of MEMS to various disciplines.

### Course Outcomes:

Upon completion of this course, students will be able to:

1. Understand various materials used for MEMS.
2. Design the micro devices and systems using the MEMS fabrication process.
3. Analyze the operation of different Sensors and Actuators.
4. Interpret the micro devices and systems using Polymer MEMS.
5. Apply different MEMS devices in various disciplines.

### UNIT- I

**Introduction:** The History of MEMS Development. The Intrinsic Characteristics of MEMS: Miniaturization, Microelectronics Integration, Parallel Fabrication with Precision, Devices: Sensors and Actuators- Energy Domains and Transducers, Sensors Considerations, Sensor Noise and Design Complexity: Actuators Considerations.

### UNIT- II

**Introduction to Micro Fabrication:** Overview of Micro fabrication, Overview of Frequently used Micro fabrication Processes: Photolithography, Thin Film Decomposition, Thermal Oxidation of Silicon, Wet Etching, Silicon Anisotropic Etching, Plasma Etching and Reactive Etching, Doping, Wafer Dicing, Wafer Bonding, Microelectronics Fabrication Process Flow, Silicon based MEMS Processes, Packaging and Integration, Process Selection and Design.

### UNIT- III

**Electrostatic Sensing and Actuation:** Introduction to Electrostatic Sensors and Actuators, Parallel Plate Capacitor, Applications of Parallel Plate Capacitors, Interdigitated Finger Capacitors, Applications of Combo Drive Devices: Inertia Sensors, Actuators. Thermal Sensing and Actuation: Introduction to Thermal Sensors, Thermal Actuators, Fundamentals of Thermal Transfer, Sensors and Actuators Based on Thermal Expansion, Thermal Couples, Thermal Resistors, Applications- Inertia Sensors, Flow Sensors, Infrared Sensors.



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#### UNIT- IV

**Piezo resistive Sensors:** Origin and Expression of Piezo resistivity, Piezo resistive Sensor Materials: Metal Strain Gauges, Single crystal Silicon, Polycrystalline Silicon, Applications of Piezo resistive Sensors: Inertial sensors, Pressure Sensors, Tactile Sensors, flow Sensors. **Piezoelectric Sensors:** Introduction, Properties of Piezoelectric Materials, Applications- Inertia Sensors, Acoustic Sensors, Tactile Sensors, Flow Sensors.

#### UNIT- V

**Polymer MEMS:** Introduction, Polymers in MEMS- Polyimide, SU-8, Liquid Crystal Polymer(LCP), Representative Applications- Acceleration Sensors, Pressure Sensors, Flow Sensors, Tactile Sensors. Case Studies of Selected MEMS Products: Blood Pressure (BP) Sensor, Microphone, Acceleration Sensor and Gyros.

#### Text Books:

1. Chang Liu, "Foundations of MEMS", 2/e, Pearson Education Inc., 2012.
2. Tai Ran Hsu, "MEMS & Micro Systems Design and Manufacture", Tata McGraw Hill, 2002.

#### Reference Books:

1. P. Rai Choudary, "MEMS and MEMS Technology and Applications", PHI publications, 2009.
2. Mohamed Gad-el-Hak, "The MEMS Handbook", CRC press, 2001.

  
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18EG 001

**TECHNICAL WRITING SKILLS**  
(Open Elective)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 marks
CIE	40 marks
Credits	3

**Objectives :** The course will introduce the students to:

1. Process of communication and channels of communication in general and technical writing.
2. Technical Writing and also contextual use of technology specific words.
3. Business letters and technical articles.
4. Technical reports and technical proposals.
5. Transferring data from verbal to graphic and vice versa and making technical presentations.

**Outcomes :** After successful completion of the course students are able to:

1. Understand the channels of communication and define nature and aspects of Technical communication
2. Compare and contrast technical communication to that of general communication while constructing error free sentences applying features of technical writing
3. Analyze data, draw inferences to write Journal articles and conference papers and to compose business letters.
4. Evaluate data to draft technical reports and technical proposals.
5. Design a technical presentation by understanding the nuances of presentation skills and also transfer data from verbal to graphic and vice versa.

**Unit I**

**Communication** – Nature and process.

**Channels of Communication** – Downward, upward and horizontal and lateral communication; Barriers to communication.

**Technical Communication** – Definition ; oral and written communication. Importance and need for Technical communication. Nature of Technical Communication; Aspects and forms of Technical communication.

**Technical communication Skills** – Listening, Speaking, Reading & Writing.

**Unit II**

**Technical Writing** – Techniques of writing. Selection of words and phrases in technical writing. Differences between technical writing and general writing. Abstract and specific words. Sentence structure and requisites of sentence construction. Paragraph length and structure.

**Unit III**

**Business correspondence** – Sales letters, letters of Quotation; Claim and Adjustment letters.

**Technical Articles:** Nature, significance and types of technical articles. Writing an abstract. Journal articles and Conference papers. Elements of technical articles.

**Unit IV**

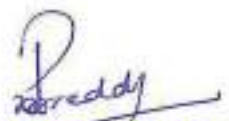
**Technical Reports** : Types, significance, structure, style and writing of reports. Routine reports, Project reports.

**Technical Proposals** : Definition, types, characteristics, structure and significance.

**Unit V**

**Information Transfer** – Graphic to verbal (written) and verbal to graphic.

**Technical Presentations** : Important aspects of oral and visual presentations.



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**Text Book :**

1. Meenakshi Raman & Sangeeta Sharma, "Technical Communications-Principles and Practice", Oxford University Press, Second Edition, 2012.
2. I.M Ashraf Rizvi, "Effective Technical Communication", Tata McGraw Hill Education Pvt Ltd, 2012.

**Suggested Reading :**

1. Kavita Tyagi & Padma Misra, "Basic Technical Communication", PHI Learning Pvt Ltd, 2012.
2. R.C Sharma & Krishna Mohan, "Business Correspondence and Report Writing", Tata McGraw Hill, 2003

**Web Resources:**

1. [https://onlinecourses.nptel.ac.in/noc18\\_mg13/preview](https://onlinecourses.nptel.ac.in/noc18_mg13/preview)
2. <https://www.technical-writing-training-and-certification.com/>
3. <https://academy.whatfix.com/technical-writing-skills>



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18BT 001

## BASICS OF BIOLOGY

(Open Elective-I)

Instruction	3LHoursperWeek
DurationofSEE	3Hours
SEE	70Marks
CIE	30Marks
Credits	3

**Course Objectives:** This course aims to:

1. Impart knowledge of origin and evolution of biological organisms.
2. Understand the structure and functions of human organ systems.
3. Understand the principles behind medical devices for diagnosis of human health and environment protection.
4. Give an insight of biological information, relationship and genome sequencing of various organisms.

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

1. Explain the theories of origin and evolution of life.
2. Describe the anatomical structure and physiological functions of the human organ systems.
3. Outline the principle and applications of medical devices.
4. Discuss the technology advancements in improving human health and environment.
5. Explain the biological information, sequencing and evolutionary relationship among organisms.

### UNIT-I

**Introduction to Biology:** Classical Vs Modern Biology; Importance of Biological Science and Historical developments; Origin of Life, Urey Miller Experiment, Spontaneous Generation Theory; Three Domains of Life; Principle and Applications of Microscope (Light and Electron Microscope), Prokaryotic and Eukaryotic Cell-Structure and their differences.

### UNIT-II

**Human organ systems and their functions -I:** Introduction to various organ systems of human body and their functions; Skeletal System-Bones, Tendon, Ligaments, principle and applications in knee replacement; Nervous System - Structure of Brain, Spinal Cord, Neuron, Neurotransmitters, Synapse, Alzheimer's disease study, principle and applications of imaging Techniques (CT & MRI scans); Circulatory System-Heart structure and functions, principle and applications of cardiac devices (Stent and Pacemaker), Artificial heart, blood components and typing, haemocytometer.

### UNIT-III


**Human Anatomy and Functions-II:** Respiratory Systems-Lung structure and function, principle and applications of Peak Flow Meter, ECMO (ExtraCorporal Membrane Oxygenation); Excretory Systems-Kidney structure and function, principle and applications of Dialysis; Prenatal diagnosis; Assisted reproductive techniques- IVF, Surrogacy.

### UNIT-IV

**Medical Biotechnology and Bioremediation:** Cells of Immune System, Etiology of cancer, Cancer treatment (Radiation Therapy); Stem Cells and its Clinical applications; Scaffolds and 3D printing of organs; Bio sensors and their applications; Parts of bioreactor and its types; Bioremediation.

### UNIT-V

**Bioinformatics:** Nucleic acid composition, Genetic Code, Amino acid, Polypeptide, Levels of protein structure, Homolog, Ortholog and Paralog, Phylogenetics, Genome Sequencing, Human Genome Project, Next generation sequencing.

  
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**TextBooks:**

1. Campbell, N.A., Reece, J.B., Urry, Lisa, Cain, M.L., Wasserman, S.A., Minorsky, P.V., Jackson, R.B. "Biology: A Global Approach", 11th edition, Pearson Education Ltd. 2017
2. Shier, David, Butler, Jackie, Lewis, Ricki, "Hole's Human Anatomy & Physiology", 13<sup>th</sup> edition, McGrawHill 2017.
3. Dubey RC "A Text book of Biotechnology" 5<sup>th</sup> Edition, S Chand and Company limited, 2014.
4. Bernard R. Glick, T. L. Delovitch, Cheryl L. Patten, "Medical Biotechnology", 1st edition, ASM Press, 2014.

  
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18CE 002

## DISASTER MITIGATION AND MANAGEMENT (M)

(Open Elective)

Instruction	3 L Hours per Week
End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

**Course Objectives:** This course aims to,

1. Equip the students with the basic knowledge of hazards, disasters, risks and vulnerabilities.
2. Impart knowledge in students about the nature, causes, consequences and mitigation measures of the various Hydro-meteorological disasters.
3. Introduce the concepts of causes, consequences and mitigation measures of the various Geographical disasters.
4. Enable the students to understand risks, vulnerabilities and human errors associated with human induced disasters.
5. Equip the students with the knowledge of the impacts of disaster, chronological phases in a disaster management cycle and to create awareness about the disaster management framework and legislations in the context of Central and State Level Authorities.

**Course Outcomes:** Upon completion of this course, the student will be able to,

1. Identify and understand the fundamental terminologies in disaster management.
2. Distinguish between the Hydro-meteorological disasters and apply the concepts of structural and non- structural mitigation measures.
3. Categorize different Geographical Disasters and apply the knowledge in utilizing the early warning systems.
4. Analyze various mechanisms and consequences of human induced disasters.
5. Develop an awareness of disaster management phases and formulating effective disaster management plans, ability to understand various participatory roles of stakeholders- Central and State Government bodies at different levels.

### UNIT- I:

**Introduction:** Basic definitions- Hazard, Disaster, Vulnerability, Risk, Resilience, Mitigation, Management; classification of types of disaster- Natural and manmade; Introduction to Disaster management cycle; International Decade for natural disaster reduction (IDNDR); International strategy for disaster reduction (ISDR), National disaster management authority (NDMA).

### UNIT- II:

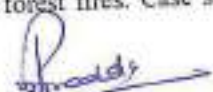
#### Natural Disasters:

#### Hydro meteorological disasters:

Causes, Early warning systems- monitoring and management, structural and non-structural measures for floods, drought and Tropical cyclones; Applications. Case studies related to various hydro-meteorological disasters.

### UNIT- III:

**Geographical based disasters:** Causes, zoning, Early warning systems- monitoring and management, structural and non-structural mitigation measures for earthquakes, tsunami, landslides, avalanches and forest fires. Case studies related to various geographical based disasters.



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**UNIT- IV:**

**Human Induced Disasters:** Chemical disaster- Causes, impacts and mitigation measures for chemical accidents, Risks and control measures in a chemical industry, chemical disaster management; Case studies related to various chemical industrial hazards eg: Bhopal gas leakage; Management of chemical terrorism disasters and biological disasters; Case studies related to power break downs, fire accidents, traffic accidents, oil spills and stampedes, building failure disasters.

**UNIT- V:**

**Concept of Disaster Impacts and Management:**

Disaster impacts- environmental, physical, social, ecological, economical, political, etc.; health, psycho-social issues; demographic aspects, gender, age, special needs; hazard locations; global and national disaster trends; climate change and urban disasters.

Disaster management cycle and its phases, risk analysis, vulnerability and capacity assessment; Post-disaster environmental response water, sanitation, food safety, waste management, disease control; Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National Disaster Management Authority.

**Text Books:**

1. Pradeep Sahni, "Disaster Risk Reduction in South Asia", Prentice Hall, 2003.
2. B. K. Singh, "Handbook of Disaster Management: Techniques & Guidelines", Rajat Publication, 2008.

**Suggested Reading:**

1. Ministry of Home Affairs, Government of India, "National Disaster Management Plan, Part I and II",
2. K. K. Ghosh, "Disaster Management", APH Publishing Corporation, 2006.
3. [http://www.indiaenvironmentportal.org.in/files/file/disaster\\_management\\_india1.pdf](http://www.indiaenvironmentportal.org.in/files/file/disaster_management_india1.pdf)
4. <http://www.ndmindia.nic.in/> (National Disaster management in India, Ministry of Home Affairs)
5. Hazards, Disasters and your community: A booklet for students and the community, Ministry of Home Affairs.
6. Disaster Medical Systems Guidelines, Emergency Medical Services Authority, State of California, EMSA no.214, June 2003.
7. Inter Agency Standing Committee (IASC) (Feb. 2007), IASC Guidelines on Mental Health and Psychosocial Support in Emergency Settings, Geneva: IASC.
8. <http://ndma.gov.in/> (Home page of National Disaster Management Authority)

  
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18EE0 05

## WASTE MANAGEMENT

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

### Course Objectives:

1. To imbibe the concept of effective utilization of any scrap
2. To become familiar with the processes of all disciplines of engineering.
3. To learn the technique of connectivity from waste to utility.

### Course Outcomes:

1. Understand the various processes involved in allied disciplines of engineering
2. Infer the regulations of governance in managing the waste
3. Distinguish the nature of waste materials concerned to the particular branch of engineering
4. Explore the ways and means of disposal of waste material
5. Identify the remedies for the disposal of a selected hazardous waste material

### UNIT-I

**Introduction to waste management:** Relevant Regulations Municipal solid waste (management and handling) rules; hazardous waste (management and handling) rules; biomedical waste handling rules; fly ash rules; recycled plastics usage rules; batteries (management and handling) rules. Municipal Solid Waste Management – Fundamentals Sources; composition; generation rates; collection of waste; separation, transfer and transport of waste; treatment and disposal options.

### UNIT-II

**Hazardous Waste Management :** Fundamentals Characterization of waste; compatibility and flammability of chemicals; fate and transport of chemicals; health effects, Radioactive Waste Management – Fundamentals Sources, measures and health effects; nuclear power plants and fuel production; waste generation from nuclear power plants; disposal options.

### UNI-III

**Environmental Risk Assessment:** Defining risk and environmental risk; methods of risk assessment; case studies, Physicochemical Treatment of Solid and Hazardous Waste Chemical treatment processes for MSW (combustion, stabilization and solidification of hazardous wastes); physicochemical processes for hazardous wastes (soil vapor extraction, air stripping, chemical oxidation); ground water contamination and remediation

### UNIT-IV

**Biological Treatment:** Solid and Hazardous Waste Composting; bioreactors; anaerobic decomposition of solid waste; principles of biodegradation of toxic waste; inhibition; co-metabolism; oxidative and reductive processes; slurry phase bioreactor; in-situ remediation.

### UNIT-V

**Landfill design aspects:** Landfill design for solid and hazardous wastes; leachate collection and removal; landfill covers; incineration

### Text Books:

1. John Pichtel Waste Management Practices CRC Press, Taylor and Francis Group 2005.
2. LaGrega, M.D. Buckingham, P.L. and Evans, J.C. Hazardous Waste Management, McGraw Hill International Editions, New York, 1994
3. Richard J. Watts, Hazardous Wastes - Sources, Pathways, Receptors John Wiley and Sons, New York, 1997

### Suggested Reading:

1. Basics of Solid and Hazardous Waste Mgmt. Tech. by Kanti L. Shah 1999, Prentice Hall
2. Solid and Hazardous Waste Management 2007 by S.C.Bhatia Atlantic Publishers

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18EC 007

**SYSTEM AUTOMATION AND CONTROL**  
(Open Elective)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

**Course Objectives:** This course aims to:

1. Learn the concepts industrial control systems
2. Learn how to measure the physical parameters in industry
3. Learn the applications of Robots in industry.

**Course Outcomes:** After completion of this course, students are able to:

1. Understand the features of various automatic and process control systems.
2. Define and analyze various measuring parameters in the industry.
3. Compare performance of various controllers (P, PD, PI, and PID).
4. Illustrate the role of digital computers in automation.
5. Develop various robot structures for different applications.

**UNIT-I**

**Introduction to Automatic Control Systems:** Purpose of Automatic Control, How an Industrial Control System is implemented, Introduction to Automatic Control theory.

**Sensors:** Sensor definition, Different types of Sensors: Motion, Position, Force, Level sensors, and Thermo couples.

**UNIT-II**

**Theory of Measurements:** Measurement goals and concepts. Scale factor, Linearity, accuracy, Range, Resolution, Precision and repeatability.

**Measurement Techniques and Hardware:** Typical Sensor outputs, Bridge measurements: General equation for bridge balance, Resistance balanced Wheatstone bridge, Variable voltage type measurements, Frequency type measurements.

**UNIT-III**

**Process Controllers:** What is a Controller, uses of Controllers, Open loop and closed loop Control, proportional, PD, PI, PID Controllers, Analog and Digital methods of Control.

**Controller Hardware:** Analog and Digital Controllers.

**UNIT-IV**

**Digital Computers as Process Controllers:** Use by Digital Computer for process control, Information required by the computer, Information required by the process, Computer Interface electronics, Digital Computer input-output, computer processing of data, Digital Process control computer design, Computer programming.

**Actuators:** Electro mechanical - Linear motion and rotary motion solenoids, DC motors, AC motors and Stepped motors.

**UNIT-V**

**Robots:** What are robots, Robots and process Control systems, Degrees of freedom, factories of the future, Delivery, Disposal and transport systems, Sensing elements, Robot Classifications and Applications. Trouble shooting System failures: Preliminary steps and other troubleshooting aids.

**Text Books:**

1. Ronald P. Hunter, "Automated process control systems – concepts and Hardware", 2/e, PHI, 1987.
2. Norman A. Anderson, "Instrumentation for process measurement and Control", 3/e, CRC Press, 2005.

**Suggested Reading:**

1. Kuo B. C, "Automatic Control Systems", 9<sup>th</sup> edition
2. A.K Sawhney, "A course on Electrical and Electronic Measurements and Instrumentation".

  
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18ME C28

### TECHNICAL SEMINAR

Instruction	2 Hours per week
Duration of SEE	---
SEE	---
CIE	50 Marks
Credits	1

**Objective:** The goal of a seminar is to introduce students to critical reading, understanding, summarizing, explaining and preparing report on 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 and the student shall read further relevant articles in the domain.

- Outcomes:** At the end of the course, the students are able to
1. Identify the recent advances in the field of engineering/technology. (BL-1)
  2. Develop the skills and expertise in report writing. (BL-6)
  3. Compile the content and prepare comprehensive report. (BL-4)
  4. Demonstrate skills required for preparation of a technical report. (BL-3)
  5. Present technical know-how and professional skills before the committee. (BL-3)

**The seminar must be clearly structured and the power point presentation shall include following aspects:**

1. Introduction to the field
2. Literature survey
3. Consolidation of available information
4. Summary and conclusions
5. References

**Each student is required to:**

1. Submit a one page synopsis of the seminar talk for display on the noticeboard.
2. Deliver the seminar for a maximum duration of 30 minutes, where the presentation should be for 20 minutes in PowerPoint, followed by question and answers session for 10minutes.
3. Submit the detailed report of the seminar in spiral bound in a précised format as suggested by the department.

Seminars are to be scheduled from 3<sup>rd</sup> week to the last week of the semester and any change in schedule shall 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 shall be preferably from any peer reviewed recent journal publications.

Sl No.	Description	Max Marks
1.	Contents and relevance	10
2.	Presentation skills	10
3.	Preparation of PPT slides	05
4.	Questions and answers	05
5.	Report in a prescribed format	20
<b>Total Marks</b>		<b>50</b>

  
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18ME C29

**PROJECT: PART - 2**

Instruction	20Hours per week
Duration of SEE	---
SEE	100 Marks
CIE	100 Marks
Credits	10

**Objectives:** The objective of Project Part-2 is to enable the student extend further the investigative study taken up, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership.

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


1. Summarize the literature review for the identified problem. (BL-2)
2. Identify methods and materials to carry out experiments/ develop code/simulation. (BL-4)
3. Integrate the methodology and engineering tools adopted for solving the problem. (BL-6)
4. Analyze and discuss the results to draw valid conclusions. (BL-4)
5. Exhibit knowledge, skill, attitude and technical knowhow in preparing report as per format and presenting as a professional engineer. (BL-3)

**The assignment to normally include:**

1. In depth study of the topic assigned.
2. Review and finalization of the Approach to the Problem relating to the assigned topic.
3. Preparing an Action Plan for conducting the investigation, including teamwork.
4. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed.
5. Final development of product/process, testing, results, conclusions and future directions.
6. Preparing a paper for Conference presentation/ Publication in Journals, if possible.
7. Preparing a Dissertation in the standard format for being evaluated by the Department.
8. Final Seminar presentation before Departmental Committee.

**Guidelines for the award of marks in CIE:**

Evaluation by	Maximum Marks	Evaluation Criteria / Parameter
Department Review Committee	10	Review 1
	15	Review 2
	25	Submission
Supervisor	10	Regularity and Punctuality
	10	Work Progress
	10	Quality of the work which may lead to publications
	10	Report Preparation
	10	Analytical / Programming / Experimental Skills

  
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Guidelines for awarding marks in SEE:

Evaluation by	Maximum Marks	Evaluation Criteria / Parameter
External and Internal Examiners together	20	Power Point Presentation
	40	Thesis Evaluation
	20	Quality of the project <ul style="list-style-type: none"><li>• Innovations</li><li>• Applications</li><li>• Live research projects</li><li>• Scope for future study</li><li>• Application to society</li></ul>
	20	Viva-Voce

  
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**METROLOGY AND INSTRUMENTATION**

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

**Objectives:**

1. To familiarize with limits, fits & tolerances and fundamental concepts of linear and angular measurements.
2. To have adequate skill in the usage of various precision measuring instruments and the concepts of limit gauges.
3. To learn the importance of Geometric form and how to measure form errors.
4. To have knowledge in the concepts of classification of instrument errors and their characteristics.
5. To understand the working principles of various instruments used for the measurement of displacement, pressure and temperature.

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

1. Understand the need, accuracy and associated concepts of measurements. (BL-2)
2. Select appropriate gauges for inspection and design. (BL-3)
3. Calculate surface roughness by using appropriate instruments. (BL-3)
4. Analyze and interpret the types of errors, strain measurement and instrument characteristics. (BL-4)
5. Evaluate measuring methods and devices for displacement, pressure & temperature. (BL-5)

**UNIT-I**

**Limits, Fits and Tolerances:** Interchangeability, nominal size, limits, tolerances, allowance, fundamental deviation, unilateral and bilateral tolerances, types of fits, alpha numeric designation of limits/fits, hole and shaft basis systems, selective assembly.

**Linear and angular measurement:** Line and end standards, slip gauges, Trolinson gauges and sine bar.

**UNIT-II**

**Design of limit gauges:** Taylor's Principle for plan limit gauges, design of GO and NO GO gauges, use of plug, ring and snap gauges.

**Comparators:** Introduction, dial indicator, sigma mechanical comparator, back pressure type pneumatic comparator.

**Optical measuring instruments:** Optical projector principle and its uses, tool maker's microscope principle and its uses, interferometry.

**UNIT-III**

**Straightness, Flatness and Roundness Measurement:** Definitions, measurement by beam comparator, straight edge, spirit level, and bench centers.

**Surface roughness measurements:** Roughness and waviness, numerical assessment of surface roughness, surface roughness measurement by profilometer, Taylor Hobson Talysurf, ISI symbols for indication of surface finish.

**UNIT-IV**

**Screw thread metrology:** Basic terminology of screw thread, measurement of effective diameter by 2 wire and 3 wire methods, best wire size.

**Gear tooth metrology:** Spur gear nomenclature, gear tooth thickness measurement by gear tooth vernier.

  
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**Instrumentation:** Static and dynamic characteristics of instruments, types of errors, strain measurement with strain gauges, gauge factor, rosette Gauges.

**UNIT-V**

**Transducers:** Displacement measurement by L.V.D.T, pressure measurement by bourdon pressure gauge, bulk modulus pressure gauge, pirani gauge, temperature measurement by thermo couples, laws of thermoelectricity, types of materials used in thermocouples.

**Text Books:**

1. R.K. Jain, "Engineering Metrology", Khanna Publications, 1996.
2. Doebelin, "Measurement Systems Application and Design", TMH, 5/e., 2004.
3. Beckwith, Buck, Lienhard, "Mechanical Measurements", PEA, 3rd Indian Reprint, 2001.

**Suggested Reading:**

1. RegaRajendra, "Principles of Engineering Metrology", Jaico Publishing House, Mumbai, 2008.
2. B.C. Nakra & K.K. Chaudhary, "Instrumentation Measurement and Analysis", 3/e, McGrawhill, 2014

  
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**OPERATIONS RESEARCH**

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

**Objectives:**

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

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

1. Understand the concepts of linear programming problems. (BL-2)
2. Solve the given transportation problem. (BL-3)
3. Develop optimum pair of operations and resources by using Assignment technique. (BL-3)
4. Analyze project management techniques like CPM and PERT to plan and execute projects successfully. (BL-4)
5. Apply sequencing and queuing theory concepts for industry applications. (BL-3)

**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.

**UNIT-V**

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

**Queuing theory:** Introduction, Kendall's notation, single channel - Poisson arrivals-exponential service times.

**Text Books:**

1. Hamdy A. Taha, "Operations Research-An Introduction", 10/e, Pearson education India, 2017.



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. R. PaneerSelvam, "Operations Research", 2/e, PHI Learning Pvt. Ltd., New Delhi, 2008.
2. Nita H. Shah, Ravi M. Gor, HardikSoni, "Operations Research", PHI Learning Private Limited, 2013.

  
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18PE C11

**ADDITIVE MANUFACTURING TECHNOLOGIES**

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

**Objectives:**

1. To introduce to students the basics of Additive Manufacturing, its advantages and limitations and concept of mass customization.
2. To familiarize students with various Additive Manufacturing processes.
3. To teach students about STL file issues and familiarize them with various AM softwares.
4. To demonstrate various post processing techniques and rapid tooling concept.
5. To demonstrate the applications of rapid prototyping in various fields

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

1. Explain the process chain of Additive manufacturing and their classification, advantages and disadvantages
2. Critically explore and compare the technologies used for additive manufacturing in terms of their material, parameters, applications and limitations
3. Analyse various software issues for rapid prototyping and related operations for STL file and features of various slicing softwares.
4. Identify different post processing techniques involved in enhancing the properties of the 3d printed components, understand rapid tooling
5. Understand applications of Additive Manufacturing in various fields

**UNIT - I**

**Introduction to AM:** 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**

**AM Techniques:** Photopolymerization, Stereolithography (SLA) , Fused Deposition Modeling (FDM), Solid Ground Curing(SGC) , Shape deposition manufacturing(SDM) - Working principles and their applications, advantages and disadvantages. Laser sintering based technologies (SLA and DMLS ) and their related details.

**UNIT - III**

**Pre-processing in AM:** Pre-processing of CAD model- STL conversion, STL error diagnostics, STL file Repair: Generic Solution, Newly Proposed Formats. Support generation, transformations, slicing, surface preparation of materials, pre-heating of powders.

**Rapid Prototyping Softwares:** Features of various RP softwares - Magics, Mimics, Solid View, Rhino.

**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..

**RP in Medical and Bioengineering Applications:** Planning and simulation of complex surgery, Forensic

Science.

**Text Books:**

1. Gibson, DW. Rosen and B.Stucker, "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". 4/e of rapid prototyping
3. PK. Venavinod, "Rapid prototyping – Laser based and other technologies", Kluwer, 2004.

**Suggested Reading:**

1. Jacob, Paul, "Rapid tooling : Technologies and industrial applications"
2. Andreas Gebhardt, "Understanding Additive manufacturing", Hanser, 2012.
3. Alain Brunard, Georges Talliander, "Additive Manufacturing", Wiley, 2014.

  
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**POWER PLANT ENGINEERING**  
(Core Elective - VI)

Instruction	3	Hours Per Week
Duration of SEE	3	Hours
SEE	70	Marks
CTE	30	Marks
Credits	3	

**Objectives:**

1. Different types of power plants and their site selection criteria
2. Operation of thermal power plant
3. About hydraulic power plants, 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, environmental and safety aspects of power plant operation.

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

1. Select the suitability of site for a power plant in the context of environment. (BL-4)
2. Discuss ash handling and coal handling methods in thermal power plants. (BL-2)
3. Understand the importance of site selection for a hydro-power plant in the context of societal and environment. (BL-2)
4. Explain the safety aspects of nuclear waste disposal. (BL-2)
5. Estimate the economic factors and pollutant formation from power plants. (BL-3)

**UNIT - I**

**Introduction:** Power plant, classification of power plants, conventional and non-conventional power plants, merits and demerits of conventional and non-conventional power plants.

**Steam power plant:** Selection of site for steam power plant, plant layout, formation and types of coal, stages in coal handling, working of coal handling equipment – belt conveyors, screw conveyors, bucket elevators and grab bucket conveyors, general layout of ash handling and dust collection system, uses of ash and dust, ash handling systems – mechanical, pneumatic, steam jet and hydraulic systems of ash handling.

**UNIT- II**

**Combustion process in steam power plant:** Stoker firing, overfeed stokers - travelling grate stokers and spreader stokers, underfeed stokers - single retort and multi-retort underfeed stokers, elements of pulverized fuel burning system, advantages and disadvantages of pulverized fuel burning system, pulverized fuel burners – long flame, short flame, tangential and cyclone burners, fluidized bed combustion (FBC), benefits and disadvantages of FBC.

**UNIT- III**

**Hydro electric power plant:** Hydrological cycle, hydrograph, flow/mass duration curve, selection of site for hydro-electric plant, advantages and disadvantages of hydro-electric plants, elements (flow-sheet) of hydro-electric power plant, types and working of hydroelectric power plants, storage and pondage, parts and terminology of a dam, selection of site for dams, classification and working of different types of dams, spillways, necessity and location of spillways, classification and working of different types of spillways.

**UNIT - IV**

**Nuclear power plant:** Nuclear fuel, breeding and fertile materials, distinction between fissionable, fissile and fertile materials, advantages and disadvantages of nuclear power, components of nuclear reactor, types of nuclear reactors, working of pressurized water reactor, boiling water reactor, sodium-graphite reactor, fast breeder reactor and gas cooled reactors – radioactive (nuclear) waste disposal methods.

**UNIT - V**

**Power plant economics and environmental considerations:** Definition and related exercises on connected load, demand (load), maximum demand (peak load), demand factor, average load, load factor, diversity factor, utilization factor, plant capacity factor and plant use factor, fixed cost and variable cost, methods to find depreciation cost and related numerical problems, economics in plant selection, effluents from power plants and impact on environment, pollutants, pollution control.

**Text Books:**

1. R.K. Rajput, "A Text Book of Power Plant Engineering", 4/e, Laxmi Publications (P) Ltd., New Delhi, 2015.
2. P.K. Nag, "Power Plant Engineering", 4/e, McGraw-Hill Education (India) Private Limited, New Delhi, 2014.
3. P.C. Sharma, "A Text Book of Power Plant Engineering", S.K. Kataria & sons, 2019

**Suggested Reading:**

1. R. Yadav, "Fundamentals of Power Plant Engineering", Central Publishing House, Allahabad, 2012.
2. S.C. Arora and S. Domkundwar, "A Course in Power Plant Engineering", Dhanpat Rai & Sons, New Delhi, 2005.

  
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18ME E22

**ENGINEERING RESEARCH METHODOLOGY**  
(Core Elective - VI)

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

**Objectives:**

1. To make the students to formulate the research problem.
2. To identify various sources for literature review and data collection.
3. To prepare the research design.
4. To equip the students with good methods to analyze the collected data.
5. To explain how to interpret the results and report writing

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

1. Define research problem. (BL-1)
2. Review and assess the quality of literature from various sources. (BL-2)
3. Understand and develop various research designs. (BL-2)
4. Analyze problem by statistical techniques: ANOVA, F-test, Chi-square. (BL-4)
5. Improve the style and format of writing a report for technical paper/ Journal report. (BL-4)

**UNIT - I**

**Research methodology:** Objectives and motivation of research, types of research- descriptive vs. analytical, applied vs. fundamental, quantitative vs. qualitative, conceptual vs. empirical, research approaches, significance of research, research methods vs. methodology, research process, criteria of good research, problems encountered by researchers in India, technique involved in defining problem.

**UNIT-II**

**Literature survey:** Importance of literature survey, sources of information-primary, secondary, tertiary, assessment of quality of journals and articles, information through internet.

**UNIT - III**

**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, steps in sample design.

**UNIT - IV**

**Data collection:** Collection of primary data, Secondary data, measures of central tendency-mean, mode, median, measures of dispersion- range, mean deviation, standard deviation, measures of asymmetry (skewness), important parametric tests -z, t, F, Chi-Square, ANOVA significance.

**UNIT - V**

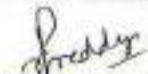
**Research report formulation and presentation:** Synopsis, dissertation, technical paper and journal paper, writing research grant proposal, making presentation with the use of visual aids, writing a proposal for research grant.

**Text Books:**

1. C.R Kothari, "Research Methodology Methods & Technique", New Age International publishers, 2004.
2. R. Ganesan, "Research Methodology for Engineers", MJP Publishers, 2011.
3. Vijay Upgaade and Araviad Shende, "Research Methodology", S. Chand & Company Ltd., New Delhi, 2009.

**Suggested Reading:**

1. G. Nageswara Rao, "Research Methodology and Quantitative methods", BS Publications, Hyderabad, 2012.
2. Naval Bajrai, "Business Research Methods", Pearson Education, 2011.

  
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18ME E23

**DATA ANALYTICS**  
(Core Elective - VI)

Instruction	3Hours per Week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

**Objectives:**

1. To familiarise the students with the concept of descriptive and inferential statistics.
2. To make the students to understand the concept of machine learning.
3. To make the students to understand various techniques of supervised learning.
4. To make the students to learn the concepts of unsupervised learning.
5. To make the students to learn the prescriptive analytics.

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

1. Solve the problems using statistics, regression analysis and ANOVA. (BL-3)
2. Understand the concept of machine learning. (BL-2)
3. Apply various supervised learning techniques to a given problem. (BL-3)
4. Understand unsupervised learning and problems in big data analysis. (BL-2)
5. Demonstrate prescriptive analytics methods to the given data. (BL-2)

**UNIT-I**

**Introduction:** Introduction to data and analytics ,taxonomy of data analytics, typical data challenges (data quality, enrichment, integration of ERP & PLM data) ,preparing data for analytics (techniques to improve data quality, integration - BTL).

**Descriptive and inferential statistics:** Descriptive statistics: introduction, probability distributions, inferential statistics, inferential statistics through hypothesis tests permutation & randomization test, regression & ANOVA.

**UNIT-II**

**Machine Learning:** Introduction and concepts, differentiating algorithmic and model based frameworks, regression, ordinary least squares, K nearest neighbours regression & classification.

**UNIT-III**

**Supervised learning with regression and classification techniques:** Model validation approaches, discriminant analysis, quadratic discriminant analysis, regression and classification trees, support vector machine.

**Ensemble Methods:** Neural networks, deep learning.

**UNIT-IV**

**Unsupervised learning and challenges for big data analytics:** Clustering, associative rule mining, challenges for big data analytics.

**UNIT-V**

**Prescriptive analytics:** Creating data for analytics through designed experiments, creating data for analytics through active learning, creating data for analytics through reinforcement learning


**Text Books:**

1. Hastie, Trevor, "The elements of statistical learning", Vol. 2, No.1, New York, springer, 2009.
2. Montgomery, Douglas C., and George C. "Ranger. Applied statistics and probability for engineers", John Wiley & Sons, 2010
3. Christopher Tong and D. Srirani, "Artificial Intelligence in Engineering Design: Knowledge acquisition, commercial systems, and integrated environments", Boston : Academic Press, 1992.

**Suggested Reading:**

  
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1. Anil Maheswari, "Data Analytics", McGraw-Hill, 2017.
2. V.K.Jain "Data Science and Analytics (with Python, R and SPSS Programming)", Khanna Publishers, 2018.

  
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**INNOVATION AND INTELLECTUAL PROPERTY RIGHTS**  
(Core Elective - VI)

Instruction	3 Hours per Week	
Duration of SEE		3 Hours
SEE		70 Marks
CIE		30 Marks
Credits		3

**Objectives:**

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 and techno-business aspects of IPR.

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

1. Understand the evolution of Intellectual property, working of organization's at global level to protect and promote intellectual property. (BL-2)
2. Apply the patent filing process at national and international level. (BL-3)
3. Derive logical conclusion of research, innovation and patent filing. (BL-4)
4. Compare different kinds of Intellectual property and their patenting system. (BL-2)
5. Understand the techno-legal-business angle of Intellectual property, infringement and enforcement Mechanisms for protection. (BL-2)

**UNIT-I**

**Overview of IPR:** Introduction and the need for intellectual property rights (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 licensors of right & revocation, utility models, differences between a utility model and a patent, trade secrets and know-how agreements.

**UNIT-II**

**Industrial design:** What is an industrial design, protection of industrial design, kind of protection available, term of protection of industrial design and need for protection.

**UNIT-III**


**Trademarks:** Definition of trademarks, types of trademarks and functions of a trademark, registration of Trademark, benefits of registration of trademark, procedure for registration of trademark and term of validity of trademark, infringement and passing off.

**UNIT-IV**

**Copyright:** What is copyright, what is covered by copyright, term of enforcement of copyright and need for copyright protection, copyright and related rights, copyrights in computer programming.

**UNIT-V**

**Geographical indications:** Introduction, definition, difference between GI and trademark, difference between GI and appellation of origin, GI as factors of rural development, developing a geographical indication and protection

  
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**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. AjitParulekar and Sarita D' Souza, "Indian Patents Law – Legal & Business Implications"; Macmillan India Ltd, 2006.
2. B. L. Wadhwa;" 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.R, "Intellectual Property; Patents, copyright, Trademarks and allied rights", Sweet & Maxwell, 1993.
2. P. Narayanan, "Intellectual Property Law", Eastern Law Edn, 1997.

  
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**SUPPLY CHAIN MANAGEMENT**  
(Core Elective - VI)

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

**Objectives:**

1. The awareness about transportation and warehouse management systems.
2. The designing supply chain networks.
3. The concept of demand and supply and integrating it with supply chain management.
4. The planning and managing inventories.
5. The pricing and revenue management.

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

- |   |        |
|---|--------|
| 1. Understand fundamentals of supply chain and its key concepts.    | (BL-2) |
| 2. Design an effective supply chain network.                        | (BL-4) |
| 3. Understand the essence of demand and supply and associated gaps. | (BL-2) |
| 4. Apply inventory management techniques.                           | (BL-3) |
| 5. Evaluate pricing and revenue management systems.                 | (BL-5) |

**UNIT-I**

**Concept of SCM:** Supply chain definition, stages of supply chain, objectives, drivers of SCM-facilities, inventory, transportation, information, sourcing and pricing, decision phases in Supply chain, pull and push processes introduction to logistics management.

**UNIT-II**

**Designing the supply chain network:** Role of distribution in supply chain and factors influencing its network design and decisions, types of distribution networks – manufacturer storage with direct shipping, manufacturer storage with direct shipping and in transit merge, distributor storage with package carrier delivery, distributor storage with last mile delivery, manufacturer/distributor storage with customer pickup, retail storage with customer pick up, framework for network design decisions-supply chain strategy, regional facility configuration, desirable sites and location choices.

**UNIT-III**

**Planning supply and demand:** Planning demand & supply in a supply chain, demand forecasting- moving averages, exponential smoothing, trend and seasonality, aggregate planning, master scheduling, materials requirement planning, time phased order plan, critical ratio, product tree structures.


**UNIT-IV**

**Planning & managing inventories in a supply chain:** Inventory control, objectives of inventory management in supply chain, deterministic inventory and probabilistic inventory control, economic order quantity, quantity discounts, Reorder point, basics of ABC analysis, FNSD analysis, VED analysis.

**UNIT-V**

**Sourcing, pricing, coordination and IT in supply chain:** Sourcing decisions, key sourcing related processes, in-house or outsource, pricing & revenue management, differential pricing strategies, coordination in supply chain, bullwhip effect, information technology and supply chain, supply chain macro processes- CRM, ISCM, SRM, TMF.

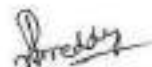
**Text Books:**

  
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1. Sunil Chopra & Peter Meindl, "Supply Chain Management – Strategy, Planning and Operation", Pearson Education, Inc., Upper Saddle River, New Jersey, 2003.
2. N. J. Kumar & Mukesh Bhatia, "Supply Chain Management", Neha publishers & Distributors, 2010.
3. Michael H. Hugos, "Essentials of Supply Chain Management", 3/e, John Wiley & Sons, Inc, Hoboken, New Jersey, 2011.

**Suggested Reading:**

1. Martin Christopher, "Logistics & Supply Chain Management", 5/e, Financial Times Series, 2010.
2. Dobler Donald. W, David.N.Burt, "Purchasing & supply Management Text & Cases", McGraw-Hill, 1996.



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18IT 001

**OBJECT ORIENTED PROGRAMMING USING JAVA**  
(Open Elective)

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

**Course Objectives:**

1. To familiarize with fundamentals of object-oriented programming paradigm.
2. To impart the knowledge of string handling, interfaces, packages and inner classes.
3. To facilitate learning Exception handling and Multithreading mechanisms.
4. To gain knowledge on collection framework, stream classes.
5. To familiarize with event driven GUI programming and Database connectivity.

**Outcomes:** Upon completing this course, students are able to:

1. Understand Object-Oriented concepts.
2. Create Java applications using sound OOP practices e.g. Inheritance, Interfaces, Packages, and Inner Classes.
3. Implement Exception Handling and Multithreading concepts in java programs.
4. Develop programs using the Java Collection API and Stream classes.
5. Design and Develop GUI applications with the integration of event handling, JDBC.

**Modified Course Outcomes:**

1. Understand the concepts of Object-Oriented Programming and class concept in Java.
2. Apply concepts of OOP such as Inheritance, Interfaces, Packages and Inner classes.
3. Handle exceptions and demonstrate the concepts of Multithreading and Generic classes.
4. Develop programs using Java Collection API and Stream classes.
5. Design and Develop GUI applications with JDBC.

**UNIT-I**

**OOP concepts** - Data abstraction, encapsulation, inheritance, benefits of inheritance, polymorphism, classes and objects, Procedural and object oriented programming paradigms.

**Introduction to Java:** Java's Magic: The Byte code, The Java Buzzwords, Simple Java Programs, Java Primitive Types, Arrays: How to create and define arrays, Basic Operators, Control statements.

**Introducing Classes:** Declaring objects, methods, Constructors, this keyword, Method Overloading and Constructor Overloading, Objects as parameters, Returning objects, Use of static and final keywords.

**UNIT-II**

**Inheritance:** super and subclasses, Member access rules, super keyword, Method overriding, Dynamic method dispatch, Abstract classes, using final with inheritance, Introduction to Object class.

**Packages:** Defining, Creating and Accessing a Package, Understanding CLASSPATH, importing packages.

**Interfaces:** Defining and implementing interfaces, Nested Interfaces.

**Strings Handling:** String & StringBuffer classes, StringTokenizer class and Wrapper classes and conversion between Objects and primitives.

**Inner classes in Java:** Types of inner classes, Creating static / non-static inner classes, Local and anonymous inner classes.

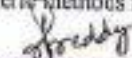
**UNIT-III**

**Exception Handling in Java:** what are Exceptions? Exception types, Usage of try, catch, throw, throws and finally clauses, writing your own exception classes.

**Multithreading in Java:** The java Thread Model, How to create threads, Thread class in java, Thread priorities, Thread synchronization.

**Generics:** What are Generics? Generic classes, bounded types, Generic methods and interfaces.

**UNIT-IV**

  
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**Collections Framework:** Overview of Collection Framework, Commonly used Collection classes – ArrayList, LinkedList, HashSet, LinkedHashMap, TreeSet, Collection Interfaces –Collection, List, Set, SortedSet, Accessing a collection via an Iterator, Storing user-defined classes in collections, Map Interfaces and Classes, Using a comparator. Legacy classes – Vector, Hashtable, The Enumeration interface.

**Input/Output :** How to read user input (from keyboard) using scanner class, Stream classes, InputStream, OutputStream, FileInputStream, FileOutputStream, Reader and Writer, FileReader, FileWriter classes, File class.

#### UNIT-V

**GUI Design and Event Handling:** Component, Container, window, Frame classes. Working with Frame window GUI Controls, Layout Managers, Introduction to Swings, Delegation Event Model, Event Classes, Source of Events, Event Listener Interfaces, Handling button click events, Adapter classes. Writing GUI Based applications.

**Database Handling in Java:** Java Database Connectivity (JDBC) using MySQL.

#### Text Books:

1. Herbert Schildt, "Java: The Complete Reference", 8<sup>th</sup> Edition, Tata McGraw Hill Publications, 2011.
2. Cay S. Horstmann, Gary Cornell, "Core Java, Volume I, Fundamentals", 8<sup>th</sup> Edition, Prentice Hall, 2008.

#### Suggested Reading:

1. E Balagurusamy "Programming with JAVA", 6th Edition , Tata McGraw-Hill Publishing company Ltd, 2019.
2. Sachin Malhotra & Saurabh Choudhary, "Programming in Java", 2<sup>nd</sup> Edition, Oxford University Press, 2014.
3. C. Thomas Wu, "An introduction to Object-oriented programming with Java", 4<sup>th</sup> Edition, Tata McGraw-Hill Publishing company Ltd., 2010.
4. Kathy Sierra, Bert Bates, "Head First Java: A Brain-Friendly Guide" 2<sup>nd</sup> Edition, O'Reilly, 2005

#### Web Resources:

1. [https://www.cse.iitb.ac.in/~nlp-aj/javalect\\_august2004.html](https://www.cse.iitb.ac.in/~nlp-aj/javalect_august2004.html)
2. <http://nptel.ac.in/courses/106106147/>
3. <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-092-introduction-to-programming-in-java-january-iap-2010/lecture-notes>



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**HISTORY OF SCIENCE AND TECHNOLOGY**  
(Open Elective)

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

**Course Objectives:** The objectives of the course is to make the student

1. Gains the knowledge about origin of science in the Stone Age and its progress during Antiquity period.
2. Familiar with scientific views in the Medieval period and during the Industrial revolution..
3. Aware of modern scientific developments from 19<sup>th</sup> century onwards.

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

1. Demonstrate the process of beginning of science and civilization, knowledge acquisition and philosophical approach of science and its advancements in the Stone Ages and Antiquity period.
2. Illustrate the advancements in science and technology in the medieval period across Asia and Arab countries and decline and revival of science in Europe.
3. Explain the scientific approach and its advances of the Europeans and how the role of engineer during the industrial revolution and the major advancements.
4. Make use of the advancements in the field of science and technology by adopting new philosophies of 19<sup>th</sup> and first half of 20<sup>th</sup> century in finding ethical solutions to the societal problems.
5. Interpret the changes in specializations of science and the technology and build the relation between information and society from second half of 20<sup>th</sup> century onwards.

**UNIT-I**

**Science - The Beginning (through 599 BCE):** The Stone Ages, Knowledge among hunter gatherers, Agricultural Revolution and other revolutions, Civilization, Major advances.

**Science in Antiquity (600 BCE- 529 CE):** Philosophy- a precursor to science, Hellenistic world and the Roman Empire, Other cultures of the period, Major advances.

**UNIT-II**

**Medieval Science (530 CE - 1452 CE):** The decline of science in Europe, Science in China, Science and mathematics in India, Arab science, Revival of science in Europe, Technology revolution of the Middle ages, Major advances.

**The Renaissance and the Scientific Revolution (1453 CE – 1659 CE):** Renaissance, Scientific Revolution, Technology, Major advances.

**UNIT-III**

**Scientific Method: Measurement and Communication (1660 CE – 1734 CE):** European domination, The scientific method, Major advances.

**The Industrial Revolution (1735 CE – 1819 CE):** Industrial Revolution, Rise of the engineer, Major Advances.

**UNIT-IV**

**Science and Technology in the 19th Century (1820 CE – 1894 CE):** Philosophical basis of 19th-century science, Science and the public, Science and technology, Major advances.

**Rise of Modern Science and Technology (1895 CE – 1945 CE):** The growth of 20<sup>th</sup> century science, New philosophies, Quantum reality, Energy sources, Electricity: a revolution in technology, Major advances.

**UNIT-V**

**Big Science and the Post-Industrial Society (1946 CE – 1972 CE):** Big science, Specialization and changing categories, Technology changes society, Major advances.

**The Information Age (1973 CE – 2015 CE):** Information and society, Globalization, The post-industrial society, **Problems of the Information age, Major Advances**

**Text Books:**

1. Bryan Bunch and Alexander Hellemans, "The History of Science and Technology", Houghton Mifflin Company (New York), 2004
2. JD Bernal, "Science in History", 4 Volumes, Eklavya Publishers, 2012

**Suggested Readings:**

1. "The 100 Most Influential Scientists of All Time", Edited by Kara Rogers, Britannica Educational Publishing, 2010
2. Alberto Hernandez, "A Visual History of Science and Technology", The Rosea Publishing Group, 2016



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**GENDER SENSITIZATION**  
(Open Elective)

Instruction	3 Periods per week
Duration of SEE Examination	3 Hours
SEE Examination	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** This course will introduce the students to:

1. Sensibility regarding issues of gender in contemporary India.
2. A critical perspective on the socialization of men and women.
3. Popular debates on the politics and economics of work while helping them reflect critically on gender violence.

**Outcomes:** After completion of the course the students are able to

1. Understand the difference between "Sex" and "Gender" and be able to explain socially constructed theories of identity.
2. Recognize shifting definitions of "Man" and "Women" in relation to evolving notions of "Masculinity" and "Femininity".
3. Appreciate women's contributions to society historically, culturally and politically.
4. Analyze the contemporary system of privilege and oppressions, with special attention to the ways gender intersects with race, class, sexuality, ethnicity, ability, religion, and nationality.
5. Demonstrate an understanding of personal life, the workplace, the community and active civic engagement through classroom learning.

**UNIT – I**

**Understanding Gender:**

**Gender:** Why Should We Study It? (Towards a World of Equals: Unit -1)

**Socialization:** Making Women, Making Men (Towards a World of Equals: Unit -2) Introduction. Preparing for Womanhood. Growing up Male. First lessons in Caste. Different Masculinities.

**UNIT – II**

**Gender And Biology:**

**Missing Women:** Sex Selection and Its Consequences (Towards a World of Equals: Unit -4) Declining Sex Ratio. Demographic Consequences.

**Gender Spectrum:** Beyond the Binary (Towards a World of Equals: Unit -10) Two or Many? Struggles with Discrimination.

**UNIT – III**

**Gender and Labour:**

**Housework:** the Invisible Labour (Towards a World of Equals: Unit -3) "My Mother doesn't Work." "Share the Load."

**Women's Work:** Its Politics and Economics (Towards a World of Equals: Unit -7) Fact and Fiction. Unrecognized and Unaccounted work. Additional Reading: Wages and Conditions of Work.

**UNIT-IV**

**Issues Of Violence**

**Sexual Harassment:** Say No! (Towards a World of Equals: Unit -6) Sexual Harassment, not Eve-teasing- Coping with Everyday Harassment- Further Reading: "Chupala".

**Domestic Violence:** Speaking Out (Towards a World of Equals: Unit -8) Is Home a Safe Place? -When Women Unite [Film]. Rebuilding Lives. Additional Reading: New Forums for Justice. Thinking about Sexual Violence (Towards a World of Equals: Unit -11) Blaming the Victim-"I Fought for my Life..." - Additional Reading: The Caste Face of Violence.

  
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18IT003

**PRINCIPLES OF INTERNET OF THINGS**  
(Open Elective)

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

**Course Objectives:**

1. To provide an overview of Internet of Things, building blocks of IoT and real-world applications.
2. To explore various IOT enabling technologies.
3. To facilitate students, understand Python scripts for IoT platform.
4. To identify steps in IOT design Methodology.
5. To introduce about the Raspberry Pi device, its interfaces and Django Framework.

**Outcomes:** Upon completing this course, students are able to:

1. Comprehend the terminology, protocols and communication models of IoT.
2. Define the various IoT enabling technologies and differentiate between M2M and IoT.
3. Acquire the basics of Python Scripting Language used in developing IoT applications.
4. Describe the steps involved in IoT system design methodology.
5. Design simple IoT systems using Raspberry Pi board and interfacing sensors with Raspberry Pi.

**Modified Course Outcomes:**

1. Outline the terminology, protocols, Communication models and Communication APIs of IoT.
2. Define the various IoT enabling technologies, Levels, Domain Specific applications and differentiation between M2M and IoT.
3. Make use the basics of Python Scripting Language for developing IoT applications.
4. Infer the steps involved in IoT system design methodology with Home Automation case study.
5. Examine IoT systems using the Raspberry Pi board and interfacing sensors.

**UNIT-I**

**Introduction & Concepts:** Introduction to Internet of Things- Definitions & Characteristics of IoT, Physical Design of IOT-Physical Layer, Network Layer, Transport Layer, Application Layer, Things in IoT, IoT Protocols, Logical Design of IOT-IoT Functional Blocks, IoT Communication Models-Request-response, Publisher-Subscriber, Push-Pull, Exclusive Pair, IoT Communication APIs-REST API, WebSocket API,

**UNIT-II**

**IOT Enabling Technologies:** Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols, Embedded Systems, IOT Levels & Deployment Templates. Differences and similarities between IOT and M2M, Domain Specific IoT's – IoT applications for Home Automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, health and Lifestyle.

**UNIT-III**

**Introduction to Python**–Motivation for using Python for designing IoT systems, Language features of Python, Data types- Numbers, Strings, Lists, Tuples, Dictionaries, Type Conversions, Data Structures: Control of flow-if, for, while, range, break/continue, pass, functions, modules, packaging, file handling, data/time operations, classes, Exception handling,

**UNIT-IV**

**IoT Platforms Design Methodology:** Introduction, IoT Design Methodology Steps-Purpose and Requirements Specification, Process Specification, Domain Model Specification, Information Model Specification, Service Specifications, IoT Level Specification, Functional View Specification, Operational View Specification, Device and Component Integration, Application Development, Case Study on IoT System for Weather Monitoring.

  
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**UNIT-V**

**IoT Physical Devices and End Points:** Basic building blocks of an IoT device, RaspberryPi about the Raspberry Pi board, Raspberry Pi interfaces-Serial, SPI,I2C, Other IoT Devices-~~Duino, BeagleBone Black, Cubieboard.~~Python Web Application Framework: Django Framework-Roles of Model, Template and View.

**Text Books:**

1. Arshdeep Bahga and Vijay Madisetti, "Internet of Things - A Hands-on Approach, Universities Press, 2015.
2. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014.



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18CSO 09

**BASICS OF ARTIFICIAL INTELLIGENCE**  
(Open Elective)

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

**Pre-requisites:** Basic Mathematics.

**Course Objectives:** The main objectives of this course are:

1. To Provide fundamental concepts in Artificial Intelligence.
2. Discuss the various paradigms involved in solving an AI problems which involve perception, reasoning and learning
3. Apply the AI concepts to build an expert system to solve the real-world problems.

**Course Outcomes:** On Successful completion of this course, student will be able to

1. Identify various search strategies to solve problems.
2. Compare and contrast knowledge representation schemes.
3. Apply Bayesian Networks and Dempster Shafer theory for reasoning
4. Explain the role of agents and interaction with the environment
5. Determine different learning paradigms.
6. Explain robotic architectures and expert systems.

**UNIT - I**

Introduction: Definition, history, applications. Problem Solving: AI problems, AI Technique, Defining problem as a State-Space Search, Problem Characteristics. Heuristic Search Techniques: Generate-and-test, Hill Climbing, Constraint Satisfaction.

**UNIT - II**

Knowledge Representation (Logic): Representing facts in logic, proposition logic, predicate logic, resolution and unification. Knowledge Representation (Structured): Declarative representation, Semantic nets, procedural representation, frames.

**UNIT - III**

Reasoning: Probability and Bayes theorem, Certainty factors and Rule based systems, Bayesian Networks, Dempster-Shafer Theory. Planning: Components, goal stack planning, nonlinear planning, hierarchical planning.

**UNIT - IV**

Learning: Introduction, Rote learning, learning by taking advice, learning in problem solving and learning from examples: Decision tree. Intelligent Agents: Classification, Working of an agent, single agent and multi agent systems, multi agent application.

**UNIT - V**


Expert System: Representing and Using Domain Knowledge, Expert systems shells, Explanation, Knowledge Acquisition, Perception and Action: Real Time Search, Vision, Speech Recognition, ACTION: Navigation, Manipulation, Robot architectures.

**Text Books:**

1. Elaine Rich, Kevin Night, Shivashankar B Nair, "Artificial Intelligence", 3rd Edition, 2008
2. Russell Norvig, "Artificial Intelligence-Modern Approach", 3rd edition, 2010.

**Suggested Reading:**

1. Suroj Koushik, "Artificial Intelligence", Cengage Learning India, 2012.
2. Nelson M. Mattos, "An Approach to Knowledge Base Management", Springer Berlin Heidelberg, 1991.

  
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**Online Resources:**

1. <http://nptel.ac.in/courses/106106126/>
2. <http://nptel.ac.in/courses/106105077/>



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18ME C25

**METROLOGY AND INSTRUMENTATION LAB**

Instruction	3Hours per week
Duration of SEE	3 Hours
SEE	50Marks
CIE	25 Marks
Credits	1.5

**Objectives:**

1. To choose the proper measuring instrument for the precise measurement of length, height and diameter.
2. To classify the different measuring instruments used for the angular measurement.
3. To develop gear & screw thread parameters using optical projector and tool maker's microscope.
4. To analyze the limits, fits and tolerances for selection and design of gauges.
5. To determine the working principles in the measurement of Flatness, Roundness and Surface roughness.

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

1. Measure the linear dimension by using appropriate method & device. (BL-3)
2. Demonstrate the knowledge of angular measurements and use measuring instruments as per requirements. (BL-2)
3. Determine the gear and screw thread parameters using profile projector and tool maker's microscope. (BL-3)
4. Design and test plain limit gauges for a given specimen. (BL-3)
5. Evaluate and estimate the measurement of flatness, roundness and surface roughness. (BL-5)

**Experiments:**

1. Measurement with inside, outside and depth micrometers.
2. Measurement with height gauges, height masters.
3. Measurement of linear and angular dimensions with Tool maker's microscope – diameter of thin wire and single point cutting tool angle.
4. Measurement with dial indicator and its calibration.
5. Measurement of angles with sine bar and clinometers.
6. Measurement of roundness errors with bench centers.
7. Measurement of flatness errors of a surface plate with precision spirit level.
8. Measurement with optical profile projector.
9. Design of plug and snap gauges for a given component.
10. Surface roughness measurement by Taylor Hobson -Talysurf.
11. Measurement of gear tooth thickness by gear tooth vernier.
12. Displacement measurement with LVDT.
13. Analyze, assess, measure and document all Measuring attributes of a selected component by using appropriate methods and devices.

**Note:** Student should complete a minimum of 10 experiments including experiment number 13 which is compulsory.

**Text Books:**

1. R.K. Jain, "Engineering Metrology", Khanna Publications, 1996.
2. Doebelin, "Measurement Systems Application and Design", TMH, 5/e., 2004.
3. Beckwith, Buck, Lienhard, "Mechanical Measurements", PEA, 3rd Indian Reprint, 2001.

**Suggested Reading:**

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1. RegaRajendra, "Principles of Engineering Metrology", Jaico Publishing House, Mumbai, 2008.
2. B.C. Nakra & K.K. Chaudhary, "Instrumentation Measurement and Analysis", 3/e, McGraw-Hill, 2014.



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18PE C12

**ADDITIVE MANUFACTURING LAB**

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

**Objectives:**

The objectives of the course are

1. To introduce to the students the additive manufacturing machines
2. To impart knowledge about various materials used for the digital fabrication
3. To demonstrate rapid tooling concept
4. To demonstrate reverse engineering process
5. To impart knowledge about tool path generation

**Outcomes:**

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

1. Generate tool path data for any component using slicing software
2. Compare different Additive manufacturing processes and select a subtractive or an AM process for a particular application for product development of engineering components
3. Use different post processing techniques to enhance the component after fabrication
4. Generate STL file from digital data input
5. Operate themselves the 3d printing machine.

**List of the 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 , Slicing of STL files, Obtaining the tool path data and sending it to RP Machines
4. 3d printing of jigs, fixtures and other manufacturing tools
5. 3d printing of bottle die
6. Prototyping of petrol engine Connecting rod
7. Fabrication of Components of Screw jack and assembling them
8. Demonstration of working of Stereo lithography machine
9. Removing the supports & post processing (cleaning the surfaces) Post curing of fabricated resin parts.
10. Reverse engineering: from scanner to model validation (solid works).

**Text Books:**

1. Gibson, DW, Rosen and B.Stucker; "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 of rapid prototyping" 4/e,
3. PK. Venurao, Ma, W, "Rapid prototyping – Laser based and other technologies", Kluwer , 2004.

**Suggested Reading:**

1. Jacob, Paul, "Rapid tooling : Technologies and industrial applications".
2. Andreas Gebhardt, "Understanding Additive Manufacturing", Hanser, 2012.
3. Alain Brnard, Georges Talliander, "Additive Manufacturing", Wiley, 2014.

  
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18PEC13

## PROJECT: PART - 1

Instruction	4 Hours per week
Duration of SEE	---
SEE	---
CIE	50 Marks
Credits	2

**Objective:** The objective of Project Part -1 is to enable the student take up investigative study in the broad field of Engineering / Technology, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a supervisor. This is expected to provide a good initiation for the student(s) towards R&D.

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

1. Identify a topic in advanced areas of Mechanical / Allied fields of Engineering. (BL-1)
2. Review literature to identify the gaps, define the objectives and scope of the work. (BL-2)
3. Generate innovative ideas for societal benefit and Nation building. (BL-6)
4. Develop prototypes/models, experimental setup and software systems necessary to meet the objectives. (BL-6)
5. Prepare a technical report and present before the departmental committee (BL-5)

**The work shall include:**

1. Survey and study of published literature on the assigned topic.
2. Working out a preliminary Approach to the Problem relating to the assigned topic.
3. Conducting preliminary Analysis/Modelling/Simulation/Experiment/Design/Feasibility.
4. Preparing a Written Report on the Study conducted for Presentation to the Department.
5. Final Seminar, as oral Presentation before a departmental Committee.

**Guidelines for the award of marks:**

Evaluation by	Maximum Marks	Evaluation Criteria / Parameter
Supervisor	20	Project Status / Review
	5	Report
Departmental Committee	5	Relevance of the Topic
	5	PPT Preparation
	5	Presentation
	5	Question and Answers
	5	Report Preparation

  
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18EC 001

**REMOTE SENSING AND GIS (Open Elective – II)**

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

**Course Objectives:**

This course aims to:

1. Explain the fundamental concepts of remote sensing and digital imaging techniques.
2. Make the students to understand the principles of thermal and microwave remote sensing.
3. Make the students understand the significance of GIS and the process of GIS.

**Course Outcomes:**

Upon completion of this course, students will be able to:

1. Understand the fundamental concepts of remote sensing.
2. Analyze types of remote sensing and digital imaging techniques.
3. Analyze the hyperspectral imaging and thermal remote sensing techniques.
4. Apply Microwave remote sensing techniques
5. Understand GIS data models and carryout geospatial analysis.

**UNIT-I**

**Concept of Remote Sensing:** Remote sensing definition, data, process, EM bands used in remote sensing, Interactions and recording of energy: interaction with atmosphere, interaction with earth surface features (soil, water, vegetation), recording of energy by sensors, Transmission, reception and processing, Image interpretation and analysis, Applications, Advantages and limitations of Remote sensing, Orbits of Remote sensing satellites, Indian remote sensing satellites.

**UNIT-II**

**Digital Imaging:** Types of Remote sensing, Sensor resolutions, Digital Image, Sensor components, Principle of a long-track and across-track scanning, Hyperspectral Imaging, Thermal Remote Sensing.

**UNIT-III**

**Microwave Remote Sensing:** Active and Passive Microwave Remote Sensing, Radar Imaging: Key components of imaging radar, viewing geometry, spatial resolution, principle of RAR, SAR and their range resolution, Satellite Radar Imaging, Photogrammetry: definition and process, photogrammetry and LIDAR, lidargrammetry.

**UNIT-IV**

**Concept of Geographic Information Systems:** Key components of GIS, joining spatial and attribute data, functions, advantages and applications of GIS, Spatial data model, Raster data model, Vector data model.

**UNIT-V**

**Process of GIS and Geospatial analysis:** Data sources, encoding raster data, encoding vector data, Encoding attribute data, linking spatial and attribute data, Geospatial data analysis methods database query, geospatial measurement, overlay operations, network analysis and surface analysis, Integration of GIS and remote sensing.

**Text Books:**

1. BasudebDhatta, "Remote Sensing and GIS", 2/e, Oxford University Press, 2012.
2. Lillesand T.M., and Kiefer R.W. "Remote Sensing and Image Interpretation", 6/e, John Wiley & Sons, 2000.

**Suggested Reading:**

1. James B. Campbell and Randolph H. Wynne, "Introduction to Remote Sensing", the Guilford Press, 2011.
2. Michael N DeMers, "Fundamentals of GIS", 2/e, John Wiley, 2008.

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18MT 001

**APPLIED OPERATIONS RESEARCH (Open Elective – II)**

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

**Objectives:**

1. Identifying and develop Operations Research Models from the verbal description of real system.
2. Able to learn different techniques to get optimum solution LPP.
3. Able to understand the Mathematical tools that are needed to solve optimization problem.
4. Able to analyse the results of the different real world problems.
5. Able to formulate the problems and solve situation using dynamic programming problem technique.

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

1. Define and formulate LPP and appreciate their limitations.
2. Solve the problem using different optimization techniques.
3. Solve the problem of transporting the products from origins to destination with least cost.
4. Convert and solve the practical situations into Dynamic programming problem.
5. Identifying the resources required for a project and generate a plan and work schedule.

**UNIT-I**

**Introduction to Operations Research:** Basics definition, scope, objectives, phases, models and limitations of Operations Research, Linear Programming Problem-Formulation of LPP, Graphical solution of LPP, Simplex Method, Artificial variables, big-M method.

**UNIT-II**

**Transportation Problems:** Formulation, solution, unbalanced transportation problems, finding basic feasible solutions-Northwest corner rule, least cost method and Vogel's approximations method, Optimality test: the stepping stone method and MODI method.

**UNIT-III**

**Assignment Model:** Formulation, Hungarian method for optimal solution, solving unbalanced problem, Traveling salesman problem and assignment problem

**UNIT IV**

**Sequencing Models:** Solution of sequencing problem-processing  $n$  jobs through 2 Machines-processing  $n$  jobs through 3 Machines-processing 2 jobs through  $m$  machines-processing  $n$  jobs through  $m$  machines.

**UNIT-V**

**Dynamic Programming:** Characteristics of dynamic programming, Dynamic programming approach for priority management employment smoothening, capital budgeting, stage coach/shortest path, cargo loading and Reliability problems.

**Text Books:**

1. P.Sankaralayer, "Operations Research", Tata McGraw-Hill, 2008.
2. A.M.Natarajan, P.Balasubramani, A.Tamilarasi, "Operations Research", Pearson Education, 2005.

**Suggested Reading:**

1. J K Sharma, "Operations Research Theory & Applications", 3/e, Macmillan India Ltd, 2007.
2. P.K.Gupta and D.S.Hira, "Operations Research", S.Chand & Co, 2007

  
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18EE 003

**ENERGY AUDITING (Open Elective – II)**

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

**Objectives:**

1. To know the concept of Energy auditing
2. To understand the formulation of efficiency for various engineering systems
3. To explore the different ways to design various technologies for efficient engineering systems.

**Outcomes:** After completion of this course, students will be able to:

1. Know the current energy scenario and importance of energy auditing.
2. Understand the concepts of energy auditing.
3. Evaluate the performance of existing engineering systems
4. Explore the methods of improving energy efficiency in different engineering systems
5. Design different energy efficient devices.

**UNIT-I**

**Basics of Energy and its various forms:** Overview of engineering, elements Solar energy, electricity generation methods using solar energy, PV cell, elements of wind energy, electricity generation using wind energy, elements of bio energy, bio mass energy conservation, elements of geothermal energy, sources of geothermal energy, sources of chemical energy, fuel cells, Energy Scenario in India

**UNIT-II**

**Energy Auditing-1: Introduction:** Need for energy audit, directions for the study of energy auditing, inclusions for energy auditing, types of energy audit: preliminary audit, general/mini audit, investment-grade/comprehensive audit. Major energy consuming equipments and systems, energy audit team, energy auditing methodology: preliminary and detailed, Process flow diagram, energy audit report format

**UNIT-III**

**Energy Auditing-2: For Buildings:** Energy auditing instruments, energy efficiency, energy auditing for buildings: stages in programs, surveying, measurements and model analysis, Energy audit form of commercial buildings, checklist for energy saving measures

**UNIT-IV**

**Energy Efficient Technologies-I:** Importance of energy efficiency for engineers, Energy efficient technology in mechanical engineering: Heating, ventilation and air-conditioning, boiler and steam distribution systems, Energy efficient technology in civil engineering: future of roads, harnessing road and transport infrastructure;

**UNIT-V**

**Energy Efficient Technologies-II:** Energy efficient technology in electrical engineering: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors; Energy efficient technology in chemical engineering: green chemistry, low carbon cements, recycling paper

**Text Books:**

1. Umesh Rathore, 'Energy management', Kataria publications, 2nd edition, 2014.
2. Guide books for National Certification Examination for Energy Manager/ Energy Auditors Book-I, General Aspects
3. Hargroves, K., Gockowiak, K., Wilson, K., Lawry, N., and Desha, C. (2014) An Overview of Energy Efficiency Opportunities in Mechanical/civil/electrical/chemical Engineering, The University of Adelaide and Queensland University of Technology.

**Suggested reading:**

1. Success stories of Energy Conservation by BEE, New Delhi ([www.bee-india.org](http://www.bee-india.org))

  
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18CSO 07

## BASICS OF CYBER SECURITY

(Open Elective)

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

**Pre-requisites:** Operating System, Computer Network, Cryptography.

**Course Objectives:** The main objectives of this course are:

1. To Identify and present indicators that a cybercrime has occurred and understand methods and tools used in cybercrimes.
2. To collect, Process, Analyze and Present Computer Forensics Evidence.
3. To understand the legal perspectives and Organizational implications of Cyber Security

**Outcomes:** On Successful completion of this course, student will be able to

1. List the different types of cybercrimes and analyze legal frameworks to handle cybercrimes.
2. Identify the Tools and Methods used in cybercrimes.
3. Analyze and resolve cyber security issues and laws governing Cyberspace.
4. Describe the need of Digital Forensics and the importance of digital evidence in prosecution.
5. Interpret the commercial activities in the event of significant information security incidents in the Organization.
6. Discuss the vulnerabilities in networking protocols and their mitigation techniques.

### UNIT - I

Introduction to Cyber Crime: Cyber Crime: Definition and Origins of the Word, Cyber crime and Information Security, Classification of Cyber Crimes, Cyber Crime: The Legal Perspective, Cyber Crime: An Indian Perspective, A Global Perspective of Cyber Crime.

### UNIT - II

Cyber Offenses: Introduction, How Criminals plan the Attacks, Social Engineering, Cyber stalking, Cyber cafe and Cybercrimes, Botnets: The Fuel for Cybercrime, Attack Vector.  
Tools and Methods Used in Cybercrime: Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horse and Backdoors, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Overflow.

### UNIT - III

Cyber Security: The Legal Perspectives: Cyber Crime and the Legal Landscape around the World, Need of Cyber laws: the Indian Context, The Indian IT Act, Challenges to Indian Law and Cyber Crime Scenario in India, Digital Signatures and the Indian IT Act, Cyber Crime and Punishment, Cyber Law, Technology and Students: The Indian Scenario.

  
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**UNIT - IV**

Understanding Cyber Forensics: Introduction ,Digital Forensics Science, Need for Computer Forensics, Cyber Forensics and Digital Evidence, Forensics Analysis of Email, Digital Forensics Life Cycle, Chain of Custody Concept, Network Forensics, Approaching a Cyber Forensics Investigation, Challenges in Computer Forensics.

**UNIT - V**

Cyber Security: Organizational Implications: Introduction, Cost of Cybercrimes and IPR issues, Web threats for Organizations, Security and Privacy Implications, Social media marketing: Security Risks and Perils for Organizations, Social Computing and the associated challenges for Organizations.

**Text Books:**

1. Sunit Belpre and Nina Godbole, "Cyber Security: Understanding Cyber Crimes, Computer Forensics And Legal Perspectives", Wiley India Pvt.Ltd, 2011.
2. Kevin Mandia, Chris Proise, "Incident Response and computer forensics", Tata McGraw Hill, 2006.

**Suggested Reading:**

1. Alfred Basta, Nadine Basta, Mary Brown, Ravinder Kumar, "Cyber Security and Cyber Laws", Paperback – 2018.
2. Mark F Grady, Fransesco Parisi, "The Law and Economics of Cyber Security", Cambridge university press, 2006.

**Online Resources:**

1. <https://www.edx.org/learn/cybersecurity>
2. <https://www.coursera.org/courses?query=cyber%20security>
3. <https://swayam.gov.in/course/4002-cyber-law>

  
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18EC 005

## MEMS AND ITS APPLICATIONS

(Open Elective)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

### Course Objectives:

This course aims to:

1. Provide knowledge of semiconductors, various materials used for MEMS.
2. Introduce various Electrostatic and Thermal Sensors and Actuators.
3. Educate on the applications of MEMS to various disciplines.

### Course Outcomes:

Upon completion of this course, students will be able to:

1. Understand various materials used for MEMS.
2. Design the micro devices and systems using the MEMS fabrication process.
3. Analyze the operation of different Sensors and Actuators.
4. Interpret the micro devices and systems using Polymer MEMS.
5. Apply different MEMS devices in various disciplines.

### UNIT- I

**Introduction:** The History of MEMS Development. The Intrinsic Characteristics of MEMS: Miniaturization, Microelectronics Integration, Parallel Fabrication with Precision, Devices: Sensors and Actuators- Energy Domains and Transducers, Sensors Considerations, Sensor Noise and Design Complexity: Actuators Considerations.

### UNIT- II

**Introduction to Micro Fabrication:** Overview of Micro fabrication, Overview of Frequently used Micro fabrication Processes: Photolithography, Thin Film Decomposition, Thermal Oxidation of Silicon, Wet Etching, Silicon Anisotropic Etching, Plasma Etching and Reactive Etching, Doping, Wafer Dicing, Wafer Bonding, Microelectronics Fabrication Process Flow, Silicon based MEMS Processes, Packaging and Integration, Process Selection and Design.

### UNIT- III

**Electrostatic Sensing and Actuation:** Introduction to Electrostatic Sensors and Actuators, Parallel Plate Capacitor, Applications of Parallel Plate Capacitors, Interdigitated Finger Capacitors, Applications of Combo Drive Devices: Inertia Sensors, Actuators. Thermal Sensing and Actuation: Introduction to Thermal Sensors, Thermal Actuators, Fundamentals of Thermal Transfer, Sensors and Actuators Based on Thermal Expansion, Thermal Couples, Thermal Resistors, Applications- Inertia Sensors, Flow Sensors, Infrared Sensors.



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#### UNIT- IV

**Piezo resistive Sensors:** Origin and Expression of Piezo resistivity, Piezo resistive Sensor Materials: Metal Strain Gauges, Single crystal Silicon, Polycrystalline Silicon, Applications of Piezo resistive Sensors: Inertial sensors, Pressure Sensors, Tactile Sensors, flow Sensors. **Piezoelectric Sensors:** Introduction, Properties of Piezoelectric Materials, Applications- Inertia Sensors, Acoustic Sensors, Tactile Sensors, Flow Sensors.

#### UNIT- V

**Polymer MEMS:** Introduction, Polymers in MEMS- Polyimide, SU-8, Liquid Crystal Polymer(LCP), Representative Applications- Acceleration Sensors, Pressure Sensors, Flow Sensors, Tactile Sensors. Case Studies of Selected MEMS Products: Blood Pressure (BP) Sensor, Microphone, Acceleration Sensor and Gyros.

#### Text Books:

1. Chang Liu, "Foundations of MEMS", 2/e, Pearson Education Inc., 2012.
2. Tai Ran Hsu, "MEMS & Micro Systems Design and Manufacture", Tata McGraw Hill, 2002.

#### Reference Books:

1. P. Rai Choudary, "MEMS and MEMS Technology and Applications", PHI publications, 2009.
2. Mohamed Gad-el-Hak, "The MEMS Handbook", CRC press, 2001.

  
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18EG 001

**TECHNICAL WRITING SKILLS**  
(Open Elective)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 marks
CIE	40 marks
Credits	3

**Objectives :** The course will introduce the students to:

1. Process of communication and channels of communication in general and technical writing.
2. Technical Writing and also contextual use of technology specific words.
3. Business letters and technical articles.
4. Technical reports and technical proposals.
5. Transferring data from verbal to graphic and vice versa and making technical presentations.

**Outcomes :** After successful completion of the course students are able to:

1. Understand the channels of communication and define nature and aspects of Technical communication
2. Compare and contrast technical communication to that of general communication while constructing error free sentences applying features of technical writing
3. Analyze data, draw inferences to write Journal articles and conference papers and to compose business letters.
4. Evaluate data to draft technical reports and technical proposals.
5. Design a technical presentation by understanding the nuances of presentation skills and also transfer data from verbal to graphic and vice versa.

**Unit I**

**Communication** – Nature and process.

**Channels of Communication** – Downward, upward and horizontal and lateral communication; Barriers to communication.

**Technical Communication** – Definition ; oral and written communication. Importance and need for Technical communication. Nature of Technical Communication; Aspects and forms of Technical communication.

**Technical communication Skills** – Listening, Speaking, Reading & Writing.

**Unit II**

**Technical Writing** – Techniques of writing. Selection of words and phrases in technical writing. Differences between technical writing and general writing. Abstract and specific words. Sentence structure and requisites of sentence construction. Paragraph length and structure.

**Unit III**

**Business correspondence** – Sales letters, letters of Quotation; Claim and Adjustment letters.

**Technical Articles:** Nature, significance and types of technical articles. Writing an abstract. Journal articles and Conference papers. Elements of technical articles.

**Unit IV**

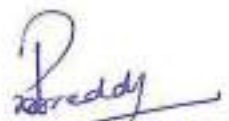
**Technical Reports** : Types, significance, structure, style and writing of reports. Routine reports, Project reports.

**Technical Proposals** : Definition, types, characteristics, structure and significance.

**Unit V**

**Information Transfer** – Graphic to verbal (written) and verbal to graphic.

**Technical Presentations** : Important aspects of oral and visual presentations.



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**Text Book :**

1. Meenakshi Raman & Sangeeta Sharma, "Technical Communications-Principles and Practice", Oxford University Press, Second Edition, 2012.
2. I.M Ashraf Rizvi, "Effective Technical Communication", Tata McGraw Hill Education Pvt Ltd, 2012.

**Suggested Reading :**

1. Kavita Tyagi & Padma Misra, "Basic Technical Communication", PHI Learning Pvt Ltd, 2012.
2. R.C Sharma & Krishna Mohan, "Business Correspondence and Report Writing", Tata McGraw Hill, 2003

**Web Resources:**

1. [https://onlinecourses.nptel.ac.in/noc18\\_mg13/preview](https://onlinecourses.nptel.ac.in/noc18_mg13/preview)
2. <https://www.technical-writing-training-and-certification.com/>
3. <https://academy.whatfix.com/technical-writing-skills>



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18BT 001

## BASICS OF BIOLOGY

(Open Elective-I)

Instruction	3LHoursperWeek
DurationofSEE	3Hours
SEE	70Marks
CIE	30Marks
Credits	3

**Course Objectives:** This course aims to:

1. Impart knowledge of origin and evolution of biological organisms.
2. Understand the structure and functions of human organ systems.
3. Understand the principles behind medical devices for diagnosis of human health and environment protection.
4. Give an insight of biological information, relationship and genome sequencing of various organisms.

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

1. Explain the theories of origin and evolution of life.
2. Describe the anatomical structure and physiological functions of the human organ systems.
3. Outline the principle and applications of medical devices.
4. Discuss the technology advancements in improving human health and environment.
5. Explain the biological information, sequencing and evolutionary relationship among organisms.

### UNIT-I

**Introduction to Biology:** Classical Vs Modern Biology; Importance of Biological Science and Historical developments; Origin of Life, Urey Miller Experiment, Spontaneous Generation Theory; Three Domains of Life; Principle and Applications of Microscope (Light and Electron Microscope), Prokaryotic and Eukaryotic Cell-Structure and their differences.

### UNIT-II

**Human organ systems and their functions -I:** Introduction to various organ systems of human body and their functions; Skeletal System-Bones, Tendon, Ligaments, principle and applications in knee replacement; Nervous System - Structure of Brain, Spinal Cord, Neuron, Neurotransmitters, Synapse, Alzheimer's disease study, principle and applications of imaging Techniques (CT & MRI scans); Circulatory System-Heart structure and functions, principle and applications of cardiac devices (Stent and Pacemaker), Artificial heart, blood components and typing, haemocytometer.

### UNIT-III


**Human Anatomy and Functions-II:** Respiratory Systems-Lung structure and function, principle and applications of Peak Flow Meter, ECMO (ExtraCorporal Membrane Oxygenation); Excretory Systems-Kidney structure and function, principle and applications of Dialysis; Prenatal diagnosis; Assisted reproductive techniques- IVF, Surrogacy.

### UNIT-IV

**Medical Biotechnology and Bioremediation:** Cells of Immune System, Etiology of cancer, Cancer treatment (Radiation Therapy); Stem Cells and its Clinical applications; Scaffolds and 3D printing of organs; Bio sensors and their applications; Parts of bioreactor and its types; Bioremediation.

### UNIT-V

**Bioinformatics:** Nucleic acid composition, Genetic Code, Amino acid, Polypeptide, Levels of protein structure, Homolog, Ortholog and Paralog, Phylogenetics, Genome Sequencing, Human Genome Project, Next generation sequencing.

  
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**TextBooks:**

1. Campbell, N.A., Reece, J.B., Urry, Lisa, Cain, M.L., Wasserman, S.A., Minorsky, P.V., Jackson, R.B. "Biology: A Global Approach", 11th edition, Pearson Education Ltd. 2017
2. Shier, David, Butler, Jackie, Lewis, Ricki, "Hole's Human Anatomy & Physiology", 13<sup>th</sup> edition, McGrawHill 2017.
3. Dubey RC "A Text book of Biotechnology" 5<sup>th</sup> Edition, S Chand and Company limited, 2014.
4. Bernard R. Glick, T. L. Delovitch, Cheryl L. Patten, "Medical Biotechnology", 1st edition, ASM Press, 2014.

  
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18CE 002

## DISASTER MITIGATION AND MANAGEMENT (M)

(Open Elective)

Instruction	3 L Hours per Week
End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

**Course Objectives:** This course aims to,

1. Equip the students with the basic knowledge of hazards, disasters, risks and vulnerabilities.
2. Impart knowledge in students about the nature, causes, consequences and mitigation measures of the various Hydro-meteorological disasters.
3. Introduce the concepts of causes, consequences and mitigation measures of the various Geographical disasters.
4. Enable the students to understand risks, vulnerabilities and human errors associated with human induced disasters.
5. Equip the students with the knowledge of the impacts of disaster, chronological phases in a disaster management cycle and to create awareness about the disaster management framework and legislations in the context of Central and State Level Authorities.

**Course Outcomes:** Upon completion of this course, the student will be able to,

1. Identify and understand the fundamental terminologies in disaster management.
2. Distinguish between the Hydro-meteorological disasters and apply the concepts of structural and non- structural mitigation measures.
3. Categorize different Geographical Disasters and apply the knowledge in utilizing the early warning systems.
4. Analyze various mechanisms and consequences of human induced disasters.
5. Develop an awareness of disaster management phases and formulating effective disaster management plans, ability to understand various participatory roles of stakeholders- Central and State Government bodies at different levels.

### UNIT- I:

**Introduction:** Basic definitions- Hazard, Disaster, Vulnerability, Risk, Resilience, Mitigation, Management; classification of types of disaster- Natural and manmade; Introduction to Disaster management cycle; International Decade for natural disaster reduction (IDNDR); International strategy for disaster reduction (ISDR), National disaster management authority (NDMA).

### UNIT- II:

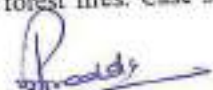
#### Natural Disasters:

#### Hydro meteorological disasters:

Causes, Early warning systems- monitoring and management, structural and non-structural measures for floods, drought and Tropical cyclones; Applications. Case studies related to various hydro-meteorological disasters.

### UNIT- III:

**Geographical based disasters:** Causes, zoning, Early warning systems- monitoring and management, structural and non-structural mitigation measures for earthquakes, tsunami, landslides, avalanches and forest fires. Case studies related to various geographical based disasters.



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**UNIT- IV:**

**Human Induced Disasters:** Chemical disaster- Causes, impacts and mitigation measures for chemical accidents, Risks and control measures in a chemical industry, chemical disaster management; Case studies related to various chemical industrial hazards eg: Bhopal gas leakage; Management of chemical terrorism disasters and biological disasters; Case studies related to power break downs, fire accidents, traffic accidents, oil spills and stampedes, building failure disasters.

**UNIT- V:**

**Concept of Disaster Impacts and Management:**

Disaster impacts- environmental, physical, social, ecological, economical, political, etc.; health, psycho-social issues; demographic aspects, gender, age, special needs; hazard locations; global and national disaster trends; climate change and urban disasters.

Disaster management cycle and its phases, risk analysis, vulnerability and capacity assessment; Post-disaster environmental response water, sanitation, food safety, waste management, disease control; Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National Disaster Management Authority.

**Text Books:**

1. Pradeep Sahni, "Disaster Risk Reduction in South Asia", Prentice Hall, 2003.
2. B. K. Singh, "Handbook of Disaster Management: Techniques & Guidelines", Rajat Publication, 2008.

**Suggested Reading:**

1. Ministry of Home Affairs, Government of India, "National Disaster Management Plan, Part I and II",
2. K. K. Ghosh, "Disaster Management", APH Publishing Corporation, 2006.
3. [http://www.indiaenvironmentportal.org.in/files/file/disaster\\_management\\_india1.pdf](http://www.indiaenvironmentportal.org.in/files/file/disaster_management_india1.pdf)
4. <http://www.ndmindia.nic.in/> (National Disaster management in India, Ministry of Home Affairs)
5. Hazards, Disasters and your community: A booklet for students and the community, Ministry of Home Affairs.
6. Disaster Medical Systems Guidelines, Emergency Medical Services Authority, State of California, EMSA no.214, June 2003.
7. Inter Agency Standing Committee (IASC) (Feb. 2007), IASC Guidelines on Mental Health and Psychosocial Support in Emergency Settings, Geneva: IASC.
8. <http://ndma.gov.in/> (Home page of National Disaster Management Authority)

  
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18EE0 05

## WASTE MANAGEMENT

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

### Course Objectives:

1. To imbibe the concept of effective utilization of any scrap
2. To become familiar with the processes of all disciplines of engineering.
3. To learn the technique of connectivity from waste to utility.

### Course Outcomes:

1. Understand the various processes involved in allied disciplines of engineering
2. Infer the regulations of governance in managing the waste
3. Distinguish the nature of waste materials concerned to the particular branch of engineering
4. Explore the ways and means of disposal of waste material
5. Identify the remedies for the disposal of a selected hazardous waste material

### UNIT-I

**Introduction to waste management:** Relevant Regulations Municipal solid waste (management and handling) rules; hazardous waste (management and handling) rules; biomedical waste handling rules; fly ash rules; recycled plastics usage rules; batteries (management and handling) rules. Municipal Solid Waste Management – Fundamentals Sources; composition; generation rates; collection of waste; separation, transfer and transport of waste; treatment and disposal options.

### UNIT-II

**Hazardous Waste Management :** Fundamentals Characterization of waste; compatibility and flammability of chemicals; fate and transport of chemicals; health effects, Radioactive Waste Management – Fundamentals Sources, measures and health effects; nuclear power plants and fuel production; waste generation from nuclear power plants; disposal options.

### UNI-III

**Environmental Risk Assessment:** Defining risk and environmental risk; methods of risk assessment; case studies, Physicochemical Treatment of Solid and Hazardous Waste Chemical treatment processes for MSW (combustion, stabilization and solidification of hazardous wastes); physicochemical processes for hazardous wastes (soil vapor extraction, air stripping, chemical oxidation); ground water contamination and remediation

### UNIT-IV

**Biological Treatment:** Solid and Hazardous Waste Composting; bioreactors; anaerobic decomposition of solid waste; principles of biodegradation of toxic waste; inhibition; co-metabolism; oxidative and reductive processes; slurry phase bioreactor; in-situ remediation.

### UNIT-V

**Landfill design aspects:** Landfill design for solid and hazardous wastes; leachate collection and removal; landfill covers; incineration

### Text Books:

1. John Pichtel Waste Management Practices CRC Press, Taylor and Francis Group 2005.
2. LaGrega, M.D. Buckingham, P.L. and Evans, J.C. Hazardous Waste Management, McGraw Hill International Editions, New York, 1994
3. Richard J. Watts, Hazardous Wastes - Sources, Pathways, Receptors John Wiley and Sons, New York, 1997

### Suggested Reading:

1. Basics of Solid and Hazardous Waste Mgmt. Tech. by Kanti L. Shah 1999, Prentice Hall
2. Solid and Hazardous Waste Management 2007 by S.C.Bhatia Atlantic Publishers

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18EC 007

**SYSTEM AUTOMATION AND CONTROL**  
(Open Elective)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

**Course Objectives:** This course aims to:

1. Learn the concepts industrial control systems
2. Learn how to measure the physical parameters in industry
3. Learn the applications of Robots in industry.

**Course Outcomes:** After completion of this course, students are able to:

1. Understand the features of various automatic and process control systems.
2. Define and analyze various measuring parameters in the industry.
3. Compare performance of various controllers (P, PD, PI, and PID).
4. Illustrate the role of digital computers in automation.
5. Develop various robot structures for different applications.

**UNIT-I**

**Introduction to Automatic Control Systems:** Purpose of Automatic Control, How an Industrial Control System is implemented, Introduction to Automatic Control theory.

**Sensors:** Sensor definition, Different types of Sensors: Motion, Position, Force, Level sensors, and Thermo couples.

**UNIT-II**

**Theory of Measurements:** Measurement goals and concepts. Scale factor, Linearity, accuracy, Range, Resolution, Precision and repeatability.

**Measurement Techniques and Hardware:** Typical Sensor outputs, Bridge measurements: General equation for bridge balance, Resistance balanced Wheatstone bridge, Variable voltage type measurements, Frequency type measurements.

**UNIT-III**

**Process Controllers:** What is a Controller, uses of Controllers, Open loop and closed loop Control, proportional, PD, PI, PID Controllers, Analog and Digital methods of Control.

**Controller Hardware:** Analog and Digital Controllers.

**UNIT-IV**

**Digital Computers as Process Controllers:** Use by Digital Computer for process control, Information required by the computer, Information required by the process, Computer Interface electronics, Digital Computer input-output, computer processing of data, Digital Process control computer design, Computer programming.

**Actuators:** Electro mechanical - Linear motion and rotary motion solenoids, DC motors, AC motors and Stepped motors.

**UNIT-V**

**Robots:** What are robots, Robots and process Control systems, Degrees of freedom, factories of the future, Delivery, Disposal and transport systems, Sensing elements, Robot Classifications and Applications. Trouble shooting System failures: Preliminary steps and other troubleshooting aids.



**Text Books:**

1. Ronald P. Hunter, "Automated process control systems – concepts and Hardware", 2/e, PHI, 1987.
2. Norman A. Anderson, "Instrumentation for process measurement and Control", 3/e, CRC Press, 2005.

**Suggested Reading:**

1. Kuo B. C, "Automatic Control Systems", 9<sup>th</sup> edition
2. A.K Sawhney, "A course on Electrical and Electronic Measurements and Instrumentation".

  
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18PE C14

## TECHNICAL SEMINAR

Instruction	2 Hours per week
Duration of SEE	---
SEE	50 Marks
CIE	1
Credits	

**Objective:** The goal of a seminar is to introduce students to critical reading, understanding, summarizing, explaining and preparing report on 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 and the student shall read further relevant articles in the domain.

- Outcomes:** At the end of the course, the students are able to
1. Identify the recent advances in the field of engineering/technology. (BL-1)
  2. Develop the skills and expertise in report writing. (BL-6)
  3. Compile the content and prepare comprehensive report. (BL-4)
  4. Demonstrate skills required for preparation of a technical report. (BL-3)
  5. Present technical know-how and professional skills before the committee. (BL-3)

The seminar must be clearly structured and the power point presentation shall include following aspects:

1. Introduction to the field
2. Literature survey
3. Consolidation of available information
4. Summary and conclusions
5. References


Each student is required to:

1. Submit a one page synopsis of the seminar talk for display on the noticeboard.
2. Deliver the seminar for a maximum duration of 30 minutes, where the presentation should be for 20 minutes in PowerPoint, followed by question and answers session for 10 minutes.
3. Submit the detailed report of the seminar in spiral bound in a prescribed format as suggested by the department.

Seminars are to be scheduled from 3<sup>rd</sup> week to the last week of the semester and any change in schedule shall 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 shall be preferably from any peer reviewed recent journal publications.

Guidelines for awarding marks		
Sl No.	Description	Max Marks
1.	Contents and relevance	10
2.	Presentation skills	10
3.	Preparation of PPT slides	05
4.	Questions and answers	05
5.	Report in a prescribed format	20
<b>Total Marks</b>		<b>50</b>

  
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18PE C15

**PROJECT: PART - 2**

Instruction	20Hours per week
Duration of SEE	----
SEE	100 Marks
CIE	100 Marks
Credits	10

**Objectives:** The objective of Project Part-2 is to enable the student extend further the investigative study taken up, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership.

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

1. Summarize the literature review for the identified problem. (BL-2)
2. Identify methods and materials to carry out experiments/ develop code/simulation. (BL-4)
3. Integrate the methodology and engineering tools adopted for solving the problem. (BL-6)
4. Analyze and discuss the results to draw valid conclusions. (BL-4)
5. Exhibit knowledge, skill, attitude and technical knowhow in preparing report as per format and presenting as a professional engineer. (BL-3)

**The assignment to normally include:**

1. In depth study of the topic assigned.
2. Review and finalization of the Approach to the Problem relating to the assigned topic.
3. Preparing an Action Plan for conducting the investigation, including teamwork.
4. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed.
5. Final development of product/process, testing, results, conclusions and future directions.
6. Preparing a paper for Conference presentation/ Publication in Journals, if possible.
7. Preparing a Dissertation in the standard format for being evaluated by the Department.
8. Final Seminar presentation before Departmental Committee.

**Guidelines for the award of marks in CIE:**

Evaluation by	Maximum Marks	Evaluation Criteria / Parameter
Department Review Committee	10	Review 1
	15	Review 2
	25	Submission
Supervisor	10	Regularity and Punctuality
	10	Work Progress
	10	Quality of the work which may lead to publications
	10	Report Preparation
	10	Analytical / Programming / Experimental Skills

  
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Guidelines for awarding marks in SEE:

Evaluation by	Maximum Marks	Evaluation Criteria / Parameter
External and Internal Examiners together	20	Power Point Presentation
	40	Thesis Evaluation
	20	Quality of the project <ul style="list-style-type: none"><li>• Innovations</li><li>• Applications</li><li>• Live research projects</li><li>• Scope for future study</li><li>• Application to society</li></ul>
	20	Viva-Voce

  
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**20ME C101****COMPUTER AIDED MODELING AND DESIGN**

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** To make the students

1. Understand the basics of computer aided design
2. Gain the knowledge on design process
3. Explain the uses of wireframe and surface entities
4. Learn and apply various geometric transformations
5. Understand various advanced modeling concepts

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

1. Understand the design process, visualize models through graphics standards and apply principles of computer graphics like geometric transformations, windowing and clipping
2. Recognize various wireframe entities and model them
3. Apply surface modelling techniques for generating various parts
4. Differentiate various solid modelling techniques
5. Understand various advanced modelling concepts like parametric and variational modelling , feature based design, interference detection

**UNIT - I**

**Introduction:** Criteria for selection of CAD workstations, Shigley's design process, Design criteria, Geometric modelling, 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

**UNIT – II**

**Modeling of Curves:** Curve representation, Analytic curves- Lines, and Circles, Ellipse, and Conics, Synthetic curves – Cubic, Bezier, B-Splines, and Non Uniform Rational B-Splines. Curve Manipulations,

**UNIT- III**

**Surface Modeling:** Surface representation, Analytic Surfaces: Plane Surface, Ruled Surface, Surface of Revolution, Tabulated Cylinder. Synthetic Surface: Cubic, Bezier, B-spline, Coons surface.

**UNIT - IV**

**Solid Modeling Techniques:** Boundary Representation (B-rep) & Constructive Solid Geometry (CSG), Graph Based Models, Boolean Models, Primitive Instancing, Cell Decomposition & Spatial Occupancy Enumeration

**UNIT - V**

**Advanced Modeling Concepts:** 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

**Text Books:**

1. Ibrahim Zeid, "CAD/CAM Theory and Practice", Mc Graw Hill, 1998.
2. Foley, Van Dam, Feiner and Hughes, "Computer Graphics Principles and Practice", 2/e., Addison Wesley, 2000.

**Suggested Reading:**

1. E. Michael, "Geometric Modelling", John Wiley & Sons, 1995.
2. Hill Jr, F.S., "Computer Graphics using open GL", Pearson Education, 2003.

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**20ME C102****COMPUTER INTEGRATED MANUFACTURING**

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** To make the students

1. To understand the role of computers in manufacturing
2. To provide an in-depth understanding of manufacturing and database systems
3. To provide an understanding of needs of the market and design the product
4. To design and develop material handling, storage and retrieval systems for specific cases of manufacturing
5. To develop CIM systems for current manufacturing scenario by using computer and networking tools.

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

1. Select the necessary computing tools for development of product
2. Use appropriate database systems for manufacturing a product and store the same for future use
3. Use modern manufacturing techniques and tools including principles of networking
4. Apply the concepts of lean manufacturing and agile manufacturing
5. Apply the latest technology of manufacturing systems and software for the development of a product.

**UNIT - I**

**Basic Concepts of CIM:** The meaning of Manufacturing, Types of Manufacturing; 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.

**UNIT - II**

**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, SQLAccess, Sybase, DB2. Product Data Management (PDM), Advantages of PDM.

**UNIT- III**

**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. FMSbenefits

**UNIT – IV**

**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 OSAModel, NIST-AMRF Model, Siemens Model of CIM, Digital Equipment Corporation Model, IBM Concept of CIM.

**UNIT - V**

**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.

**Text Books:**

1. S.Kant Vajpayee: "Principles of Computer Integrated Manufacturing", Prentice Hall India
2. Nanua Singh: "Systems Approach to Computer Integrated Design and Manufacturing", John Wiley

**Suggested Reading:**

1. P.Radhakrishnan, S.Subramanyam: "CAD/CAM/CIM", New Age International
2. Alavudeen, Venkateshwaran: "Computer Integrated Manufacturing", Prentice Hall India.

  
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20ME M103

**RESEARCH METHODOLOGY AND IPR**

Instruction	2 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** To make the students to

1. Motivate to choose research as career
2. Formulate the research problem, prepare the research design
3. Identify various sources for literature review and data collection report writing
4. Equip with good methods to analyze the collected data
5. Know about IPR copyrights

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

1. Define research problem, review and assess the quality of literature from various sources
2. Improve the style and format of writing a report for technical paper/ Journal report, understand and develop various research designs
3. Collect the data by various methods: observation, interview, questionnaires
4. Analyze problem by statistical techniques: ANOVA, F-test, Chi-square
5. Understand apply for patent and copyrights

**UNIT - I**

**Research Methodology:** 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

**UNIT - II**

**Literature Survey Report writing:** Literature Survey: Importance and purpose of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Information through Internet. 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

### UNIT- III

**Research Design:** 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.

### UNIT - IV

**Data Collection and Analysis:** Data Collection: Methods of data collection, importance of Parametric, non parametric test, testing of variance of two normal population, use of Chi-square, ANOVA, Ftest, z-test

### UNIT - V

**Patents and Copyright:** Patent: Macro economic impact of the patent system, Patent document, How to protect your inventions. Granting of patent, Rights of a patent, how extensive is patent protection. Copyright: What is copyright. What is covered by copyright. How long does copyright last? Why protect copyright? Related Rights: what are related rights? Enforcement of Intellectual Property Rights: Infringement of intellectual property rights, Case studies of patents and IP Protection

#### Text Books:

1. C.R Kothari, "Research Methodology, Methods & Technique"; New Age International Publishers, 2004
2. R. Ganesan, "Research Methodology for Engineers", MJ Publishers, 2011
3. Y.P. Agarwal, "Statistical Methods: Concepts, Application and Computation", Sterling Publs., Pvt., Ltd., New Delhi, 2004.

#### Suggested Reading:

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.

**ADVANCED MACHINE DESIGN**  
(Programme Elective – I)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** To make the students to understand the

1. Failure theories of engineering components
2. Fatigue life estimation by S-N approach
3. LEFM approach
4. Fatigue from variable amplitude loading
5. Surface failure

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

1. Predict failure of engineering components using failure theories
2. Identify and explain the types of fractures of engineered materials and their characteristic features
3. Understand LEFM approach
4. Estimate life of components using stress life and strain life
5. Categorize different types of surface failure

**UNIT - I**

**Introduction:** Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr's theory and modified Mohr's theory, Numerical examples. Fatigue of Materials: Introductory concepts, High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods, Fatigue design criteria, Fatigue testing, Test methods and standard test specimens, Fatigue fracture surfaces and macroscopic features, Fatigue mechanisms and microscopic features

**UNIT - II**

**Stress-Life (S-N) Approach:** S-N curves, Statistical nature of fatigue test data, General S-N behavior, Mean stress effects, Different factors influencing S-N behavior, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using S-N approach. Strain-Life( $\epsilon$ -N) approach: Monotonic stress-strain behavior, Strain controlled test methods, Cyclic stress-strain behavior, Strain based approach to life estimation, Determination of strain life

fatigue properties, Mean stress effects, Effect of surface finish, Life estimation by  $\sigma$ -N approach

### UNIT- III

**LEFM Approach:** LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects. Notches and their effects: Concentrations and gradients in stress and strain, S-N approach for notched membranes, mean stress effects and Haigh diagrams, Notch strain analysis and the strain – life approach. Neuber’s rule.

### UNIT - IV

**Fatigue from Variable Amplitude Loading:** Spectrum loads and cumulative damage, Damage quantification and the concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life estimation using stress life approach.

### UNIT-V

**Surface Failure:** Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue spherical contact, Cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength.

### Text Books:

1. Ralph I. Stephens, Ali Fatemi, Robert and Henry O. Fuchs, “Metal Fatigue in Engineering”, John Wiley NewYork, Second edition. 2001.
2. Jack. A. Collins, “Failure of Materials in Mechanical Design”, John Wiley, NewYork1992.
3. Robert L. Norton, “Machine Design”, Pearson Education India, 2000

### Suggested Reading:

1. S. Suresh, “Fatigue of Materials”, Cambridge University Press, 1998.
2. Julie. A. Benantine, “Fundamentals of Metal Fatigue Analysis”, Prentice Hall,1990.
3. “Fatigue and Fracture”, ASM Hand Book, Vol 19, 2002.

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20ME E102

**ADVANCED VIBRATIONS AND ACOUSTICS**

(Programme Elective – I)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** To make the students to understand the

1. 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. Evaluate damping in vibrating structure.
3. Develop the equations of motion for a continuous system in elongation, bending and torsion to find the natural frequencies and mode shapes.
4. Knowledge on fundamentals of acoustics, measuring techniques.
5. Knowledge on vibration and noise measuring instruments.

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

1. Predict response of a SDOF system, damped or undamped, subjected to simple harmonic excitations. They will be able to obtain Step Response Spectrum of SDOF systems for such excitations
2. Write differential equations of motion for MDOF systems, should be able to obtain the Eigen-values and mode shapes of natural vibrations and response to harmonic excitations, able to measure damping in the system using logarithmic decrement and half power method.
3. Obtain the frequency and mode shapes for string, rod and beam using continuous systems.
4. Understand basic concept of acoustics, source of models, and measuring of noise.
5. Understand vibration and noise measuring instruments.

**Unit 1**

**Review of Mechanical Vibrations:** Free and harmonically forced vibration of single degree of freedom systems with and without damping.

**Transient Vibration of Single Degree-of-Freedom Systems:** Impulse excitation, Arbitrary excitation: step excitation. Laplace transforms formulation. Convolution (Duhamel's) integral, impulse response function.

**Unit 2**

**Multi Degree of Freedom Systems:** Free and forced vibrations of two degree of freedom systems, Eigen values and Eigen vectors, normal modes and their

properties, mode summation method, use of Lagrange's equations to derive the equations of motion.

**Measurement of Damping Capacity and their Interpretation of Damping Coefficient:** damping factor, logarithmic decrement, and half power band width.

### Unit 3

**Continuous Systems:** Vibrating string, longitudinal vibration of rods, beams– Differential equation of motion, solution by the method of separation of variables, forced vibration of simply supported beam subjected to concentrated harmonic force at a point, Mode summation method.

### Unit 4

**Fundamentals of Acoustics:** The homogeneous acoustic wave equation-1-D,3-D,Fundamental acoustic source models: Monopoles, Dipoles, Monopoles near rigid, reflecting, ground plane, Sound radiation from a vibrating piston mounted in a rigid baffle, Noise measuring units: decibels, frequency analysis bandwidths, The measurement of sound power, sound pressure levels, sound intensity levels, frequency response function, Sound power models-constant power. Sound power evaluation methods,

### Unit 5

**Noise and Vibration Measuring Instruments:** Transducers: piezoelectric, electrodynamic. Vibration pickups: Vibrometer, accelerometer, velometer. Frequency measuring instruments, Vibration exciters: Mechanical exciter, Electrodynamic shaker and impact hammer. Microphones: Condenser, dynamic. Sound intensity probe, Sound level meter.

### Text Books:

1. W.T.Thomson, "Theory of Vibrations with applications", George Allen and Unwh Ltd. London, 1981.
2. S.S. Rao, Addison, "Mechanical Vibrations", Wesley Publishing Co., 1990.
3. Leonard Meirovitch, "Fundamentals of vibrations", McGraw Hill International Edition

### Suggested Reading:

1. S. Timoshenko, "Vibration problems in Engineering", Wiley, 1974.
2. Lawrence E. Kinsler and Austin R. Frey, "Fundamentals of acoustics", Wiley Eastern Ltd., 1987.
3. Michael Rettinger, "Acoustic Design and Noise Control", Vol. I & II. Chemical Publishing Co., New York, 1977.
4. M.P. Norton and D.G. Karczub., "Fundamentals of Noise and vibration analysis for engineers", Cambridge university press., 2/e, 2003.

## 20ME E103

**OPTIMIZATION TECHNIQUES**

(Programme Elective – I)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** The students will

1. Come to know the formulation of LPP models
2. Understand the Transportation and Assignment techniques
3. Come to know the procedure of Project Management along with CPM and PERT techniques
4. Understand the concepts of queuing theory and inventory models
5. Understand sequencing techniques and game theory

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

1. Formulate a linear programming problems (LPP)
2. Build and solve Transportation Models and Assignment Models.
3. Apply project management techniques like CPM and PERT to plan and execute project successfully
4. Apply queing and inventory concepts in industrial applications
5. Apply sequencing models and game theory in industries

**UNIT - I****Operations Research:** Definition, scope, Models, Linear programming problems, Formulation, Graphical Method, Simplex Method, and 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****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.

#### UNIT - IV

**Queuing Theory:** Kendols Notation, single server models, Inventory control - deterministic inventory models - Probabilistic inventory control models.

#### UNIT - V

**Sequencing Models:** Introduction, General assumptions, processing 'n' jobs through two Machines, processing 'n' jobs through three machines. Game Theory – definition saddle point Principle of Dominance.

#### Text Books:

1. H.A. Taha, "Operations Research, An Introduction", PHI, 2008
2. H.M. Wagner, "Principles of Operations Research", PHI, Delhi, 1982
3. J.C. Pant, "Introduction to Optimisation: Operations Research", Jain Brothers, Delhi, 2008

#### Suggested Reading:

1. Hitler Libermann, "Operations Research", McGraw Hill Pub. 2009
2. Pannerselvam, "Operations Research", Prentice Hall of India 2010
3. Harvey M Wagner, "Principles of Operations Research", Prentice Hall of India 2010

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**20ME E104**

**AUTOMATION**  
(Programme Elective – II)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** To make the students to understand

1. Basic concepts of automation & its significance in manufacturing industries.
2. Automated flowlines.
3. Conceptualize & design following assembly line balancing.
4. About automated material handling systems
5. Effective design and appropriate tests & inspection systems

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

1. Conceptualize and design automated flow lines.
2. Implement line balancing concepts in production and assembly lines
3. Understand and develop automated material handling systems suitable for plant operations.
4. Design, implement and use and appropriate automated inspection facility.
5. Design and develop an automated production system for manufacturing a product using futuristic technologies

**UNIT - I**

**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.

**UNIT - II**

**Analysis of Automated Flow Lines:** Automated Flow lines, Methods of Workpart Transport, Transfer Mechanism, Buffer Storage, Control Functions, Automation for Machining Operations, Design and Fabrication Considerations. General Terminology and Analysis, Analysis of Transfer Lines Without Storage, Partial Automation, Automated Flow Lines with Storage Buffers, Computer Simulation of Automated Flow Lines.

**UNIT- III**

**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.

**UNIT - IV**

**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.

**UNIT - V**

**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.

**Text Books:**

1. Mikell P. Grover, Automation, "Production Systems and Computer Integrated Manufacturing", Pearson Education Asia, 2012.
2. Nanua Singh, "Systems Approach to Computer-Integrated Design and Manufacturing", Wiley India Pvt Ltd, New York, 1995.

**Suggested Reading:**

1. C. Ray Asfahl, "Robots and Manufacturing Automation", John Wiley and Sons New York, 1995.
2. Stephen J. Derby, "Design of Automatic Machinery", Special Indian Edition, Marcel Decker, New York, Yesdee publishing Pvt. Ltd, Chennai, 1998
3. N. Viswanadham and Y. Narahari, "Performance Modeling of Automated Manufacturing Systems", Prentice Hall India Pvt. Ltd, 1980.

**DESIGN FOR MANUFACTURING AND ASSEMBLY**

(Programme Elective – II)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** To make the students to

1. Understand the need for design of a product
2. Understand the selection of material on the basis of manufacturing process
3. To familiarize various fabrication procedures
4. To reduce the manufacturing / process time
5. Make design according to ergonomics

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

1. Understand the product development cycle
2. Know the manufacturing issues that must be considered in the mechanical engineering design process
3. Know the effect of manufacturing process and assembly operations on the product
4. Know the principles of assembly to minimize the assembly time
5. Be familiar with tools and methods to facilitate development of manufacturing mechanical designs

**UNIT - I**

**Introduction:** Need Identification and Problem Definition, Concept Generation and Evaluation, Embodiment Design, Selection of Materials and Shapes

**UNIT - II**

**Properties of Engineering Materials:** Selection of Materials – I, Selection of Materials – II, Case Studies – I, Selection of Shapes, Co-selection of Materials and Shapes, Case Studies – II

**UNIT- III**

**Selection of Manufacturing Processes:** Review of Manufacturing Processes, Design for Casting, Design for Bulk Deformation Processes, Design for Sheet Metal Forming Processes, Design for Machining, Design for Powder Metallurgy.

Design for Polymer Processing, Co- selection of Materials and Processes, Case-Studies – III

#### UNIT - IV

**Design for Assembly:** Review of Assembly Processes, Design for Welding – I, Design for Welding – II, Design for Brazing and Soldering, Design for Adhesive Bonding, Design for Joining of Polymers, Design for Heat Treatment, Case-Studies -IV

#### UNIT - V

**Design for Reliability:** Failure Mode and Effect Analysis and Quality, Design for Quality, Design for Reliability, Approach to Robust Design, Design for Optimization

#### Text Books:

1. M F Ashby and K Johnson, “Materials and Design - The art and science of material selection in product design”, Butterworth-Heinemann, 03.
2. G Dieter, Engineering “Design - a materials and processing approach”, McGrawHill, NY,
3. M F Ashby, “Material Selection in Mechanical Design”, Butterworth-Heinemann, 1999.
4. K.G.Swift and J.D.Booker, “Process Selection from Design to Manufacture”, Wiley Publishers, New York, 1997.

#### Suggested Reading:

1. T H Courtney, “Mechanical Behavior of Materials”, McGraw Hill, NY, 00.
2. G Boothroyd, P Dewhurst and W Knight, “Product design for manufacture and assembly”, John Wiley, NY: Marcel Dekkar, 1994.
3. J G Bralla, “Handbook for Product Design for Manufacture”, McGraw Hill, NY, 1998.

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**20ME E106****INDUSTRIAL ROBOTICS**

(Programme Elective– II)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** Student will understand the

1. Principle of working of a robot , types and specifications
2. Transformations, various types of representations, kinematics of robots
3. Singularities, jacobian and trajectory planning of a robot to prepare the robot for various tasks
4. Design, working of sensors and controllers for finding position and orientation of various industrial robots
5. Robot vision for image acquisition and processing and plan for various tasks and programming

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

1. Principle of working of a robot , types and prepare specifications for various requirements.
2. Transformations, kinematics of robots to find out the position and orientation.
3. Singularities, avoiding singularities while designing, find jacobian and trajectory planning of a robot to prepare the robot for various tasks
4. dynamic analysis using various formulations and design the robots
5. Working of sensors and controllers for finding position and orientation, analyze robot vision for image acquisition and processing and plan for various tasks and programming.

**UNIT - I**

**Overview of Robot Subsystems:** 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 and requirements of different industrial robots.

**UNIT – II**

**Direct Kinematics:** 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

**UNIT- III**

**Inverse Kinematics:** 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

**UNIT - IV**

**Analysis of RP and RR Type Robots:** 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

**UNIT - V**

**Sensors and Controllers:** Internal and external sensors, position, velocity and acceleration sensors, proximity sensors, force sensors, laser rangefinder.

**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

**Text Books:**

1. Nagrath and Mittal, "Robotics and Control", Tata McGraw-Hill, 2003.
2. Spong and Vidhyasagar, "Robot Dynamics and Control", John Wiley and sons, 2008.

**Suggested Reading:**

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 Algorithms", 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 Implementations", Prentice Hall of India, 2005.

**20ME C104****INTEGRATED DESIGN AND MANUFACTURING LAB**

Instruction	4 Hours per week
Duration of SEE	---
SEE	---
CIE	50 Marks
Credits	2

**Objectives:** To make the students to

1. Generate the part and assembly models using cad software
2. Create automated drawing and apply proper annotations on them.
3. Write different part programs for different components to be machined on lathe and milling machine
4. Understand the reverse engineering concept
5. Understand the stl file generation and manipulations

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

1. Generate complex components in the part module and assemble them by using suitable constraints.
2. Generate engineering drawing and apply size, form and positional tolerances on the drawing
3. Write part programs using G and M codes for lathe and milling operations for various components.
4. Differentiate additive and subtractive methods of manufacturing and their integration to build the component
5. Gain confidence to operate the 3d printing machine.

**List of Experiments:**

1. Part modeling of simple and complex components by using various features of the software
2. Assembly modeling of components using different constraints
3. Creation of Engineering drawing details and adding various annotations and generation of automated BOM.
4. Specifying tolerances for part and assembly Drawings
5. Writing of CNC programming for creation of Contours and Pockets
6. Surface Roughing of Crane Hook
7. Manufacturing of Bottle Die
8. Taper Turning and Multiple Turning on CNC Lathe Machine.
9. Introduction to RP machine, Machine Specifications, Materials, Stl file generation



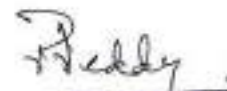
CBIT (A) AICTE Model Curriculum with effect from the AY 2020 – 2021

10. Slicing of stl files and obtaining the tool path data and sending it to RP machines
11. Demonstration of rapid tooling using fused deposition modeling.
12. Conversion of physical model to digital data format to demonstrate Reverse Engineering

**Note:** Out of the above 12 experiments, any 10 experiments have to be carried out.

**Suggested Reading :**

1. Solidworks Essentials, “Solidworks” By Dassault Systems



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## 20ME C105

## VIBRATION AND ACOUSTICS LAB

Instruction	4 Hours per week
Duration of SEE	---
SEE	---
CIE	50 Marks
Credits	2

**Objectives:** To make the students to

1. Determine mass moment of inertia from vibrating systems.
2. Evaluate damping in vibrating structure.
3. Evaluate natural frequencies and mode shapes for continuous system.
4. Gain the knowledge on using impact hammer.
5. Gain knowledge on fundamentals of acoustics, measuring techniques.

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

1. Predict response of a SDOF system, damped or undamped, subjected to simple harmonic excitations. They will be able to obtain Step Response Spectrum of SDOF systems for such excitations
2. Measure damping in the system using logarithmic decrement and half power method.
3. Obtain the frequency and mode shapes for beam using continuous systems.
4. Understand basic concept of acoustics, source of models, and measuring of noise.
5. Understand vibration and noise measuring instruments.

**List of Experiments:**

1. To find damping coefficient and undamped natural frequencies of an under-damped single degree of freedom system from its response to an initial displacement.
2. SDOF system to harmonic excitation applied to the mass for different values of damping factor.
3. To find fundamental natural frequency of a cantilever beam by free vibration and find the damping by logarithmic decrement, plot number of cycles Vs damping.
4. To find FRF and damping for cantilever beam, giving impact test.
5. The response of a cantilever beam by sinusoidal excitation. Plotting FRF curve and phase plot.
6. Determining the oscillation frequency of a string as a function of the string length and tension

7. **Determining the wavelength of standing sound waves**
8. Demonstration on stroboscope for natural frequencies of beam.
9. Sloshing due to vibration of partially filled liquid cylinder.
10. Measure the sound pressure (in Pa) and sound pressure level (in dB) as a function of distance from a simple source consisting of a smallboxed loudspeaker producing white noise.
11. **Directivity patterns.**

**Text Books:**

1. Yvan, “Mechanical Vibrations, Applications to Equipment”, Willey Publications, 2017.
2. H. Ginsberg. Jerry, “Acoustics, A Text Book for Engineers and Physicists”, Springer International Publishers, 2014.

**Suggested Reading:**

1. G.K.Grover, “Mechanical Vibrations”, Nem Chad and Brothers, 1996.
2. Finch, “Introduction to Acoustics”, Pearson Education India; 1/e,, 2016

  
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## 20EC A101

## VALUE EDUCATION

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	_____
Credits	0

**Objectives:** This course aims to:

1. Understand the need and importance of Values for self-development and for National development.
2. Imbibe good human values and Morals
3. Cultivate individual and National character.

**Outcomes:** After completion of the Course, students will be able to:

1. Gain necessary Knowledge for self-development
2. Learn the importance of Human values and their application in day to day professional life.
3. Appreciate the need and importance of interpersonal skills for successful career and social life
4. Emphasize the role of personal and social responsibility of an individual for all-round growth.
5. Develop a perspective based on spiritual outlook and respect women, other religious practices, equality, non-violence and universal brotherhood.

**UNIT-I**

**Human Values, Ethics and Morals:** Concept of Values, Indian concept of humanism, human values; Values for self-development, Social values, individual attitudes; Work ethics, moral and non-moral behaviour, standards and principles based on religion, culture and tradition.

**UNIT-II**

**Value Cultivation, and Self-management:** Need and Importance of cultivation of values such as Sense-of Duty, Devotion to work, Self-reliance, Confidence, Concentration, Integrity & discipline, and Truthfulness.

**UNIT-III**

**Spiritual outlook and social values:** Personality and Behavior, Scientific attitude and Spiritual (soul) outlook; Cultivation of Social Values Such as Positive

Thinking, Punctuality, Love & Kindness, Avoiding fault finding in others, Reduction of anger, forgiveness, Dignity of labour, True friendship, Universal brotherhood and religious tolerance.

#### UNIT-IV

**Values in Holy Books :** Self-management and Good health; internal & external cleanliness, Holy books versus Blind faith, Character and Competence, Equality, Nonviolence, Humility, Role of Women.

#### UNIT-V


**Dharma, Karma and Guna:** Concept of soul; Science of Reincarnation, Character and Conduct, Concept of Dharma; Cause and Effect based Karma Theory; The qualities of Devine and Devilish; Satwic, Rajasic and Tamasic gunas.

#### Text Books:

1. Chakroborty, S.K. “Values & Ethics for organizations Theory and practice”, Oxford University Press, New Delhi, 1998.

#### Suggested Reading:

1. Jaya Dayal Goyandaka, “Srimad Bhagavad Gita with SanskritText, Word Meaning and Prose Meaning”, Gita Press, Gorakhpur, 2017.

  
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## 20IT A101

**PEDAGOGY STUDIES**

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	_____
Credits	0

**Course Objectives:**

1. To present the basic concepts of design and policies of pedagogy studies.
2. To provide understanding of the abilities and dispositions with regard to teaching techniques, curriculum design and assessment practices.
3. To familiarize various theories of learning and their connection to teaching practice.
4. To create awareness about the practices followed by DFID, other agencies and other researchers.
5. To provide understanding of critical evidence gaps that guides the professional development.

**Course Outcomes:** Upon completing this course, students will be able to:

1. Illustrate the pedagogical practices followed by teachers in developing countries both in formal and informal classrooms.
2. Examine the effectiveness of pedagogical practices.
3. Understand the concept, characteristics and types of educational research and perspectives of research.
4. Describe the role of classroom practices, curriculum and barriers to learning.
5. Understand Research gaps and learn the future directions.

**UNIT-I**

**Introduction and Methodology:** Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions - Overview of methodology and Searching.

**UNIT-II**

**Thematic Overview:** Pedagogical practices followed by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

**UNIT-III**

**Evidence on the Effectiveness of Pedagogical Practices: Methodology for the in depth stage:** quality assessment of included studies - How can teacher education (curriculum and Practicum) and the school curriculum and guidance material best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and pedagogic strategies.

**UNIT-IV**

**Professional Development:** alignment with classroom practices and follow up support - Support from the head teacher and the community – Curriculum and assessment - Barriers to learning: Limited resources and large class sizes.

**UNIT-V**

**Research Gaps and Future Directions:** Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment – Dissemination and research impact.

**Text Books:**

1. Ackers J, Hardman F, "Classroom Interaction in Kenyan Primary Schools, Compare", 31 (2): 245 – 261, 2001.
2. Agarwal M, "Curricular Reform in Schools: The importance of evaluation", Journal of Curriculum Studies, 36 (3): 361 – 379, 2004.

**Suggested Reading:**

1. Akyeamong K, "Teacher Training in Ghana – does it count? Multisite teacher education research project (MUSTER)", Country Report 1. London: DFID, 2003.
2. Akyeamong K, Lussier K, Pryor J, Westbrook J, "Improving teaching and learning of Basic Maths and Reading in Africa: Does teacher Preparation count?", International Journal Educational Development, 33(3):272-282, 2013.
3. Alexander R J, "Culture and Pedagogy: International Comparisons in Primary Education", Oxford and Boston: Blackwell, 2001.
- 4 . Chavan M, "Read India: A mass scale, rapid, 'learning to read' campaign", 2003.

**Web Resources:**

1. [https://onlinecourses.nptel.ac.in/noc17\\_ge03/preview](https://onlinecourses.nptel.ac.in/noc17_ge03/preview)
2. [www.pratham.org/images/resources%20working%20paper%202.pdf](http://www.pratham.org/images/resources%20working%20paper%202.pdf).

**20CE A101****DISASTER MITIGATION AND MANAGEMENT**

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	_____
Credits	0

**Objectives:**

1. To equip the students with the basic knowledge of hazards, disasters, risks and vulnerabilities including natural, climatic and human induced factors and associated impacts
2. To impart knowledge in students about the nature, causes, consequences and mitigation measures of the various natural disasters
3. To enable the students to understand risks, vulnerabilities and human errors associated with human induced disasters
4. To enable the students to understand and assimilate the impacts of any disaster on the affected area depending on its position/ location, environmental conditions, demographic, etc.
5. To equip the students with the knowledge of the chronological phases in a disaster management cycle and to create awareness about the disaster management framework and legislations in the context of national and global conventions

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

1. Analyze and critically examine existing programs in disaster management regarding vulnerability, risk and capacity at different levels
2. Understand and choose the appropriate activities and tools and set up priorities to build a coherent and adapted disaster management plan
3. Understand various mechanisms and consequences of human induced disasters for the participatory role of engineers in disaster management
4. Understand the impact on various elements affected by the disaster and to suggest and apply appropriate measures for the same
5. Develop an awareness of the chronological phases of disaster preparedness, response and relief operations for formulating effective disaster management plans and ability to understand various participatory approaches/strategies and their application in disaster management



**UNIT- I:**

**Introduction:** Basic definitions- Hazard, Disaster, Vulnerability, Risk, Resilience, Mitigation, Management; classification of types of disaster- Natural and man-made; International Decade for natural disaster reduction (IDNDR); International strategy for disaster reduction (ISDR), National disaster management authority (NDMA).

**UNIT-II:**

**Natural Disasters:** Hydro meteorological disasters: Causes, Early warning systems- monitoring and management, structural and non-structural measures for floods, drought and Tropical cyclones; Geographical based disasters: Tsunami generation, causes, zoning, Early warning systems- monitoring and management, structural and non-structural mitigation measures for earthquakes, tsunami, landslides, avalanches and forest fires. Case studies related to various hydro meteorological and geographical based disasters.

**UNIT-III:**

**Human induced hazards:** Chemical disaster- Causes, impacts and mitigation measures for chemical accidents, Risks and control measures in a chemical industry, chemical disaster management; 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; Casestudies related to major power break downs, fire accidents, traffic accidents, oil spills and stampedes, disasters due to double cellar construction in multi-storeyed buildings.

**UNIT- IV:**

**Disaster Impacts:** Disasterimpacts- environmental, physical, social, ecological, economical, political, etc.; health, psycho-social issues; demographic aspects- gender, age, special needs; hazard locations; global and national disaster trends; climate change and urban disasters.

**UNIT- V:**

**Concept of Disaster Management:** Disaster management cycle – its phases; prevention, mitigation, preparedness, relief and recovery; risk analysis, vulnerability and capacity assessment; Post-disaster environmental response- water, sanitation, food safety, waste management, disease control; Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National Disaster Management Authority.

**Text Books:**

1. Pradeep Sahni, "Disaster Risk Reduction in South Asia", Prentice Hall, 2003.
2. B. K. Singh, "Handbook of Disaster Management: techniques & Guidelines", Rajat Publication, 2008.

**Suggested Reading:**

1. Ministry of Home Affairs, "Government of India, "National disaster management plan, Part I and II"
2. K. K. Ghosh, "Disaster Management", APH Publishing Corporation, 2006.
3. "Hazards, Disasters and your community: A booklet for students and the community", Ministry of home affairs.

**Online Resources:**

1. [http://www.indiaenvironmentportal.org.in/files/file/disaster\\_management\\_india.pdf](http://www.indiaenvironmentportal.org.in/files/file/disaster_management_india.pdf)
2. <http://www.ndmindia.nic.in/>(National Disaster management in India, Ministry of Home Affairs)

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**20EE A101****SANSKRIT FOR TECHNICAL KNOWLEDGE**

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	_____
Credits	0

**Objectives:**

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. To make the novice Learn the Sanskrit to develop the logic in mathematics, science & other subjects
3. To explore the huge knowledge from ancient Indian literature

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

1. Develop passion towards Sanskrit language
2. Decipher the latent engineering principles from Sanskrit literature
3. Correlates the technological concepts with the ancient Sanskrit history.
4. Develop knowledge for the technological progress
5. Explore the avenue for research in engineering with aid of Sanskrit

**UNIT-I**

**Introduction to Sanskrit Language:** Sanskrit Alphabets-vowels-consonants-significance of Amarakosa-parts of speech-Morphology-creation of new words-significance of synonyms-sandhi-samasa-sutras-active and passive voice-Past/Present/Future Tense-syntax-Simple Sentences (elementary treatment only)

**UNIT-II**

**Role of Sanskrit in Basic Sciences:** Brahmagupthas lemmas (second degree indeterminate equations), sum of squares of n-terms of AP- sulba\_sutram or baudhayana theorem (origination of pythagorous theorem)-value of pie-Madhava's sine and cosine theory (origination of Taylor's series).

**The measurements system-time-mass-length-temp, Matter elasticity-optics-speed of light (origination of michealson and morley theory).**

**UNIT-III**

**Role of Sanskrit in Engineering-I (Civil, Mechanical, Electrical and Electronics Engineering):**

Building construction-soil testing-mortar-town planning-Machine definition-

crucible-furnace-air blower- Generation of electricity in a cell-magnetism-Solar system-Sun: The source of energy, the earth-Pingala chandasutram (origination of digital logic system)

#### UNIT-IV

**Role of Sanskrit in Engineering-II (Computer Science Engineering & Information Technology):** Computer languages and the Sanskrit languages-computer command words and the vedic command words-analogy of pramana in memamsa with operators in computer language-sanskrit analogy of physical sequence and logical sequence, programming.

#### UNIT-V

**Role of Sanskrit in Engineering-III (Bio-technology and Chemical Engineering):** Classification of plants-plants, the living-plants have senses-classification of living creatures, Chemical laboratory location and layout-equipment-distillation vessel-kosthi yanthram

#### Text Books:

1. M Krishnamachariar, "History of Classical Sanskrit Literature", TTD Press, 1937.
2. M.R. Kale, "A Higher Sanskrit Grammar: For the Use of School and College Students", Motilal Banarsidass Publishers, ISBN-13: 978-8120801783, 2015

#### Suggested Reading:

1. Kapail Kapoor, "Language, Linguistics and Literature: The Indian Perspective", ISBN-10: 8171880649, 1994.
2. "Pride of India", Samskrita Bharati Publisher, ISBN: 81-87276-27-4, 2007.
3. Shri RamaVerma, "Vedas the source of ultimate science", Nag publishers, ISBN:81-7081-618-1,2005.

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## 20ME C106

## FINITE ELEMENT TECHNIQUES

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** To make the students to

1. Understand finite element analysis fundamentals and formulations
2. Formulate the axial, truss, beam and 2D problems
3. Formulate the heat conduction and dynamics problems, understand the use of numerical integration and Gauss quadrature
4. Understand the convergence requirements and 3D problems
5. Perform engineering simulations using finite element analysis software (ANSYS)

**Outcomes:** At the end of the course, 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, truss and beam, torsional analysis of circular shaft
3. Analyze 2D structural problems using CST element and analyze the axi-symmetric problems with triangular elements. Write shape functions for 4 node quadrilateral, isoparametric elements and apply numerical integration and Gaussian quadrature to solve the problems.
4. Evaluate the eigen values and eigen vectors for stepped bar, formulate 3 D elements, check for convergence requirements
5. Solve linear 1 D and 2 D heat conduction and convection heat transfer problems, Use of FE software ANSYS for engineering solutions

### UNIT - I

**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.

### UNIT - II

**Analysis of Trusses:** 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:** Analysis of frames with two translations and a rotational degree of freedom at each node.

### UNIT- III

**Two Dimensional Stress Analysis:** Finite element modeling of two dimensional stress analysis problems with constant strain triangles and treatment of boundary conditions. Two dimensional four noded isoparametric elements and numerical integration. Finite element modeling of Axisymmetric solids subjected of axisymmetric loading with triangular elements.

Convergence requirements and geometric isotropy

### UNIT - IV

**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.

### UNIT - V

**Three Dimensional Problems in Stress Analysis:** 3D elements: Introduction to tetrahedron and brick elements.

Introduction to thin and thick plates

Introduction to non-linear formulation through FE.

### Text Books:

1. R. Tirupathi, Chandrupatla and A.D Ashok, "Introduction of Finite Element in Engineering", Prentice Hall of India, 2004
2. S.S. Rao, "The Finite Element Methods in Engineering", 2/e Pergamon Press, 2001.
3. David.V.Hutton, "Fundamentals of Finite Element Analysis", Tata McGrawHill, 2003

### Suggested Reading:

1. Robert Cook, "Concepts and applications of finite element analysis", 4/e, John Wiley and sons, 2009
2. K.J Bathe, "Finite element procedures", 2/e, Prentice Hall of India, 2007
3. D.L. Logan, "First course in finite element method", (5/e). Mason, OH: SouthWestern, Cengage Learning, 2011.

**20ME C107**

**MECHANICAL DESIGN AND ANALYSIS**

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** To make the students to

1. Develop the necessary skills to understand and analyze problems in pressure vessels
2. Achieve fundamental understanding of the theory of bending of flat plates with various loading and boundary conditions
3. Understand design principles of a component and structures using fracture mechanics approaches
4. Enable the importance of vibrations in mechanical design to understand the basic concepts of matrix algebra and understand the different mode extraction methods in vibrations
5. Understand the fundamental concepts various algorithms used for dynamic analysis

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

1. 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. Design a system or a component to meet the desired needs of fracture mechanics
4. Understand, solve various Eigen value and Eigen vectors and will understand different mode extraction methods to calculate frequencies
5. Understand methods in solving single degree freedom dynamic analysis problems

**UNIT - I**

**Design of Pressure Vessels:** Introduction and selection of materials for pressure vessels, stresses in thick walled cylindrical pressure vessels subjected to both internal and external pressures, shrink fit stresses in built up cylinders, autofrettage of thick cylinders, thermal stresses and their significance.

**UNIT - II**

**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**

**UNIT- III**

**Fracture Mechanics:** Introduction, **Modes of fracture failure Griffith Analysis, Energy release rate, Stress Intensity Factor: SIF's for edge and centre line crack, Fracture toughness**, Elasticplasticanalysis through J-integralmethod: Relevance and scope, Definition of J-integral, Path independence, Strain Energy Release Rate VsJ-integral

**UNIT - IV**

**Eigen Value Problems:** Properties of Eigen values and Eigen Vectors, Torsional, Longitudinal vibration, lateral vibration, Sturm sequence method. Subspace iteration and Lanczo's method, Component mode synthesis

**UNIT - V**

**Dynamic Analysis:** **Direct integration method, Central difference method, Wilson-q method, Newmark method, Mode superposition, Single degree of freedom system response, Rayleigh damping.** (Note: The related algorithms and codes to be practiced by students)

**Text Books:**

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, NewDelhi-1999.
3. David.V.Hutton, "Fundamentals of Finite Element Analysis", Tata McGrawHill, 2003.

**Suggested Reading:**

1. G.Ramamurti, "Computer Aided Mechanical Design and Analysis", Tata Mc Graw Hill-1992.
2. J. Bathe, "Finite Element Procedures", Prentice Hall of India-1996.

  
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## 20ME E206

**COMPUTATIONAL FLUID DYNAMICS**

(Programme Elective – III)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** To make the students to learn the

1. Basic equations and concept of CFD
2. Concept of pdes and finite difference methods
3. Various types of grid generation and errors in numerical solution
4. Crank-Nicolson, Implicit and Explicit methods & Jacobi, Gauss Seidel and ADI methods
5. Importance of FVM

**Outcomes:** At the end of the course, student 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-Nicolson, Implicit and Explicit methods and analyze problem by Jacobi, Gauss Seidel and ADI methods
5. Solve conduction and convection problems using FVM.

**UNIT - I**

**Governing Equations:** Continuity, Momentum and Energy equations, Navier Stokes equations, Reynolds and Favre averaged N – S equations. Introduction to turbulence, Turbulence models-mixing length model, K- $\epsilon$  turbulence Model.

**UNIT - II**

**Grid Generation:** Grid Generation- Types of grid O,H,C. Coordinate transformation, Unstructured grid generation, **Errors, Consistency, Stability analysis by von Neumann. Convergence criteria**

**UNIT- III**

**Classification of PDEs:** Elliptic, parabolic and hyperbolic equations, Initial and boundary conditions. Concepts of Finite difference methods – forward, backward and central difference

**UNIT - IV**

**Finite Difference Solutions:** Finite difference solutions - Crank Nicholson, Implicit and Explicit, ADI - Jacobi, Gauss Seidel, solution for Viscous incompressible flow using Stream function – Vorticity method

**UNIT - V**

**Finite Volume Method:** 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

**Text Books:**

1. John D Anderson, "Computational Fluid Dynamics", Mc Graw Hill, Inc., 2015.
2. H.K.Versteeg and Malala Shekara, "Introduction to Finite Volume Method", Pearson, 2015

**Suggested Reading:**

1. K. Muralidhar and T. Sundararajan, "Computational Fluid flow and Heat transfer", Narosa Publishing House, 2003.
2. S.V.Patankar, "Numerical Heat transfer and Fluid flow", Hemisphere Publishing Company, New York, 1980.

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## 20ME E107

**MECHANICS OF COMPOSITE MATERIALS**

(Programme Elective – III)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** To make the students to learn the

1. Basics of composite materials, types of fibers and reinforcements.
2. Evaluation of material properties using micro-mechanics approach and semi-empirical relations..
3. Analysis of laminates using classical laminate plate theory.
4. Failure analysis of an orthotropic lamina.
5. Analysis of composite beams and plates for simple cases.

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

1. Understand different types of composites and their fabrication methods.
2. Characterize a UD lamina using micromechanics.
3. Analyze a given laminate for strains and stress.
4. Decide the failure of a UD lamina.
5. Design simple composite beams and plates.

**UNIT - I**

**Introduction:** Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

**UNIT - II**

**Micromechanics of lamina and mechanical properties:** Prediction of elastic constants, thermal properties, moisture properties using mechanics of materials approach. Halpin-Tsai equations for elastic constants. Mechanics of load transfer from matrix to fiber.

**UNIT- III**

**Macro-mechanical Analysis:** Introduction, Hooke's law for different types of materials, Hooke's law for 2D UD lamina, relationship between compliance and

stiffness matrix to engineering elastic constants of a lamina, engineering constants of an angle lamina. **Laminate code, stress-strain relationships for a laminate using CLT, force and moment resultants related to mid-plane strains and curvatures.**

#### UNIT - IV

**Strength and fracture:** Tensile and compressive strength's of unidirectional fiber composites, fracture modes in composites: single and multiple fractures, de-bonding, fiber pullout and de-lamination. Interlaminar stresses and edge effects.

Strength of an orthotropic lamina: Lamina Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first ply failure-insight strength;

#### UNIT - V

**Composite Beams:** comparison of CLT to Isotropic beam theory, effective axial and flexural rigidities of rectangular composite beams.

**Governing equations of thin -plate theory: equations of equilibrium for symmetric laminates and specially orthotropic laminate. Levy -Navier solution applied to specially orthotropic laminates.**

#### Text Books:

1. R.M. Jones, "Mechanics of Composite Materials", Mc Graw Hill Co., 1967
2. B.D. Agarwal et.al, "Analysis and performance of fiber composites", 3/e, Wiley sons., 2013
3. P.K. Mallick, "Fiber Reinforced Composites Materials",
4. Taylor & Francis, "Manufacturing, and Design", 3/e, 2007

#### Suggested Reading:

1. Ever J Barbero, "Introduction to composite materials design", Taylor & Francis, 1999.
2. M.W. Hyer, "Stress Analysis of Fibre Reinforced Composite Materials", McGraw Hill Co., 1998.
3. Carl. T. Herakovich, "Mechanics of Fibrous Composites", John Wiley Sons Inc, New York, 1998.

  
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## 20ME E108

**FRACTURE MECHANICS**  
(Programme Elective – III)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** To make the students to learn the

1. Classification of fracture
2. Importance of crack tip
3. Experimental setup while performing standard test
4. About R curve
5. Fatigue crack propagation.

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

1. Analyze the fracture mechanism
2. Gain familiarity with the different modes of failure under the presence of crack
3. Establish specimen size in accordance with the standard procedures
4. Distinguish between Plane stress fracture toughness and Plane strain fracture toughness
5. Accomplish the relationship between crack propagation and stress intensity factor

**UNIT - I**

**Introduction:** Crack in a structure – Griffith criterion

**Mechanism of Fracture and Crack Growth:** cleavage fracture – ductile fracture – fatigue cracking – service failure analysis

**UNIT - II**

**Elastic Crack Tip Stress Field:** Solution to crack problems – effect of finite size – stress intensity factor – special cases

**Crack Tip Plastic Zone:** Irwin plastic zone correction – actual shape of plastic zone

**UNIT- III**

**Energy Principle:** Energy release rate – criterion for crack growth – J integral

**Plane Strain Fracture Toughness:** Standard test – size requirement – nonlinearity

**UNIT - IV**

**Plane Stress and Transitional Behavior:** concept of plane stress – R curve concept – thickness effect – plane stress testing

**Elastic Plastic Fracture:** crack tip opening displacement.

**UNIT - V**


**Fatigue Crack Propagation:** Crack growth and stress intensity factor – factors affecting crack propagation – variable amplitude service loading and its numerical – retardation model

**Text Books:**

1. David Broek, "Elementary Engineering Fracture Mechanics, Kluwer Academic Publishers, The Hague – 1984.
2. Prashant Kumar., "Elements of fracture mechanics", Mc Graw Hill Education (India) Private Limited, New Delhi - 2014.

**Suggested Reading:**

1. T.L. Anderson, "Fracture Mechanics - Fundamentals and Applications", 3/e, Taylor and Francis Group, 2005.
2. R.N.L.Smith, "Basic Fracture Mechanics", Butterworth Heinemann Publications, 1991.
3. K. Ramesh, "e-Book on Engineering Fracture Mechanics", IIT Madras, 2007. URL: [http://apm.iitm.ac.in/smlab/kramesh/book\\_4.htm](http://apm.iitm.ac.in/smlab/kramesh/book_4.htm)
4. K. R. Y. Simha, "Fracture Mechanics for Modern Engineering Design", Universities Press (India) Limited, 2001

  
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**20ME E109**

**MULTI BODY DYNAMICS**  
(Programme Elective – IV)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** To make the students to learn the

1. Equations of motions in 3D for a multibody systems
2. Implementation and demonstration methods for formulation of motion equations in interconnected bodies
3. Constrained differential equations
4. Static and dynamic analysis in a multibody systems
5. Modeling and simulation of multibody dynamic systems

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

1. Derive equations of motion for interconnected bodies in multi-body systems with three dimensional motions.
2. Implement and analyze methods of formulating equations of motion for interconnected bodies.
3. Write programs to solve constrained differential equations for analyzing multi-body systems.
4. Simulate and analyze all types of static and dynamic behaviors of the multi-body systems including the kineto-static analysis.
5. Lead team projects in academic research or the industry that require modeling and simulation of multi-body systems

**UNIT - I**

**Introduction:** The method of constraints for planar kinematic analysis. Revolute, prismatic, gear and cam pairs are considered together with other 2 degrees-of-freedom types of constraints.

**UNIT - II**

**Basic Principles for Analysis of Multi-body Systems:** The automatic assembly of the systems of equations for position, velocity and acceleration analysis. Iterative solution of systems of non linear equations. Geometry of masses. The principle of virtual work and Lagrange's equations

**UNIT- III**

**Dynamics Of Planar Systems:** Dynamics of planar systems. Systematic computation and assembly of mass matrix. Computation of planar generalized forces for external forces and for actuator-spring-damper element. Simple applications of inverse and forward dynamic analysis. Numerical integration of first-order initial value problems. The method of Baumgarte for the solution of mixed differential-algebraic equations of motion. The use of coordinates partitioning, QR and SVD decomposition for the orthogonalization of constraints.

**UNIT - IV**

**Kinematics of Rigid Bodies in Space:** Reference frames for the location of a body in space. Euler angles and Euler parameters. The formula of Rodrigues. Screw motion in space. Velocity, acceleration and angular velocity. Relationship between the angular velocity vector and the time derivatives of Euler parameters.

**UNIT - V**


**Kinematic Analysis of Spatial Systems:** Basic kinematic constraints. Joint definition frames. The constraints required for the description in space of common kinematic pairs (revolute, prismatic, cylindrical, spherical). Equations of motion of constrained spatial systems.

**Text Books:**

1. J. Wittenburg, J., "Dynamics of Systems of Rigid Bodies", B.G. Teubner, Stuttgart, 1977.
2. T.R. Kane and D.A. Levinson, "Dynamics: Theory and Applications", McGraw-Hill Book Co., 1985.
3. P.E. Nikravesh, "Computer Aided Analysis of Mechanical Systems", Prentice-Hall Inc., Englewood Cliffs, J, 1988.
4. R.E. Roberson, and R. Schwertassek, "Dynamics of Multibody Systems", Springer-Verlag, Berlin, 1988.

**Suggested Reading:**

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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**20ME E110****TRIBOLOGY IN DESIGN**  
(Programme Elective – IV)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** To make the students to learn the

1. Material properties which influence the tribological characteristics of surfaces
2. Concepts of wear
3. Lubrication aspects of machine components.
4. Analytical behavior of different types bearings
5. Design of bearings based on analytical /theoretical approach.

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

1. Understand surface topography and 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. Select material/surface properties based on the tribological requirements

**UNIT - I**

**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:** 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.

**UNIT- III**

**Lubricants and Properties:** 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.**

**UNIT - IV**

**Reynolds and Sommerfield boundary conditions:** Reynolds Equation - Assumptions and limitations-One and two dimensional Reynolds Equation-Reynolds and Sommerfield 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

**UNIT-V**

**Rolling Contact Bearings:** 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.

**Text Books:**

1. E. Rabinowicz. "Friction and Wear of materials", John Willey & Sons, UK, 1995
2. A. Cameron, "Basic Lubrication Theory", Ellis Herward Ltd., UK, 1981
3. J. Halling, "Principles of Tribology" , Mac Millan – 1984.

**Suggested Reading:**

1. Kenneth C Ludema and Layo Ajay, "Friction, wear , lubrication", A text book in Tribology, 2e, CRC Press, Taylor and Francis Group, 2019
2. Ross Beckett, "Engineering Tribology", Larsen and Keller Education, 2017.
3. Stachon Iak, Andrew W Batchelor, "Engineering Tribology", 4e, Butterworth – Heinemann, 2015.

**20ME E111****FAILURE ANALYSIS AND DESIGN**

(Programme Elective –IV)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** To make the students to learn

1. Design methodology and various aspects involved in design process
2. Creative and inventive problem solving techniques
3. Different types of design processes, concepts of reliable and robust design
4. Concept of buckling of cylinders under various loading conditions
5. Fundamentals of fracture, fracture types and concepts of fatigue crack growth, fatigue life prediction and various stress theories of failure, crack propagation concepts under combined loading, fracture toughness of weld metals.

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

1. Apply the concepts of design processes
2. Provide solutions by inventive problem solving techniques
3. Develop reliable and robust design
4. Analyze the behavior of buckling of cylinders under various loading conditions
5. Predict the fracture behavior under static and fatigue loads , apply the crack propagation concepts , fracture toughness of weld metals

**UNIT - I**

**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.

**UNIT - II**

**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.

### UNIT- III

**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.

### UNIT - IV

**Theories of Failure:** 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

### UNIT - V

**Fracture Mechanics:** 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

#### Text Books:

1. Dieter and E. George, "Engineering Design - A Materials and Processing Approach", McGraw Hill, International Editions, Singapore, 2000.
2. David Broek, "Elementary Engineering Fracture Mechanics", Fiftthoff and Noerdhoff International Publisher, 1978.
3. John F. Harvey, "Theory and Design of Pressure Vessels", CBS Publishers and Distributors, 1987.

#### Suggested Reading:

1. G. Pahl and W. Beitz, "Engineering Design", Springer –Verlag, NY. 1984.
2. Prashant Kumar, "Elements of Fracture Mechanics", Wheeler Publishing, 1999.
3. Henry H. Bedner, "Pressure Vessels, Design Hand Book", CBS publishers and Distributors, 1987.

  
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## 20ME C108

**COMPUTER AIDED ENGINEERING LAB**

Instruction	4 Hours per week
Duration of SEE	---
SEE	---
CIE	50 Marks
Credits	2

**Objectives:** To make the students

1. Model one and two-dimensional elements in ANSYS
2. Understand vibration, harmonic and transient analysis
3. Carry out buckling analysis
4. Analyze forming and sheet metal operations by FEA
5. Model crackelement

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

1. Understand the applications of one and two-dimensional elements
2. Solve engineering problems
3. Find buckling factors
4. Understand industrial applications of forming and sheet metal operations
5. Find fracture toughness

**List of Exercises:**

1. Introduction to Finite Element Analysis Software
2. Statically indeterminate reaction force analysis and determination of Beam stresses and Deflection
3. Static analysis of a corner bracket
4. Analysis of cylindrical shell under pressure
5. Bending of a circular plate using axisymmetric shell element.
6. Vibration analysis of a simply supported beam
7. Harmonic analysis of plates and shells
8. Transient analysis of vehicle crash
9. Buckling analysis of shells
10. Analysis of forming
11. Analysis of sheet metal operation
12. Stress intensity factor in cracked plates

**Note:** Out of the above 12 experiments, any **ten (10)** experiments have to be carried out.

**Text Books:**

1. R. Tirupathi, Chandrupatla and B.D. Ashok, "Introduction of Finite Element in Engineering", Prentice Hall of India, 2004
2. David.V.Hutton, "Fundamentals of Finite Element Analysis", Tata McGrawHill,2003

**Suggested Reading:**

1. Robert Cook, "Concepts and applications of finite element analysis", 4/e, JohnWiley and sons,2009
2. S.S. Rao, ,"The Finite Element Methods in Engineering", 2 /e, Pergamon Press,2001.

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## 20ME C206

## COMPUTATIONAL FLUID DYNAMICS LAB

Instruction	4 Hours per week
Duration of SEE	---
SEE	---
CIE	50 Marks
Credits	2

**Objectives:** To acquaint the student with

1. Basic steps in a CFD simulation: ANSYS Workbench design modular and meshing
2. Simulation of laminar, turbulent, internal flow, steady and unsteady problems
3. Simulation of steady and unsteady problems
4. Physics setup involves boundary conditions
5. Solution of thermal related problems

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

1. Analyze laminar flow problems in plates and pipes
2. Solve steady and unsteady flow past a cylinder
3. Perform analysis for free and forced convection
4. Evaluate the effect of angle of attack and velocity on NACA aerofoil
5. Simulate compressible flow in a nozzle, premixed combustion

**List of Experiments:**

1. Laminar Flow over Flat plate
2. Laminar PipeFlow
3. Steady Flow past aCylinder
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 Aerofoil.
9. Study of compressible flow through a nozzle
10. Partially premixed combustion analysis
11. **Supersonic flow over a wedge**
12. Study of flow over wind turbine blade/flow through bifurcation artery

**Note:** Out of the above 12 experiments, any **ten (10)** experiments have to be carried out.

**Text Books:**

1. John D Anderson, "Computational Fluid Dynamics", Mc Graw Hill, Inc., 2015.
2. H.K. Versteeg and Malala Shekara, "Introduction to Finite Volume Method", Pearson, 2015.

**Suggested Reading:**

1. J.H. Ferziger and M. Peric, "Computational Methods for Fluid Dynamics", Springer.
2. K. Muralidhar and T. Sundararajan T, "Computational Fluid flow and Heat transfer", Narosa Publishing House, 2003.



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**20MEC 109****MINI PROJECT WITH SEMINAR**

Instruction	4 Hours per week
Duration of SEE	---
SEE	---
CIE	50 Marks
Credits	2

**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
5. Write the documentation in standard format

**Guidelines:**

1. As part of the curriculum in the II- semester of the programme each student shall do a mini project, generally comprising about three to four weeks of prior reading, twelve weeks of active research, and finally a presentation of their work for assessment.
2. Each student will be allotted to a faculty supervisor for mentoring.
3. 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.
4. Mini projects shall have interdisciplinary/ industry relevance.
5. The students can select a mathematical modeling based/Experimental investigations or Numerical modeling.
6. All the investigations are clearly stated and documented with the reasons/explanations.
7. The mini-project shall contain a clear statement of the research objectives, background of work, literature review, techniques used, prospective deliverables, and detailed discussion on results, conclusions and references.

Department committee: Supervisor and two faculty coordinators

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks:50		
Evaluation by	Max. Marks	Evaluation Criteria / Parameter
Supervisor	20	Progress and Review
	05	Report
Department Committee	05	Relevance of the Topic
	05	PPT Preparation
	05	Presentation
	05	Question and Answers
	05	Report Preparation

  
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**20EG A101****ENGLISH FOR RESEARCH PAPER WRITING**

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	_____
Credits	0

**Objectives:** The Course will introduce the students to

1. Understand the nuances of language and vocabulary in writing a Research Paper.
2. Develop the content, structure and format of writing a research paper.
3. Produce original research papers without plagiarism.

**Outcomes:** After successful completion of the course, the students will be able to

1. Interpret the nuances of research paper writing.
2. Differentiate the research paper format and citation of sources.
3. To review the research papers and articles in a scientific manner.
4. Avoid plagiarism and be able to develop their writing skills in presenting the research work.
5. Create a research paper and acquire the knowledge of how and where to publish their original research papers.

**UNIT - I**

**Academic Writing :** Meaning & Definition of a research paper– Purpose of a research paper – Scope – Benefits – Limitations – outcomes.

**UNIT - II**

**Research Paper Format:** Title – Abstract – Introduction – Discussion – Findings – Conclusion – Style of Indentation – Font size/Font types – Indexing – Citation of sources.

**UNIT- III**

**Research Methodology:** Methods (Qualitative – Quantitative) Review of Literature. Criticizing, Paraphrasing & Plagiarism.

**UNIT - IV**

**Process of Writing a research paper:** Choosing a topic - Thesis Statement – Outline – Organizing notes - Language of Research – Word order, Paragraphs – Writing first draft –Revising/Editing - The final draft and proof reading.

**UNIT - V**

**Research Paper Publication:** Reputed Journals– National/International– ISSN/ No, No. of volumes, Scopus Index/UGC Journals – Free publications - Paid Journal publications – /Advantages/Benefits

**Text Books:**

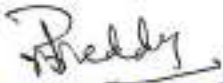
1. C. R Kothari, Gaurav, Garg, “Research Methodology Methods and Techniques”, 4/e, New Age International Publishers.

**Suggested Reading:**

1. Day R, “How to Write and Publish a Scientific Paper”, Cambridge University Press, 2006
2. “MLA Hand book for writers of Research Papers”, 7/e, East West Press Pvt. Ltd, New Delhi
3. Lauri Rozakis, Schaum’s, “Quick Guide to Writing Great Research Papers”, Tata McGraw Hills Pvt. Ltd, New Delhi.

**Online Resources:**

1. NPTEL: [https://onlinecourses.nptel.ac.in/noc18\\_mg13/preview](https://onlinecourses.nptel.ac.in/noc18_mg13/preview)

  
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**20EG A102****INDIAN CONSTITUTION AND FUNDAMENTAL RIGHTS**

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	<hr/>
Credits	0

**Objectives:** The Course will introduce the students to

1. The history of Indian Constitution and its role in the Indian democracy.
2. Address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement. to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. Have knowledge of the various Organs of Governance and Local Administration.

**Outcomes:** After successful completion of the course, the students will be able to

1. Understand the making of the Indian Constitution and its features.
2. Understand the Rights of equality, the Right of freedom and the Right to constitutional remedies.
3. Have an insight into various Organs of Governance - composition and functions.
4. Understand powers and functions of Municipalities, Panchayats and Co-operative Societies.
5. Understand Electoral Process, special provisions.

**UNIT - I**

**History of making of the Indian constitutions:** History, Drafting Committee (Composition & Working).

**Philosophy of the Indian Constitution:** Preamble, Salient Features.

**UNIT - II**

**Contours of Constitutional Rights and Duties -** Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

**UNIT- III**

**Organs of Governance - Parliament:** Composition, Qualifications, Powers and Functions

**Union Executives :** President, Governor, Council of Ministers, Judiciary, appointment and transfer of judges, qualifications, powers and functions

**UNIT - IV**

**Local Administration - District's Administration head:** Role and importance. Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Panchayati Raj: Introduction, PRI: Zilla Panchayat, Elected Officials and their roles, CEO Zilla Panchayat: positions and role.

**Block level: Organizational Hierarchy(Different departments) Village level: role of elected and appointed officials.** Importance of grass root democracy.

**UNIT - V**

**Election commission:** Election Commission: Role and functioning, Chief Election Commissioner and Election Commissioners, State Election Commission :Role and functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

**Text Books:**

1. Dr. S. N. Busi, Dr. B. R. Ambedkar, "Framing of Indian Constitution", 1/e, 2015.
2. M. P. Jain, "Indian Constitution Law", 7/e, Lexis Nexis, 2014

**Suggested Reading:**

1. "The Constitution of India", 1950 (Bare Act), Government Publication
2. D.D. Basu, "Introduction to the Constitution of India", Lexis Nexis, 2015.

**Online Resources:**

1. <http://www.nptel.ac.in/courses/103107084/Script.pdf>

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**20EG A103****STRESS MANAGEMENT BY YOGA**

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	_____
Credits	0

**Objectives:** The Course will introduce the students to

1. Creating awareness about different types of stress and the role of yoga in the management of stress.
2. Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).
3. Prevention of stress related health problems by yoga practice.

**Outcomes:** After successful completion of the course, the students will be able to

1. Understand yoga and its benefits.
2. Enhance Physical strength and flexibility.
3. Learn to relax and focus.
4. Relieve physical and mental tension through asanas
5. Improve work performance and efficiency.

**UNIT - I**

**Meaning and Definition of Yoga-** Historical perspective of Yoga- Principles of Astanga Yoga by Patanjali.

**UNIT - II**

**Meaning and Definition of Stress** - Types of stress - Eustress and Distress, Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.

**UNIT- III**

**Concept of Stress According to Yoga** - Stress assessment methods - Role of Asana, Pranayama and Meditation in the management of stress

**UNIT - IV**

**Asanas-** ( 5 Asanas in each posture) - Warm up - Standing Asanas - Sitting Asanas - Prone Asanas - Supine asanas - Surya Namaskar

**UNIT - V**

**Pranayama-** Anulom and Vilom Pranayama - Nadishudhi Pranayama - Kapalabhati Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama.

**Meditation Techniques:** Om Meditation - Cyclic meditation : Instant Relaxation technique (QRT), Quick Relaxation Technique ( QRT), Deep Relaxation Technique (DRT)

**Text Books:**

1. “Yogic Asanas for Group Training - Part-I”: Janardhan Swami Yogabhyasi Mandal, Nagpur.
2. Swami Vivekananda, “Rajayoga or Conquering the Internal Nature”, Advaita Ashrama (Publication Department), Kolkata.

**Suggested Reading:**

1. Nagendra H.R nad Nagaratna R, “Yoga Perspective in Stress Management”, Swami Vivekananda Yoga Prakashan, Bangalore,

**Online Resources:**

1. [https://onlinecourses.nptel.ac.in/noc16\\_ge04/preview](https://onlinecourses.nptel.ac.in/noc16_ge04/preview)
2. <https://freevidelectures.com/course/3539/indian-philosophy/11>

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**20EG A104****PERSONALITY DEVELOPMENT THROUGH LIFE'S  
ENLIGHTENMENT SKILLS**

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	_____
Credits	0

**Objectives:** The Course will introduce the students to

1. Learn to achieve the highest goal happily.
2. Become a person with stable mind, pleasing personality and determination.
3. Awaken wisdom among them.

**Outcomes:** After successful completion of the course, the students will be able to

1. Develop their personality and achieve their highest goal of life.
2. Lead the nation and mankind to peace and prosperity.
3. Practice emotional self regulation.
4. Develop a positive approach to work and duties.
5. Develop a versatile personality.

**UNIT - I**

**Neetisatakam – Holistic Development of Personality** - Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)

**UNIT - II**

**Neetisatakam – Holistic Development of Personality (cont'd)** - Verses 52, 53, 59 (don't's) - Verses 71,73,75 & 78 (do's) - Approach to day to day works and duties.

**UNIT- III**

**Introduction to Bhagavadgeetha for Personality Development - Shrimad Bhagavadgeetha:** Chapter 2 – Verses 41, 47, 48 - Chapter 3 – Verses 13,21,27,35 - Chapter 6 – Verses 5,13,17,23,35 - Chapter 18 – Verses 45, 46, 48  
Chapter – 6: Verses 5, 13, 17, 23, 35; Chapter – 18: Verses 45, 46, 48

**UNIT - IV**

**Statements of Basic Knowledge - Shrimad Bhagavadgeetha:** Chapter 2- Verses 56, 62,68 - Chapter 12 – Verses 13, 14, 15, 16, 17, 18 - **Personality of Role model from Shrimad Bhagawat Geeta.**

**UNIT - V**

**Role of Bhagavadgeetha in the Present Scenario** - Chapter 2 – Verses 17 -  
Chapter 3 – Verses 36, 37, 42 - Chapter 4 – Verses 18, 38, 39 - Chapter 18 – Verses  
37, 38, 63.

**Text Books:**

1. “Srimad Bhagavad Gita”, Swami SwarupanandaAdvaita Ashram  
(Publication Department), Kolkata

**Suggested Reading:**

1. “Bhartrihari’s Three Satakam (Niti-sringar-vairagya)”, P.Gopinath,  
Rashtriya Sanskrit Sansthanam, New Delhi

**Online Resources:**

1. NTPEL: <http://nptel.ac.in/downloads/109104115/>



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20MEE112

**ADVANCED FINITE ELEMENT METHOD**  
(Programme Elective - V)

Instruction	3L	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

**Objectives:** To make the students to learn the

1. FE formulation for isoparametric elements.
2. Validation of isoparametric elements.
3. Parameters to be checked to get solution.
4. Formulation of curved shells.
5. Formulation of non-linear problems.

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

1. Demonstrate understanding of FE formulation for isoparametric element.
2. Understand to evaluate the stresses in the elements.
3. Model effectively and checks the parameters to get the converged solution and verify the solutions.
4. Demonstrate use of FE formulation to shell elements and analyse for buckling loads.
5. Solve nonlinear problems with a FE formulation.

**UNIT – I**

**Isoparametric Elements-I:** Bar element, Bilinear quadrilateral element (Q4), Quadratic quadrilaterals (Q8, Q9), Hexahedral isoparametric elements, **Numerical integration.**

**UNIT - II**

**Isoparametric Element-II:** Incompatible modes (nodeless dof), Static condensation, Choices in Numerical integration, Selective integration and substitution, Load considerations (edge, surface traction), **Body forces and initial stresses, Stress calculation (stress at Gauss points),** Extrapolation calculations, Effect of element geometry, Validity of isoparametric elements, Patch test.

**UNIT- III**

**Modelling Considerations and Software Use:** Introduction, Physical behaviour versus

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element behaviour, Thin-walled construction, Element shapes and interconnection, Test cases and pilot studies, Material properties, Loads and reactions, Connections in structures, Boundary conditions, Repetitive symmetry, Stress considerations and substructures, Common mistakes, Checking the model and result.

#### UNIT – IV

**Shell Elements Formulation:** Three and four nodes shell elements, Curved isoparametric shell elements, Evaluation of stiffness and stresses in the shells, Stress stiffness and buckling of shells.

#### UNIT – V

**Non-Linear Analysis:** Non-linear problems, Solution methods, Plasticity: General formulation for calculations in uni axial stresses, General formulation for small strains, Formulation for Von-mises theory, Non-linear dynamic problems.

#### Text books:

1. Robert D.cook, David S.Malkus, Micheal E.Plesha, Robert J.Witt., Concepts and applications of finite element analysis, 4<sup>th</sup> edition, John wiley and sons, INC 2002.
2. K. J. Bathe, Finite Element Procedures, Prentice-Hall of India Private Limited, New Delhi,1996

#### Suggested Reading:

1. O. C. Zienkiewicz and R. L. Taylor, Finite Element Method: Volume 2 Solid Mechanics, 5<sup>th</sup> edition, Butterworth-Heinemann, Oxford.
2. J. C. Simo and T. J. R. Hughes, Computational Inelasticity, Springer- Verlag New York, Inc., New York, 1998
3. T. Belytschko and W. K. Liu and B. Moran, Nonlinear Finite Elements for Continua and Structures, John Wiley & Sons Ltd., England

  
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2021-22

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20MEE113

**DIGITAL MANUFACTURING AND DESIGN**  
(Programme Elective - V)

Instruction		3L	Hours per week
Duration of SEE	3	Hours	
SEE		60	Marks
CIE		40	Marks
Credits	3		

**Objectives:** To make the students to learn the

1. FE formulation for isoparametric elements.
2. Validation of isoparametric elements.
3. Parameters to be checked to get solution.
4. Formulation of curved shells.
5. Formulation of non-linear problems.

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

1. Understand the concept of digital manufacturing, technology and its potential in modern manufacturing process.
2. Design and manufacture sophisticated parts using subtractive manufacturing including metal-based additive manufacturing.
3. Implement and manage digital factory by adopting virtual manufacturing
4. Analyse the role of product life cycle and database management systems in manufacturing systems.
5. Understand the concepts of digital design and shape digitization in manufacturing

**UNIT – I**

**Introduction to digital manufacturing:** Definition of digital manufacturing, Operation Mode and Architecture of Digital Manufacturing System, Impact on manufacturing careers, Advantages of digital manufacturing and design, Information sharing in the digital thread, Multiple organizations in the manufacturing process.

**Introduction to Industry 4.0, Case study of car manufacturing by Bosch****UNIT – II**

**Subtractive manufacturing:** Basic architecture, Control hardware and software details, Tooling, Sculptured surface machining.

**Additive Manufacturing:** Basics, Hardware details and capabilities of commercial systems, planning of material addition, Rapid tooling solutions.

**UNIT – III**

**Reverse engineering:** Need, Reverse engineering process, Reverse engineering hardware and software, Geometric model development.

**Digital factory and virtual manufacturing:** Introduction, Scope, Methods and Tools Used in Virtual Manufacturing, Benefits, Virtual factory simulation, case study on a Biscuit factory.

**UNIT – IV**

**Product database management systems:** Types, Management information system, Manufacturing data preparation, Shop-floor control, Automatic identification systems (sensors, trackers)

**Product life cycle management:** Introduction, Types of Product Data, Product life cycle management (PLM) systems, integrated information systems in product lifecycle, Features of PLM System, System architecture, Product information models, Functionality of the PLM Systems.

**UNIT – V**

**Digital design:** Geometrical design of curves, Surfaces and solids, Digital twins, Digital threads and Files format (STL, AMF, 3MF).

**Shape digitization:** 3D object scanning, Solid reconstruction from point cloud and tessellated data, downstream applications.

**Text Books:**

1. Fundamentals of Digital Manufacturing Science, by Z.Zhou, S.Xie, D. Chen, Springer, 2012.
2. Ibrahim Zeid and Sivasubramanian R, "CAD/CAM - Theory and Practice", Tata McGraw Hill Education, 2011.
3. Antti Saaksvuori and Anselmi Immonen, "Product Lifecycle Management", Springer, 2004.

**Suggested Reading:**

1. Vinesh Raja and Kiran J Fernandes, "Reverse Engineering- An Industrial Perspective", Springer-Verlag, 2008.

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20MEE114

**PRODUCT DESIGN AND PROCESS PLANNING**  
(Programme Elective - V)

Instruction	3L	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

**Objectives:** To make the students to learn the

1. Basic concepts of Product design and Process planning.
2. Reliability, IPR and value analysis.
3. Conceptual design rules for few manufacturing techniques.
4. Ergonomical principles and advanced productivity techniques.
5. Role of computers in design and manufacturing.

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

1. Design and process of a product.
2. Implement reliability techniques, IPR and value engineering.
3. Understand and develop appropriate manufacturing techniques.
4. Implement Ergonomical concepts and productivity techniques.
5. Use computers in product design and process planning.

**UNIT - I**

**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

**UNIT - II**

**New Product Development:** 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.

### UNIT- III

**Various Manufacturing Processes:** Degree of accuracy and finish obtainable, Process capability studies, Methods of improving tolerances, 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.

### UNIT - IV

**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.

### UNIT - V

**Role of Computer in Product Design:** 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.

#### Text Books:

1. B.W. Niebel and A.B. Draper., Product Design and Process Engineering, Mc Graw Hill, Kogalkusha Ltd., Tokyo, 1974.
2. A.K. Chitale and Gupta, R.C., Product Design and Manufacturing, PHI, New Delhi, 2004.

#### Suggested Reading:

1. M. Mahajan., Industrial Engineering and Production Management, Dhanpath Rai & Co., 2000.
2. Bhaskaran Gopalakrishnan, Product Design and Process Planning, Chapman and Hall, New York, 1994.



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2021-22

With Effect from the Academic Year

20CEO101

**COST MANAGEMENT OF ENGINEERING PROJECTS**  
(Open Elective)

Instruction	3L	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

**Objectives:**

1. To enable the students to understand the concepts of Project management.
2. To provide knowledge on concepts of Project Planning and scheduling.
3. To create an awareness on Project Monitoring and Cost Analysis
4. To provide adequate knowledge to the students on Resource Management Costing-variance Analysis
5. To train the students with the concepts of Budgetary Control for cost management and to provide a basic platform on Quantitative techniques for cost management.

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

1. Acquire in-depth knowledge about the concepts of project management and understand the principles of project management.
2. Determine the critical path of a typical project using CPM and PERT techniques.
3. Prepare a work break down plan and perform linear scheduling using various methods.
4. Solve problems of resource scheduling and leveling using network diagrams.
5. Learn the concepts of budgetary control and apply quantitative techniques for optimizing project cost.

UNIT- I:

**Project Management:** Introduction to project managements, Stakeholders, Roles, Responsibilities and functional relationships, Principles of project management, Objectives and project management system, Project team, Organization, roles and responsibilities, Concepts of project planning, Monitoring, Staffing, Scheduling and controlling.

## UNIT-II:

**Project Planning and Scheduling:** Introduction for project planning, defining activities and their interdependency, time and resource estimation. Work break down structure. Linear scheduling methods-bar charts, Line of Balance (LOB), their limitations. Principles, definitions of network-based scheduling methods: CPM, PERT. Network representation, network analysis-forward and backward passes.

## UNIT-III:

**Project Monitoring and Cost Analysis:** introduction-Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making, Time cost tradeoff-Crashing project schedules, its impact on time on time, cost, Project direct and indirect costs.

## UNIT- IV:

**Resources Management and Costing-Variance Analysis:** Planning, Enterprise Resource Planning, Resource scheduling and leveling, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis

**Standard Costing and Variance Analysis:** Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing, Costing of service sector. Just-in-time approach, Material Requirement

## UNIT- V:

**Budgetary Control:** Flexible Budgets; Performance budgets; Zero-based budgets, Measurement of Divisional profitability pricing decisions including transfer pricing.

**Quantitative techniques for cost management:** Linear Programming, PERT/CPM, Transportation Assignment problems, Simulation, Learning Curve Theory.

## Text Books:

1. Charles T Horngren., Cost Accounting A Managerial Emphasis, 14th edition, Pearson Education, 2012,
2. Charles T. Horngren and George Foster., Advanced Management Accounting, 6th revised edition, Prentice Hall, 1987.

Suggested Reading:

1. K. K Chitkara., Construction Project Management: Planning, scheduling and controlling, Tata McGraw Hill Education, 2004.
2. Kumar Neeraj Jha., Construction Project Management Theory and Practice, 2nd edition, Pearson Education India, 2015.
3. Robert S Kaplan and Anthony A. Atkinson, Management & Cost Accounting, 2nd edition, Pearson, 1996.



**PROFESSOR & HEAD**  
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**WASTE TO ENERGY**  
(Open Elective)

Instruction	3L	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

**Objectives:**

1. To know the various forms of waste
2. To understand the processes of Biomass Pyrolysis.
3. To learn the technique of Biomass Combustion.

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

1. Understand the concept of conservation of waste
2. Identify the different forms of wastage
3. Chose the best way for conservation to produce energy from waste
4. Explore the ways and means of combustion of biomass
5. Develop a healthy environment for the mankind

**UNIT - I**

**Introduction to Energy from Waste:** Classification of waste as fuel, Agro based, Forest residue, Industrial waste, MSW, Conversion devices, Incinerators, Gasifiers, Digestors

**UNIT - II**

**Biomass Pyrolysis:** Pyrolysis, Types, Slow, Fast, Manufacture of charcoal, Methods, Yields and application, Manufacture of pyrolytic oils and gases, Yields and applications.

**UNIT - III**

**Biomass Gasification:** Gasifiers, Fixed bed system, Downdraft and updraft gasifiers, Fluidized bed gasifiers, Design, Construction and operation, Gasifier burner arrangement for thermal heating, Gasifier engine arrangement and electrical power.

UNIT-IV

**Biomass Combustion:** Biomass stoves, Improved chullahs, Types, Some exotic designs, Fixed bed combustors, Types, Inclined grate combustors, Fluidized bed combustors, Design, Construction and operation, Operation of all the above biomass combustors.

UNIT – V

**Biogas:** Properties of biogas (Calorific value and composition), Biogas plant technology and status, Bio energy system, Design and constructional features, Biomass resources and their classification, Biomass conversion processes, Thermo chemical conversion, Direct combustion, Biomass gasification, Pyrolysis and liquefaction, Biochemical conversion, Anaerobic digestion, Types of biogas plants, Applications, Alcohol production from biomass, Bio diesel production, Urban waste to energy conversion, Biomass energy programme in India.

Text Books:

1. V.Ashok, NonConventional Energy, Desai, Wiley Eastern Ltd., 1990.
2. K.C. Khandelwal and S.S. Mahdi., Biogas Technology - A Practical Hand Book, Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.

Suggested Readings:

1. D.S. Challal., Food, Feed and Fuel from Biomass, IBH Publishing Co. Pvt. Ltd., 1991.
2. C. Y. WereKo-Brobby and E. B. Hagan, Biomass Conversion and Technology, John Wiley & Sons, 1996.

  
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**BUSINESS ANALYTICS**  
(Open Elective)

Instruction	3L	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Course Objectives: **The objectives of this course are**

1. **Understanding the basic concepts of business analytics and applications.**
2. Study various business analytics methods including predictive, prescriptive and prescriptive analytics.
3. Prepare the students to model business data using various data mining, decision making methods.

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

1. Identify and describe complex business problems in terms of analytical models.
2. Apply appropriate analytical methods to find solutions to business problems that achieve stated objectives.
3. Interpret various metrics, measures used in business analytics.
4. Illustrate various descriptive, predictive and prescriptive methods and techniques.
5. Model the business data using various business analytical methods and techniques.
6. Create viable solutions to decision making problems.

## UNIT-I

Introduction to Business Analytics: **Introduction to business analytics, Need and science of data driven decision making, Descriptive, Predictive, Prescriptive analytics and techniques, Big data analytics, Web and social media analytics, Machine learning algorithms, framework for decision making, Challenges in data driven decision making and future.**

## UNIT-II

Descriptive Analytics: **Introduction, Data types and scales, Types of measurement**

scales, Population and samples, Measures of central tendency, Percentile, Decile and quadrille, Measures of variation, Measures of shape skewness, Data visualization.

### UNIT-III

Forecasting Techniques: Introduction, time-series data and components, forecasting accuracy, moving average method, single exponential smoothing, Holt's method, Holt-Winter model, Croston's forecasting method, regression model for forecasting, Auto regression models, auto-regressive moving process, ARIMA, Theil's coefficient.

### UNIT-IV

Decision Trees: CHAID, Classification and regression tree, Splitting criteria, Ensemble and method and random forest, Clustering, Distance and similarity measures used in clustering, Clustering algorithms, K-Means and hierarchical algorithms, Prescriptive analytics, Linear programming and LP model building.

### UNIT-V

Six Sigma: Introduction, Introduction, Origin, 3-Sigma Vs Six-Sigma process, Cost of poor quality, Sigma score, Industry applications, Six sigma measures, DPMO, Yield, Sigma score, DMAIC methodology, Six Sigma toolbox

### Text Books:

1. U. Dinesh Kumar, Data Analytics, Wiley Publications, 1st Edition, 2017.
2. Marc J. Schniederjans, Dara G. Schniederjans and Christopher M. Starkey, Business Analytics Principles, Concepts and Applications with SAS, Associate Publishers, 2015.

### Suggested Reading:

1. S. Christian Albright and Wayne L. Winston, Business Analytics - Data Analysis and Decision Making, 5th Edition, Cengage, 2015.

### Web Resources:

1. <https://onlinecourses.nptel.ac.in/noc18-mg11/preview>
2. <https://nptel.ac.in/courses/110105089/>

**INDUSTRIAL PROJECT / DISSERTATION PHASE - I**

Instruction	20	Hours per week
Duration of SEE	—	
SEE	—	
CIE	100	Marks
Credits	10	

**Outcomes:** At the end of the course:

1. Students will be exposed to self-learning various topics.
2. Students will learn to survey the literature such as books, national/ international refereed journals and contact resource persons for the selected topic of research.
3. Students will learn to write technical reports.
4. Students will develop oral and written communication skills to present.
5. Student will defend their work in front of technically qualified audience.

**Guidelines:**

1. The Project work will preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.
2. Seminar should be based on the area in which the candidate has undertaken the dissertation work.
3. The CIE shall include reviews and the preparation of report consisting of a detailed problem statement and a literature review.
4. The preliminary results (if available) of the problem may also be discussed in the report.
5. The work has to be presented in front of the committee consists of Head, Chairperson-BoS, Supervisor and Project coordinator.
6. The candidate has to be in regular contact with his supervisor and the topic of dissertation must be mutually decided by the guide and student.



Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 100		
Evaluation by	Max. Marks	Evaluation Criteria / Parameter
Supervisor	30	Project Status / Review(s)
	20	Report
Department Committee	10	Relevance of the Topic
	10	PPT Preparation(s)
	10	Presentation(s)
	10	Question and Answers
	10	Report Preparation

Note: Department committee has to assess the progress of the student for every two weeks.

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CBIT (A)  
2021-22

With Effect from the Academic Year

20MEC111

**INDUSTRIAL PROJECT / DISSERTATION PHASE - II**

Instruction	32 Hours per week
Duration of SEE	Viva-Voce
SEE	100 Marks
CIE	100 Marks
Credits	16

**Outcomes:** At the end of the course:

1. Students will be able to use different experimental techniques and will be able to use different software/ computational/analytical tools.
2. Students will be able to design and develop an experimental set up/ equipment/test rig.
3. Students will be able to conduct tests on existing set ups/equipments and draw logical conclusions from the results after analyzing them.
4. Students will be able to either work in a research environment or in an industrial environment.
5. Students will be conversant with technical report writing and will be able to present and convince their topic of study to the engineering community.

**Guidelines:**

1. It is a continuation of Project work started in semester III.
2. The student has to submit the report in prescribed format and also present a seminar.
3. The dissertation should be presented in standard format as provided by the department.
4. The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion.
5. The report must bring out the conclusions of the work and future scope for the study. The work has to be presented in front of the

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examiners panel consisting of an approved external examiner, an internal examiner (HoD and BoS Chair Person) guide/co-guide.

6. The candidate has to be in regular contact with his/her guide/co-guide.

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 100		
Evaluation by	Max. Marks	Evaluation Criteria / Parameter
Department Review Committee	05	Review 1
	10	Review 2
	10	Review 3
	15	Final presentation with the draft copy of the report standard format
	10	Submission of the report in a standard format
Supervisor	10	Regularity and Punctuality
	10	Work Progress
	10	Quality of the work which may lead to publications
	10	Analytical / Programming / Experimental Skills Preparation
	10	Report preparation in a standard format

  
**PROFESSOR & HEAD**  
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Sundipal, Hyderabad-500 075, Telangana

**20ME C201****THERMO DYNAMICS AND COMBUSTION**

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** To make the students to

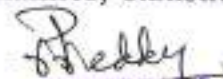
1. Review the basic laws of thermodynamics and create awareness of the importance of thermodynamic principles in engineering applications
2. Understand the behavior of real gases vis-à-vis ideal gas
3. Create awareness about the importance of combustion reactions in real time applications
4. Understand the basic principles of power cycles and its relation with combustion processes
5. Understand various methods of direct energy conversion

**Outcomes:** At the end of the course, 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
4. Understand the application of power cycles to engineering practice.
5. Understand various non-conventional energy conversion methods like fuel cells etc

**UNIT – I**

**Thermodynamic Laws:** 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. Third law of thermodynamics, Nerst heat theorem, Introduction to - Statistical thermodynamics, statistical interpretations of first and second law and Entropy

  
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**UNIT – II**

**Real Gas Behaviour:** P.V.T. surface – Equations of state – Real Gas Behaviour – Vander Waal's equation - Generalized compressibility Factor – Energy properties of Real Gases – Vapour pressure – Clausius – Clapeyron Equation – Throttling – Joule – Thompson coefficient, Non-reactive Mixture of perfect Gases – Governing Laws, Real Gas Mixture

**UNIT – III**

**Combustion:** Combustion – Combustion Reactions – Enthalpy of Formation – Entropy of Formation – Reference Levels for Tables – Heat of Reaction – Adiabatic 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**

**UNIT – IV**

**Power Cycles:** Power cycles, Review Binary vapour cycle, co-generation and combined cycles – Second law analysis of cycles – Refrigeration cycles. Thermo Dynamics of irreversible processes – Thermo electric circuits

**UNIT – V**

**Direct Energy Conversion:** Introduction – Fuel Cells - Thermo electric energy – Thermo-ionic power generation -Thermodynamic devices - Magneto Hydrodynamic Generations – Photo voltaic cells

**Text Books:**

1. Younus. A. Cengel & Michael. A. Boles, "Thermodynamics: An Engineering Approach", 7/e, TMH.
2. Y.V.C. Rao. "Postulates and Statistical Thermodynamics", Allied Publishers Inc., 1994.

**Suggested Reading:**

1. P.K. Nag, "Basic and Applied Thermodynamics", TMH, 2008.
2. J.P. Holman, "Thermo Dynamics", Mc Graw Hill, 2008
3. Howell and Dedcius, "Fundamentals of Engineering Thermodynamics", McGraw Hill Inc., U.S.A.

*S. Reddy*  
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**20ME C202****ADVANCED FLUID DYNAMICS**

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** Student will understand

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. Understand the isentropic behavior of gas in nozzles
5. Learn about shocks of fluids

**Outcomes:** At the end of the course, 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. Design nozzles and diffusers
5. Estimate various parameters in fluids subjected to shocks

**UNIT - I**

**Fluid Flows:** Classification of fluids, Lagrangian and Eulerian 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

**UNIT - II**

**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

**UNIT- III**

**Concept of Boundary Layer:** 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

**UNIT - IV**

**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**

**UNIT - V**

**Principles of Gas Dynamics Applicable to Shocks:** Isentropic flow through variable area passages. Design of supersonic and subsonic nozzles and diffusers. Supersonic flows. Expansion and Shock waves. **Normal and Oblique Shock waves. Prandtl-Meyer and Rankine-Hugoniot Relations.** Simple problems on normal and oblique shock waves.

**Text Books:**

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.

**Suggested Reading:**

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 Problems", Wiley, New York, 1980.

  
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**20ME M103****RESEARCH METHODOLOGY AND IPR**

Instruction	2 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	2

**Objectives:** To make the students to

1. Motivate to choose research as career
2. Formulate the research problem, prepare the research design
3. Identify various sources for literature review and data collection report writing
4. Equip with good methods to analyze the collected data
5. Know about IPR copyrights

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

1. Define research problem, review and assess the quality of literature from various sources
2. Improve the style and format of writing a report for technical paper/ Journal report, understand and develop various research designs
3. Collect the data by various methods: observation, interview, questionnaires
4. Analyze problem by statistical techniques: ANOVA, F-test, Chi-square
5. Understand apply for patent and copyrights

**UNIT - I**

**Research Methodology:** Research Methodology: Objectives and Motivation of Research, Types of Research, research approaches, Significance of Research, Research Methods versus 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

**UNIT - II**

**Literature Survey Report Writing:** Literature Survey: Importance and purpose of Literature Survey, Sources of Information, **Assessment of Quality of Journals and Articles**, **Information through Internet**. 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

### UNIT- III

**Research Design:** 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.

### UNIT - IV

**Data Collection and Analysis:** Data Collection: Methods of data collection, importance of Parametric, non parametric test, testing of variance of two normal population, use of Chi-square, ANOVA, Ftest, z-test

### UNIT - V

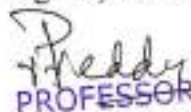
**Patents and Copy Right:** Patent: Macro economic impact of the patent system, Patent document, How to protect your inventions. Granting of patent, Rights of a patent, how extensive is patent protection. **Copyright:** What is copyright. What is covered by copyright. How long does copyright last? Why protect copyright? **Related Rights:** what are related rights? **Enforcement of Intellectual Property Rights:** Infringement of intellectual property rights, Case studies of patents and IP Protection

#### Text Books:

1. C. R. Kothari, "Research Methodology, Methods & Technique", New Age International Publishers, 2004.
2. R. Ganesan, "Research Methodology for Engineers", MJ Publishers, 2011.
3. Y. P. Agarwal, "Statistical Methods: Concepts, Application and Computation", Sterling Pubs., Pvt., Ltd., New Delhi, 2004.

#### Suggested Reading:

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.

  
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**20ME E201****THERMAL AND NUCLEAR POWER PLANTS**

(Programme Elective – I)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** Student will understand

1. Performance of steam power plant and to observe the importance of combustion of coal
2. Combined cycle effect in gas turbine power plants
3. Different nuclear reactors and estimate the economical benefits
4. Calculation of different energy tariffs under various load conditions
5. Pressure, temperature and flow parameters of a power plant

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

1. Analyze on combustion of coal and find performance of different power plant cycles
2. Analyze the combined cycle power plants and waste heat recovery systems
3. Design various types of nuclear reactors taking safety precautions and making economically beneficial
4. Calculate the energy rates of power distribution considering the factors affecting the economy
5. 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

**UNIT - I**

**Layout of Power Plants:** Sources of Energy, types of Power Plants, Direct Energy Conversion System, Energy Sources in India, and Recent developments in Power Generation. **Combustion of Coal, Volumetric Analysis, Gravimetric Analysis, and 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

**UNIT - II**

**Combined Cycle Power Plant:** Cogeneration, Combined cycle Power Plants, Analysis, Waste-Heat Recovery, IGCC Power Plants, Fluidized Bed Combustion – Advantages & Disadvantages

**UNIT- III**

**Nuclear Power Plant:** 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

**UNIT - IV**

**Economics of Power Plant:** 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

**UNIT - V**

**Power Plant Instrumentation:** Classification, Pressure measuring instruments, Temperature measurement and Flow measurement. Analysis of Combustion gases, Pollution – Types, Methods to Control

**Text Books:**

1. E.L.Wakil, "Power Plant Technology", Mc Graw Hill, New York, 1985.
2. J. Weis Man and R Eckert, "Modern Power Plant Engineering", PHI, NewDelhi, 1983.

**Suggested Reading:**

1. S.C.Arora and S. 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", Kataria Publications, 2007.

  
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**20ME E202****ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL**

(Programme Elective – I)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** Student will understand

1. Harmful effects of pollutants and their control
2. Different techniques adopted in solid waste management
3. Causes and remedies for water pollution
4. Other types of pollution like oils, pesticides, noise etc
5. Controlling methods adopted to reduce pollution from their power plants

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

1. Estimate air pollutants and suggest suitable remedial methods to control them
2. Suggest a suitable solid waste disposal system
3. Suggest suitable remedy to control water pollution
4. Suggest suitable remedy to control other pollutants like oils, pesticides, noise etc.
5. Suggest a suitable instrumentation for pollution control

**UNIT - I**

**Air Pollution:** Sources and Effect - Acid Rain - Air Sampling and Measurement - Analysis of Air Pollutants - Air Pollution Control Methods and Equipments - Issues in Air Pollution control.

**UNIT - II**

**Solid Waste Management:** 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**

**UNIT- III**

**Water Pollution:** Sources and Classification of Water Pollutants - Characteristics - Waste Water Sampling Analysis - **Waste Water Treatment - Monitoring compliance with Standards - Treatment, Utilization and Disposal of Sludge**

**UNIT - IV**

**Other Types of Pollution:** Noise Pollution and its impact- Oil Pollution- Pesticides  
- Radioactivity Pollution Prevention and Control

**UNIT - V**

**Pollution from Thermal Power Plants and Control Methods:** Instrumentation for pollution control - Water Pollution from Tanneries and other Industries and their control

**Text Books:**

1. G. Masters, "Introduction to Environmental Engineering and Science", Prentice –Hall, International Editions, 1988..
2. S. Peavy, D. R. Rowe and G. Tchobanoglous, "Environmental Engineering", McGraw- Hill Book Company, NY, 1985.

**Suggested Reading:**

1. H. Ludwig and 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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**20ME E103****OPTIMIZATION TECHNIQUES**

(Programme Elective – I)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** The students will

1. Come to know the formulation of LPP models
2. Understand the Algorithms of Graphical and Simplex Methods
3. Understand the Transportation and Assignment techniques
4. Come to know the procedure of Project Management along with CPM and PERT techniques
5. Understand the concepts of sequencing and queuing theory

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

1. Formulate a managerial decision problem into a mathematical model.
2. Apply Operations Research models to real time industry problems
3. Build and solve Transportation Models and Assignment Models.
4. Apply project management techniques like CPM and PERT to plan and execute project successfully
5. Apply sequencing and concepts in industry applications

**UNIT - I**

**Basic Concepts:** Operations Research definition, scope, Models, Linear programming problems, Formulation, Graphical Method, Simplex Method, and 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**

**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.

#### UNIT - IV

**Queuing Theory:** Kendols Notation, single server models, Inventory control - deterministic inventory models - Probabilistic inventory control models.

#### UNIT - V

**Sequencing Models:** Introduction, General assumptions, processing 'n' jobs through two Machines, processing 'n' jobs through three machines. Game Theory – definition saddle point Principle of Dominance.

#### Text Books:

1. H.A. Taha, "Operations Research, An Introduction", PHI, 2008
2. H.M. Wagner, "Principles of Operations Research", PHI, Delhi, 1982
3. J.C. Pant, "Introduction to Optimisation: Operations Research", Jain Brothers, Delhi, 2008

#### Suggested Reading:

1. Hitler Libermann, "Operations Research", McGraw Hill Pub. 2009
2. Pannerselvam, "Operations Research", Prentice Hall of India 2010
3. Harvey M Wagner, "Principles of Operations Research", Prentice Hall of India 2010

  
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**20ME E203****AIR CONDITIONING SYSTEM DESIGN**

(Programme Elective – II)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** Student will understand

1. The difference between refrigeration and air conditioning
2. Working principles of simple vapour compression refrigeration cycle and absorption refrigeration
3. Necessity of psychrometry chart in air conditioning system design
4. Classification of air conditioning systems
5. How to calculate loads on air conditioning system

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

1. Effect of refrigerants on environment and ozone depletion,
2. List out merits and demerits of absorption refrigeration system over simple vapour compression refrigeration system
3. List out factors effecting design of air conditioning system
4. Importance of air conditioning in engineering applications
5. Design components used in air conditioning circuits

**UNIT - I**

**Refrigeration and Air Conditioning:** Differentiation of refrigeration and air conditioning, COP, tone of refrigeration, classification of refrigerant, properties of refrigerants, eco-friendly refrigerants, green-house effect, ozone depletion, air refrigeration, Bell Coleman cycle, air craft refrigeration, classification of air craft refrigeration

**UNIT - II**

**Refrigeration Systems:** Simple vapor compression refrigeration system, COP, pressure-enthalpy, temperature-entropy diagrams, theoretical and practical cycles, absorption refrigeration cycle, COP of absorption refrigeration cycle, simple and practical NH<sub>3</sub> refrigeration cycle, Electrolux refrigeration cycle, lithium bromide refrigeration cycle

**UNIT- III**

**Psychrometry :** Introduction to psychrometry, psychrometric processes, comfort air conditioning, factors effecting comfort air conditioning, thermodynamics of



human being, effective temperature, comfort chart, by-pass factor, indoor air quality, infiltration, problems on summer air conditioning and winter air conditioning

#### UNIT - IV

**Air Conditioning Systems** : Classification of air conditioning systems, window air conditioning system, split air conditioning system, year round air conditioning system, **ERSH, GSHP, industrial air conditioning, transport air conditioning, food processing industries, photographic industries, food preserving industries, chillers**

#### UNIT - V

**Design of Air Conditioning System**: Loads on air conditioning system, factors effecting design of air conditioning system, design of condensers, evaporators, fillers, **humidifiers, de-humidifiers, fans, blowers and ducts, expansion devices, case studies of calculation of heat loads like auditorium, operation theatre, chilling centers, software used in design of air conditioning system.**

#### Text Books:

1. C. P. Arora, "Refrigeration & Air Conditioning", Tata Mc Graw Hill, 1985.
2. Stoecker, "Refrigeration & Air Conditioning", Mc Graw Hill, 1992.
3. W. P. Jones, "Air Conditioning Engineering", Edward Arnold Publishers Ltd., London, 1984.

#### Suggested Reading:

1. Norman C. Harris, "Modern Air Conditioning", New York, McGraw-Hill, 1974.
2. Manohar Prasad, "Refrigeration & Air Conditioning", New Age Publishers, 2014.
3. ASHRAE Hand book.

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**20ME E205****DESIGN OF SOLAR AND WIND SYSTEMS**

(Programme Elective – II)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** Student will understand

1. Need and importance of NCES and extent of Solar Energy as source.
2. Concepts of Solar collectors, applications and Storage.
3. Concepts of Solar Energy storage
4. Wind Energy Conversion Fuel cell and MHD principles
5. Biomass conversion principles and also about Geothermal energy

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

1. Understand the implementation status of NCES in India along with basic concepts of Solar Energy
2. Analyze the performance of Solar Collectors
3. Understand PV Cell technology and storage methods
4. Conceptually design the wind turbine and understand fuel cells functioning.
5. Understand various Waste to Energy conversion technologies.

**UNIT - I**

**Basics And Solar Energy:** Definition-Concepts of Non Conventional Energy Sources (NCES), potential and limitations of NCES, their Classification and comparison, Solar Radiation, Basic definitions, Sun to Earth angles, Sun rise, Sunset and Day length

**UNIT - II**

**Solar Energy Collectors:** Flat plate and concentrating collectors along with their applications. Performance of flat plate and concentrating collectors. P-V Cell.

**UNIT- III**

**Solar Energy Storage and Applications:** Solar Satellite, Different Methods of storage, Sensible, Latent and Stratified, Solar engine Stirling and Brayton engines Solar Ponds, solar chimney, solar satellite, Stand alone grid connection

**UNIT - IV**

**Wind Energy:** Wind energy conversion, General formula -Lift and Drag- Basics of wind energy conversion -Effect of density, frequency variances, angle of attack, and wind speed. Windmill rotors- Horizontal axis and vertical axis rotors. Determination of torque coefficient, Induction type generators- working principle, Fuel Cells and MHD Working principles

**UNIT - V**

**Bio-mass and Geothermal Energy:** Availability of Biomass and various conversion process; **Direct Combustion, Thermo chemical and Bio chemical conversion process, Factors effecting generation of Biogas and various types of biogas plants,** Introduction to Geothermal Energy

**Text Books:**

1. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley.
2. Hasan Sayed, and D K Sharma, "Non Conventional Energy Sources", Katson Publishing.
3. G.D. Rai, "Non Conventional Energy Sources".

**Suggested Reading:**

1. S.P. Sukhatme. "Solar Energy", Tata Mcgraw Hill Publishing, 2014..
2. N.K. Bansal, "Non Conventional Energy Sources", Vikas Publishers, 2012.

  
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**20CE A101****DISASTER MITIGATION AND MANAGEMENT**

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	_____
Credits	0

**Objectives:**

1. To equip the students with the basic knowledge of hazards, disasters, risks and vulnerabilities including natural, climatic and human induced factors and associated impacts
2. To impart knowledge in students about the nature, causes, consequences and mitigation measures of the various natural disasters
3. To enable the students to understand risks, vulnerabilities and human errors associated with human induced disasters
4. To enable the students to understand and assimilate the impacts of any disaster on the affected area depending on its position/ location, environmental conditions, demographic, etc.
5. To equip the students with the knowledge of the chronological phases in a disaster management cycle and to create awareness about the disaster management framework and legislations in the context of national and global conventions

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

1. Analyze and critically examine existing programs in disaster management regarding vulnerability, risk and capacity at different levels
2. Understand and choose the appropriate activities and tools and set up priorities to build a coherent and adapted disaster management plan
3. Understand various mechanisms and consequences of human induced disasters for the participatory role of engineers in disaster management
4. Understand the impact on various elements affected by the disaster and to suggest and apply appropriate measures for the same
5. Develop an awareness of the chronological phases of disaster preparedness, response and relief operations for formulating effective disaster management plans and ability to understand various participatory approaches/strategies and their application in disaster management.

**UNIT- I:**

**Introduction:** Basic definitions- Hazard, Disaster, Vulnerability, Risk, Resilience, Mitigation, Management; classification of types of disaster- Natural and man-made; **International Decade for natural disaster reduction (IDNDR); International strategy for disaster reduction (ISDR), National disaster management authority (NDMA).**

**UNIT-II:**

**Natural Disasters:** Hydro meteorological disasters: Causes, Early warning systems- monitoring and management, structural and non-structural measures for floods, drought and Tropical cyclones; Geographical based disasters: Tsunami generation, causes, zoning, Early warning systems- monitoring and management, structural and non-structural mitigation measures for earthquakes, tsunami, landslides, avalanches and forest fires. Case studies related to various hydro meteorological and geographical based disasters.

**UNIT-III:**

**Human induced hazards:** Chemical disaster- Causes, impacts and mitigation measures for chemical accidents, **Risks and control measures in a chemical industry, chemical disaster management;** 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;** Casestudies related to major power break downs, fire accidents, traffic accidents, oil spills and stampedes, disasters due to double cellar construction in multi-storeyed buildings.

**UNIT- IV:**

**Disaster Impacts:** Disasterimpacts- environmental, physical, social, ecological, economical, political, etc.; health, psycho-social issues; demographic aspects- gender, age, special needs; hazard locations; global and national disaster trends; climate change and urban disasters.

**UNIT- V:**

**Concept of Disaster Management:** **Disaster management cycle – its phases; prevention, mitigation, preparedness, relief and recovery; risk analysis, vulnerability and capacity assessment; Post-disaster environmental response- water, sanitation, food safety, waste management, disease control;** Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National Disaster Management Authority.

**Text Books:**

1. Pradeep Sahni, "Disaster Risk Reduction in South Asia", Prentice Hall, 2003.
2. B. K. Singh, "Handbook of Disaster Management: techniques & Guidelines", Rajat Publication, 2008.

**Suggested Reading:**

1. Ministry of Home Affairs, "Government of India, "National disaster management plan, Part I and II"
2. K. K. Ghosh, "Disaster Management", APH Publishing Corporation, 2006.
3. "Hazards, Disasters and your community: A booklet for students and the community", Ministry of home affairs.

**Online Resources:**

1. [http://www.indiaenvironmentportal.org.in/files/file disaster\\_management\\_india1.pdf](http://www.indiaenvironmentportal.org.in/files/file/disaster_management_india1.pdf)
2. [http://www.ndmindia.nic.in/\(National Disaster management in India, Ministry of Home Affairs\)](http://www.ndmindia.nic.in/(National%20Disaster%20management%20in%20India,%20Ministry%20of%20Home%20Affairs))



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**20EG A101****ENGLISH FOR RESEARCH PAPER WRITING**

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	_____
Credits	0

**Objectives:** The Course will introduce the students to

1. Understand the nuances of language and vocabulary in writing a Research Paper.
2. Develop the content, structure and format of writing a research paper.
3. Produce original research papers without plagiarism.

**Outcomes:** After successful completion of the course, the students will be able to

1. Interpret the nuances of research paper writing.
2. Differentiate the research paper format and citation of sources.
3. To review the research papers and articles in a scientific manner.
4. Avoid plagiarism and be able to develop their writing skills in presenting the research work.
5. Create a research paper and acquire the knowledge of how and where to publish their original research papers.

**UNIT - I**

**Academic Writing :** Meaning & Definition of a research paper– Purpose of a research paper – Scope – Benefits – Limitations – outcomes.

**UNIT - II**

**Research Paper Format:** Title – Abstract – Introduction – Discussion – Findings – Conclusion – Style of Indentation – Font size/Font types – Indexing – Citation of sources.

**UNIT- III**

**Research Methodology:** Methods (Qualitative – Quantitative) Review of Literature. Criticizing, Paraphrasing & Plagiarism.

**UNIT - IV**

**Process of Writing a research paper:** Choosing a topic - Thesis Statement – Outline – Organizing notes - Language of Research – Word order, Paragraphs – Writing first draft –Revising/Editing - The final draft and proof reading.

**UNIT - V**

**Research Paper Publication:** Reputed Journals- National/International- ISSN No, No. of volumes, Scopus Index/UGC Journals – Free publications - Paid Journal publications – /Advantages/Benefits

**Text Books:**

1. C. R Kothari, Gaurav, Garg, “Research Methodology Methods and Techniques”, 4/e, New Age International Publishers.

**Suggested Reading:**

1. Day R, “How to Write and Publish a Scientific Paper”, Cambridge University Press, 2006
2. “MLA Hand book for writers of Research Papers”, 7/e, East West Press Pvt. Ltd, New Delhi
3. Lauri Rozakis, Schaum’s, “Quick Guide to Writing Great Research Papers”, Tata McGraw Hills Pvt. Ltd, New Delhi.

**Online Resources:**

1. NPTEL: [https://onlinecourses.nptel.ac.in/noc18\\_mg13/preview](https://onlinecourses.nptel.ac.in/noc18_mg13/preview)

  
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**20EG A102****INDIAN CONSTITUTION AND FUNDAMENTAL RIGHTS**

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	_____
Credits	0

**Objectives:** The Course will introduce the students to

1. The history of Indian Constitution and its role in the Indian democracy.
2. Address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement. to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. Have knowledge of the various Organs of Governance and Local Administration.

**Outcomes:** After successful completion of the course, the students will be able to

1. Understand the making of the Indian Constitution and its features.
2. Understand the Rights of equality, the Right of freedom and the Right to constitutional remedies.
3. Have an insight into various Organs of Governance - composition and functions.
4. Understand powers and functions of Municipalities, Panchayats and Co-operative Societies.
5. Understand Electoral Process, special provisions.

**UNIT - I**

**History of making of the Indian constitutions:** History, Drafting Committee (Composition & Working).

**Philosophy of the Indian Constitution:** Preamble, Salient Features.

**UNIT - II**

**Contours of Constitutional Rights and Duties -** Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, **Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.**

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**UNIT- III**

**Organs of Governance - Parliament: Composition, Qualifications, Powers and Functions**

**Union Executives :** President, Governor, Council of Ministers, Judiciary, appointment and transfer of judges, qualifications, powers and functions

**UNIT - IV**

**Local Administration - District's Administration head: Role and importance. Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Panchayati Raj: Introduction, PRI: Zilla Panchayat, Elected Officials and their roles, CEO Zilla Panchayat: positions and role.**

Block level: Organizational Hierarchy(Different departments) Village level: role of elected and appointed officials. Importance of grass root democracy.

**UNIT - V**

**Election commission:** Election Commission: Role and functioning, Chief Election Commissioner and Election Commissioners, State Election Commission :Role and functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

**Text Books:**

1. Dr. S. N. Busi, Dr. B. R. Ambedkar, "Framing of Indian Constitution", 1/e, 2015.
2. M. P. Jain, "Indian Constitution Law", 7/e, Lexis Nexis, 2014

**Suggested Reading:**

1. "The Constitution of India", 1950 (Bare Act), Government Publication
2. D.D. Basu, "Introduction to the Constitution of India", Lexis Nexis, 2015.

**Online Resources:**

1. <http://www.nptel.ac.in/courses/103107084/Script.pdf>

  
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**20ME E204****ENERGY CONSERVATION AND MANAGEMENT**

(Programme Elective – II)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** Student will understand

1. Know the importance of energy sector in countries' development
2. Identify various auditing services
3. Prepare the organizational structure energy policy
4. Get the concept of management in process industries
5. Explain how to take tax considerations

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

1. Know energy scenario both India and world
2. Review and asses the various audit tools
3. Understand energy policy planning and take energy management as a profession
4. Analyze energy security, codes, standards
5. Arrange the financial arrangements for industries

**UNIT - I**

**Global & Indian Energy Scenario:** Classification of Energy sources-Energy needs of growing economy-Energy sector reform, **Energy and Environment: Global Environmental Concerns, Basics of Energy and its various forms.**

**UNIT - II**

**Energy Audit:** Types of energy audit, Energy Auditing Services Basic Components of an Energy Audit Specialized Audit Tools Industrial Audits Commercial Audits Residential Audits Indoor Air Quality

**UNIT- III****Energy Management:** Program

**Organizational Structure, Energy Policy Planning Audit Planning Educational Planning Strategic Planning,** The Value of Energy Management The Energy Management Profession Some Suggested Principles of Energy Management, Energy Management Systems Justification of EMCSs Systems Integration

**UNIT - IV**

**Waste Heat Recovery:** Energy Management in Process Industries, Energy Security, Codes, Standards, Electricity Act, Energy Conservation Act. Economics of Waste-Heat Recovery, Energy management in water and waste water treatment – solid waste treatment- air pollution control systems . **Energy Management in Boilers and Fired systems – Steam and condensate systems – cogeneration –**

**UNIT - V**

**Capital Investments:** Introduction General Characteristics of Capital Investments, **Sources of Funds Tax Considerations Time Value of Money Concepts Project Measures of Worth Economic Analysis-Financing Energy Management Projects** Introduction Financial Arrangements: A Simple Example Financial Arrangements: Details and Terminology Applying Financial Arrangements: A Case Study “Pros” & “Cons”

**Text Books:**

1. W. C. Turner, “Energy Management Handbook”, 5/e, Marcel Dekker, Inc, New York, 2005.
2. W. R. Murphy and G. McKay, “Energy Management”, Butterworth Heinemann, 2007.

**Suggested Reading:**

1. “General Aspects of Energy Management and Audit”, National Productivity Council of India, Chennai (Course Material- National Certification Examination for Energy Management).
2. B. L. Capehart, W. C. Turner, W. J. Kennedy, “Guide to Energy Management”, CRC Press, New York, 2005.

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**20EG A104****PERSONALITY DEVELOPMENT THROUGH LIFE'S  
ENLIGHTENMENT SKILLS**

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	_____
Credits	0

**Objectives:** The Course will introduce the students to

1. Learn to achieve the highest goal happily.
2. Become a person with stable mind, pleasing personality and determination.
3. Awaken wisdom among them.

**Outcomes:** After successful completion of the course, the students will be able to

1. Develop their personality and achieve their highest goal of life.
2. Lead the nation and mankind to peace and prosperity.
3. Practice emotional self regulation.
4. Develop a positive approach to work and duties.
5. Develop a versatile personality.

**UNIT - I**

**Neetisatakam – Holistic Development of Personality** - Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)

**UNIT - II**

**Neetisatakam – Holistic Development of Personality (cont'd)** - Verses 52, 53, 59 (don't's) - Verses 71,73,75 & 78 (do's) - Approach to day to day works and duties.

**UNIT- III**

**Introduction to Bhagavadgeetha for Personality Development - Shrimad Bhagavadgeetha:** Chapter 2 – Verses 41, 47, 48 - Chapter 3 – Verses 13,21,27,35 - Chapter 6 – Verses 5,13,17,23,35 - Chapter 18 – Verses 45, 46, 48  
Chapter – 6: Verses 5, 13, 17, 23, 35; Chapter – 18: Verses 45, 46, 48

**UNIT - IV**

**Statements of Basic Knowledge - Shrimad Bhagavadgeetha:** Chapter 2- Verses 56, 62,68 - Chapter 12 – Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bhagawat Geeta.

**UNIT - V**

**Role of Bhagavadgeetha in the Present Scenario** - Chapter 2 – Verses 17 -  
Chapter 3 – Verses 36, 37, 42 - Chapter 4 – Verses 18, 38, 39 - Chapter 18 – Verses  
37, 38, 63.

**Text Books:**

1. “Srimad Bhagavad Gita”, Swami SwarupanandaAdvaita Ashram  
(Publication Department), Kolkata

**Suggested Reading:**

1. “Bhartrihari’s Three Satakam (Niti-sringar-vairagya)”, P.Gopinath,  
Rashtriya Sanskrit Sansthanam, New Delhi

**Online Resources:**

1. NTPEL: <http://nptel.ac.in/downloads/109104115/>

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**20ME C203****THERMAL SYSTEMS LAB**

Instruction	4 Hours per week
Duration of SEE	---
SEE	---
CIE	50 Marks
Credits	2

**Objectives:** Student will understand to

1. Evaluate the performance of I.C Engine
2. Determine heat transfer coefficient in two phase heat transfer
3. Determine effectiveness of cross flow heat exchanger
4. Evaluate the thermal properties of fluids
5. Evaluate the COP of Refrigeration & Air conditioning Tutors

**Outcomes:** At the end of the course, 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. Find out properties of fluids such as coefficient of thermal expansion, enthalpy of fusion
5. Determine COP of Refrigeration and air conditioned tutors

**List of Experiments:**

1. Performance Evaluation on single/multi cylinder 4-stroke SI Engine.
2. Performance Evaluation on single/multi cylinder 4 stroke CI Engine.
3. Determination of heat transfer coefficient in Film wise and Drop wise condensation
4. To determine the effectiveness of Cross flow Heat Exchanger.
5. Heat Pipe Demonstration
6. Performance test on Axial flow compressor
7. Determination of coefficient of thermal expansion of Solids, Liquids and Gases
8. Determination of thermal capacity of Solids
9. Determination of isentropic coefficient of air by Clement-Desormes method
10. Measure of enthalpy of fusion and solidification
11. Determination of COP of Refrigeration tutor
12. Determination of COP of Air-conditioning tutor


**Note :** Out of the above 12 experiments, any ten experiments have to be carried out.

**Text Books:**

1. Younus. A. Cengel & Michael A. Boles, “Thermodynamics An Engineering Approach”, 7/e, TMH.
2. Y.V.C. Rao. “Postulates and Statistical Thermodynamics”, Allied Publishers Inc., 1994.

**Suggested Reading:**

1. P.K. Nag, “Basic and Applied Thermodynamics”, TMH, 2008.
2. J.P.Holman, “Thermo Dynamics”, Mc Graw Hill, 2008.
3. Howell and Dedcius, “Fundamentals of Engineering Thermodynamics”, McGraw Hill Inc., U.S.A.

  
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**20ME C204****DESIGN OF SOLAR AND WIND SYSTEMS LAB**

Instruction	4 Hours per week
Duration of SEE	---
SEE	---
CIE	50 Marks
Credits	2

**Objectives:** To make the students to understand

1. Concepts of solar energy collection and measurements
2. Wind and solar thermal applications
3. Direct conversion using solar PV cell
4. Wind turbine working and factors effecting its performance
5. Bio energy conversion principles

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

1. Measure radiation using various instruments
2. Find the performance of solar water pump, water heater
3. Determine the effect of tilting angle on pv cell
4. Evaluate efficiency of wind turbine
5. Differentiate KVIC and JANATABio energy conversion systems

**List of Experiments:**

1. Study of direct and diffused beam solar radiation (Solar Radiation Measurement)
2. Performance evaluation of solar flat plate collector (water heating, water pumping)
3. Performance evaluation of concentrating solar collector
4. Performance of PV panel in series and parallel combination: (Charging characteristics of a battery using PV panel, Effect of tilt angle on solar PV panel, Effect of shadow on solar PV panel , Effect of surrounding temperature on PV panel )
5. Study of direct and indirect solar dryer ( how to dry various types of Agricultural products)
6. Analysis of KVIC Bio gas plant
7. Performance studies of Gasifier
8. Study of Janata Bio gas plant, Deenabandhu Biogas plant for demonstration
9. Small wind turbine of 500kw for the purpose of demonstration

**Text Books:**

1. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley.
2. Hasan Sayed and D. K. Sharma, "Non Conventional Energy Sources", Katson Publishing.
3. G.D. Rai, "Non Conventional Energy Sources".

**Suggested Reading:**

1. P. Sukhatme "Solar Energy", Tata Mcgraw Hill Publishing, 2004
2. N.k. Bansal, "Non Conventional Energy Sources".Vikas Publishing, 2009.

  
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**20ME C106****FINITE ELEMENT TECHNIQUES**

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** To make the students to

1. Understand finite element analysis fundamentals and formulations
2. Formulate the axial, truss, beam and 2D problems
3. Formulate the heat conduction and dynamics problems, understand the use of numerical integration and Gauss quadrature
4. Understand the convergence requirements and 3D problems
5. Perform engineering simulations using finite element analysis software (ANSYS)

**Outcomes:** At the end of the course, 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, truss and beam, torsional analysis of circular shaft
3. Analyze 2D structural problems using CST element and analyze the axi-symmetric problems with triangular elements. Write shape functions for 4 node quadrilateral, isoparametric elements and apply numerical integration and Gaussian quadrature to solve the problems.
4. Evaluate the eigen values and eigen vectors for stepped bar, formulate 3 D elements, check for convergence requirements
5. Solve linear 1 D and 2 D heat conduction and convection heat transfer problems, Use of FEA software ANSYS for engineering solutions

**UNIT - I**

**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.

**UNIT - II**

**Analysis of Trusses:** 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:** Analysis of frames with two translations and a rotational degree of freedom at each node.

**UNIT- III**

**Two Dimensional Stress Analysis:** Finite element modeling of two dimensional stress analysis problems with constant strain triangles and treatment of boundary conditions. Two dimensional four noded isoparametric elements and numerical integration. Finite element modeling of Axisymmetric solids subjected of axisymmetric loading with triangular elements.

Convergence requirements and geometric isotropy

**UNIT - IV**

**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.

**UNIT - V**

**Three Dimensional Problems in Stress Analysis:** 3D elements: Introduction to tetrahedron and brick elements.

Introduction to thin and thick plates

Introduction to non-linear formulation through FE.

**Text Books:**

1. R. Tirupathi. Chandrupatla and D.B. Ashok, "Introduction of Finite Element in Engineering", Prentice Hall of India, 2004.
2. S.S. Rao. "The Finite Element Methods in Engineering", 2/e, Pergamon Press, 2001.
3. David. V. Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw Hill, 2003.

**Suggested Reading:**

1. Robert Cook , “Concepts and applications of finite element analysis”, 4/e, John Wiley and sons, 2009.
2. K.J. Bathe, “Finite element procedures”, 2/e, Prentice Hall of India, 2007.
3. D.L. Logan, “First course in finite element method”, 5/e, Mason, OH: South Western, Cengage Learning, 2011.

  
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**20ME C205****ADVANCED HEAT AND MASS TRANSFER**

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** To make the students to

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 principles of phase heat transfer and radiation heat transfer
5. Learn about mass transfer and its applications in process industries

**Outcomes:** At the end of the course, 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 and radiation heat transfer
5. Apply the knowledge of mass transfer in process industries

**UNIT - I**

**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**

**UNIT - II**

**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

### UNIT- III

**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 various geometries 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**

### UNIT - IV

**Free Convection & Radiation:** Approximate analysis on laminar free convective heat transfer – Boussinesque Approximation - Different geometries – combined free and forced convection, Boiling and condensation: Boiling curve – Correlations- Nusselt's theory of film condensation on a vertical plate – Assumptions & correlations of film condensation for different geometries

### UNIT - V

**Mass Transfer: 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.**

#### Text Books:

1. Necati Ozisik, "Heat Transfer", TMH, 1998.
2. Incropera Dewitt, "Fundamentals of Heat & Mass Transfer", John Wiley, 2007.
3. Yunus A. Cengel, "Heat Transfer: A basic approach", TMH, 2008.

#### Suggested Reading:

1. R. C. Sachdeva, "Fundamentals of Engineering Heat & Mass Transfer", New Age International Publications, 2010.
2. J.P. Holman, "Heat Transfer", Mc Graw Hill, 2008.

  
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## 20ME E206

**COMPUTATIONAL FLUID DYNAMICS**  
(Programme Elective – III)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** To make the students to learn the

1. Basic equations and concept of CFD
2. Concept of pdes and finite difference methods
3. Various types of grid generation and errors in numerical solution
4. Crank-Nicolson, Implicit and Explicit methods & Jacobi, Gauss Seidel and ADI methods
5. Importance of FVM

**Outcomes:** At the end of the course, student 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-Nicolson, Implicit and Explicit methods and analyze problem by Jacobi, Gauss Seidel and ADI methods
5. Solve conduction and convection problems using FVM.

**UNIT - I**

**Governing Equations:** Continuity, Momentum and Energy equations, Navier Stokes equations, Reynolds and Favre averaged N – S equations. Introduction to turbulence, **Turbulence models-mixing length model, K- $\epsilon$  turbulence Model.**

**UNIT - II**

**Grid Generation:** Grid Generation- Types of grid O,H,C. Coordinate transformation, Unstructured grid generation, **Errors, Consistency, Stability analysis by von Neumann. Convergence criteria**

**UNIT- III**

**Classification of PDEs:** Elliptic, parabolic and hyperbolic equations, Initial and boundary conditions. Concepts of Finite difference methods – forward, backward and central difference



**UNIT - IV**

**Finite Difference Solutions:** Finite difference solutions - Crank Nicholson, Implicit and explicit, ADI - Jacobi, Gauss Seidel, solution for Viscous incompressible flow using Stream function – Vorticity method

**UNIT - V**

**Finite Volume Method:** 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

**Text Books:**

1. John D. Anderson, "Computational Fluid Dynamics", Mc Graw Hill Inc., 2015.
2. H. K. Versteeg and Malala Shekara, "Introduction to Finite Volume Method", Pearson, 2015.

**Suggested Reading:**

1. K. Muralidhar and T. Sundararajan T., "Computational Fluid flow and Heat transfer", Narosa Publishing House, 2003.
2. S.V.Patankar, "Numerical Heat transfer and Fluid flow", Hemisphere Publishing Company, New York, 1980.

  
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20ME E207

**REFRIGERATION AND CRYOGENICS**

(Programme Elective – III)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** To make the students to learn the

1. Importance of selection of refrigerant,
2. Utility of simple vapour compression refrigeration cycle
3. Working principle of absorption refrigeration cycle,
4. The design principles of components of refrigeration system
5. Working principle of gas liquefaction

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

1. Learn the applications of refrigeration and ODP, GWP and related environment issues
2. To design the refrigeration systems for domestic applications
3. Understand absorption refrigeration system and its advantages over vapor compression refrigeration
4. Design equipment needed for refrigeration system like evaporators, condensers.
5. To understand the applications in cryogenics and gas-liquefaction system

**UNIT - I**

**Fundamentals of Refrigeration:** Definition of refrigeration, applications of refrigeration, COP, tone of refrigeration, refrigerants and their classification, properties of refrigerants, designation of refrigerants, ozone depletion, eco-friendly refrigerants, Air Refrigeration, Bell Coleman cycle, air craft refrigeration, classification

**UNIT - II**

**Vapor Compression Refrigeration System:** Actual cycle, theoretical cycle, flash chamber, accumulator, sub-cooling, superheating, cascade refrigeration, wet compression, dry compression, improvements in the performance of cycle, multi-stage compression with Intercooling, multi-evaporator system

**UNIT- III**

**Vapor Absorption Refrigeration System:** Absorption Refrigeration, Simple and Practical NH<sub>3</sub> refrigeration, Electrolux refrigeration, LiBr refrigeration system, Efficiency of absorption refrigeration system, steam jet refrigeration, merits and demerits of steam jet refrigeration over simple vapour compression cycle

**UNIT - IV**

**Refrigeration Applications and Psychrometry:** Design, selection of evaporators, condensers, control systems, motor selection, Refrigeration applications, food preservation, transport, Introduction to psychrometry, psychrometric processes, humidifiers, de-humidifiers, filters, ducts

**UNIT - V**

**Cryogenics:** Application of cryogenics, Gas liquefaction systems - Linde-Hampson, Linde dual pressure, Claude cycle, merits of one system over other system, Production of liquid air, Production of liquid nitrogen and production of liquid oxygen.

**Text Books**

1. C. P.Arora, "Refrigeration and Air-conditioning", Tata McGraw-Hill, 2000.
2. Stoecker & Jones, "Refrigeration and Air-conditioning", McGraw Hill Book Company, 1992.
3. Bailey, "Advanced Cryogenics", Plenum Press, London, 1971.

**Suggested Books.**

1. Jordan & Priester, "Refrigeration and Air-conditioning", Prentice-Hall, 2/e, 1957.
2. G.G.Hasseldon, "Cryogenic Fundamentals", Academic Press, 1992.

  
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20ME E208

**DESIGN OF HEAT EXCHANGERS**

(Programme Elective – III)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** To make the students to learn the

1. Importance of heat exchanger in engineering application
2. Various co-relations for forced convection heat transfer coefficients for different geometries
3. Importance of pressure drop and its effect on heat transfer rate
4. Working principle of hair pin heat exchanger
5. Design concepts of condensers and heat pipe

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

1. Explain different types of heat exchangers, LMTD method and NTU methods
2. List out co-relations for forced convection heat transfer coefficient for various geometries
3. Estimate the pressure drop in laminar and turbulent flow in heat exchangers
4. Determine pressure drop in hair pin and finned tube heat exchangers
5. Explain design and operational considerations in condensers and heat pipes

**UNIT - I**

**Heat Exchanger Types and Design Methods:** Tubular heat exchangers, plate heat exchangers, extended surface heat exchangers, flow arrangements, applications, overall heat transfer coefficient, multi-pass and cross flow heat exchangers, LMTD method, NTU method for heat exchanger analysis

**UNIT – II**

**Forced Convection Heat Transfer Coefficient:** Laminar forced convection in ducts and concentric annuli, turbulent forced convection in ducts and circular pipes, heat transfer in helical coils, and spirals and heat transfer in bends

**UNIT – III**

**Pressure Drop and Fouling:** Tube side pressure drop in laminar and turbulent flows, pressure drop in bends and fittings, Fouling of heat exchangers, basic considerations, effect of fouling on heat transfer and pressure drop.

**UNIT - IV**

**Hair Pin and Finned Heat Exchangers:** Pressure drop-hydraulic diameter, hair pin heat exchanger, parallel and series arrangements of hairpins, total pressure drop, compact heat exchangers, plate-fin heat exchangers, tube fin heat exchangers, pressure drop for fin tube heat exchanger

**UNIT - V**


**Condensers:** Horizontal shell and tube condensers, plate condensers, air cooled condensers, design and operational considerations, Heatpipe, working principle, heat pipe components and materials

**Text Books:**

1. Donald Q. Kern, "Process Heat Transfer", TMH Publications, 1963.
2. Sadik Kakac and Hongtan Liu, "Heat Exchangers-Selection, Rating and Thermal Design", 3/e, CRC Press, 2012.
3. David Reay and Peter Kew, "Heat Pipes, Theory, design and Applications", Butterworth-Heinemann (Elsevier), 5/e, 2006.

**Suggested Reading:**

1. S. Kakac, A. E. Bergles and F. Mayinger, "Heat Exchangers, Thermal, Hydraulic Fundamentals and Design", Hemisphere Publications, 1981.
2. "Standards of Tubular Exchangers Manual Association (TEMA)", 7/e, 1988.

  
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20ME E209

**TURBO MACHINES**  
(Programme Elective – IV)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** Student will understand

1. Principles and equations of turbo machinery
2. Velocity triangle and power developed by steam turbines
3. Working principles of Pelton, Francis and Kaplan turbines
4. Working principles of axial flow compressor and centrifugal compressor and their performance
5. Power required for rotary compressors and power developed by gas turbines

**Outcomes:** At the end of the course, student 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 the efficiency, pressure rise, degree of reaction, slip factor and performance of axial flow and centrifugal compressors
5. Understand cycles and improve the cycle efficiency in gas turbines

### UNIT - I

**Fundamentals of Turbo Machines:** Classifications, Applications, Isentropic flow, Energy transfer, Efficiencies, Static and Stagnation conditions, Fluid equations - continuity, Euler's, Bernoulli's equation and its applications. Euler's flow through variable cross sectional areas.

### UNIT - II

**Steam Turbines:** 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

### UNIT- III

**Hydraulic Turbines:** 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.

**UNIT - IV**

**Axial Flow Compressors and Centrifugal Compressors:** Work and velocity triangles, Efficiencies, Stage pressure rise, Degree of reaction, Performance of compressors, Velocity triangles and efficiencies; slip factor, performance of compressors.

**UNIT - V**


**Gas Turbines:** Principle of working – Classification – Joule’s cycle – work done and efficiency – Brayton Cycle – Optimum Pressure ratio for maximum power and maximum efficiency –  $P_{\max}$  and  $\eta_{\max}$  – Improvement in cycle performance – Intercooling, Reheating and Regeneration (Heat exchanging) – Problems using these principles.

**Text Books:**

1. S. M. Yahya, “Turbines, Compressors and Fans”, 4/e, Tata McGraw-Hill Education Pvt. Ltd., 2010.
2. G. Gopalakishnan and D. Prithvi Raj, “A treatise on Turbomachines”, Scitec Publications, Chennai, 2002.
3. Seppo. A. Korpela, “Principles of Turbomachinery”, John Wiley & sons Inc. Publications, 2011.

**Suggested Reading:**

1. R. K. Turton, “Principles of Turbomachinery”, E & F N Spon Publishers, London & New York, 2004.
2. Dennis G. Shepherd, “Principles of Turbomachines”, Macmillan, 2007.

  
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**20ME E210****GAS TURBINES**  
(Programme Elective – IV)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** Student will understand

1. Adiabatic energy equation of nozzle.
2. Thermodynamic cycle of gas turbine
3. Working principle of rotary compressors.
4. Working principle of gas turbine power plant.
5. Working principle of jets and propulsions.

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

1. Design nozzle with known inlet conditions
2. Evaluate thermal efficiency of gas turbines and its improvement
3. Determine overall efficiency of Axial flow compressor and Centrifugal compressors
4. Design combustion system for gas turbine plant
5. Determine thrust and propulsive force developed by jets and rockets.

**UNIT - I**

**Gas Dynamics Fundamentals:** Conservation Laws and governing equations for Mass, Momentum and Energy for Compressible flows; Basic definitions for Static and Stagnation Pressure, Mach Wave, Mach Angle and Over expanding Nozzle, Adiabatic Flow through Converging-Diverging Nozzle, Adiabatic Flow through a constant area duct, Phenomenon of Shock, Rayleigh Lines, Fanno Lines in ductflows

**UNIT - II**

**Gas Turbines:** Relative merits over conventional IC Engines, Introduction to Brayton and Atkinson cycle for Gas turbines, Pressure Ratio, Thermal Efficiency, Specific Output, optimum pressure ratio, Enhancement of Thermal Efficiency and/or specific power output using inter cooling, heat exchangers, reheat burners

**UNIT- III**

**Compressors:** Centrifugal Compressor-Major components – Inducer, Impeller, Vaneless Diffuser, Vaned Diffuser, Volute Casing, Velocity & Pressure variation



in a stage, Degree of Reaction, Prewhirl and Surging. Axial Flow Compressor : Stage consisting of a Rotor and a Stator, Pressure Rise in a Stage, Polytropic Efficiency, Losses in a Compressor stage, Phenomenon of Blade Stall & Surging and Phenomenon of Chocking, Performance Curves

#### UNIT - IV

**Gas Turbine Power Plants:** Fuel and fuel feed systems; combustion systems- design considerations and flame stabilization; regenerator types and design; gas turbine power; plant performance. Application of airfoil theory to the study of flow through turbine blades; aerodynamic and thermodynamic design considerations; blade materials; blade attachments and blade cooling.

#### UNIT - V

**Jets and Propulsion:** Concept of Propulsion and Thrust, Variety of Propulsion systems for flying vehicles – Turbo-prop, Turbojet, Ram Jet, Pulse Jet, Analysis of propulsion cycle. Thrust Augmentation: Water Injection, Liquid Injection, Afterburning, Bleed Air system


**Rocket Propulsion:** Distinction between Turbojets and Rockets, Rocket Thrust, Specific Impulse, Total Impulse, Thermal Efficiency, Rocket Equation and applications.

#### Text Books:

1. H. I. H. Saravanamuttoo, G. F. C. Rogers, H. Cohen , Paul Straznicky, "Gas Turbine Theory", Pearson education. Ltd, 6/e, 2009.
2. V.Ganesan, "Gas Turbines", Tata McGraw-Hill Education, 3/e, 2010.

#### Suggested Reading:

1. S. M. Yahya, "Turbines, Compressors and Fans", Tata McGraw-Hill Education, 1992.
2. Vincent, "The Theory and design of Gas Turbines and Jet Engines", McGraw-Hill Education, 1950.

  
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**POWER PLANT CONTROL AND INSTRUMENTATION**  
(Programme Elective – IV)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

**Objectives:** Student will understand

1. Principles of static and dynamic characteristics of instruments
2. Working principles of feedback control concepts of electrical parameters
3. Create awareness of the importance of working principles of various measuring instruments, their applications in engineering industry and understand characteristics of instruments
4. Familiarize the principles of data acquisition along influence of electrical parameters on instrumentation
5. Understand the principles of modeling of power systems

**Outcomes:** At the end of the course, 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 and model power systems using various numerical methods
4. Estimate the role of computers for data acquisition
5. Represent various types of process control system

### UNIT - I

**Static & Dynamic Characteristics of Instruments:** Static & dynamic characteristics of instruments, sensors, signal processing & data transmission elements, indicating & recording elements

### UNIT - II

**Data Acquisition:** Use of computers for data acquisition & instrumentation for measuring temperature, pressure flow, speed, vibration & noise

### UNIT- III

**Electrical Parameters:** On-line process instruments. Automatic process control systems Representation. Feedback control concepts. Transient & Frequency response. Types of controllers

**UNIT - IV**

**Stability Of Instruments: Stability, Digital Control System Modern Control theory. Boiler Control, Governing & Control of turbo-machines**

**UNIT – V**


**Computer Aided Power Systems Analysis:** Modelling 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.

**Text Books:**

1. T.G.Beckwith and N. Lewis Buck, "Mechanical Measurements". Wesley Publishing, 1961.
2. K. Tayal, "Instruments and Mechanical Measurements", Galgotia Publications.
3. Mc Cloy and H.R. Martin, "The Control of Fluid Power", Longman Publication, 1973.
4. D.A. Williams and G. James, "Liquid Fuels", London Pergamon, 1963.

**Suggested Reading:**

1. David Lindsley, "Power-Plant Control and Instrumentation", IEE Control Engineering Series 585.
2. W. Bolton, "Instrumentation and Control Systems", 1/e, Elsevier, 2004.

  
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**20EE A101****SANSKRIT FOR TECHNICAL KNOWLEDGE**

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	_____
Credits	0

**Objectives:**

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. To make the novice Learn the Sanskrit to develop the logic in mathematics, science & other subjects
3. To explore the huge knowledge from ancient Indian literature

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

1. Develop passion towards Sanskrit language
2. Decipher the latent engineering principles from Sanskrit literature
3. Correlates the technological concepts with the ancient Sanskrit history.
4. Develop knowledge for the technological progress
5. Explore the avenue for research in engineering with aid of Sanskrit

**UNIT-I**

**Introduction to Sanskrit Language:** Sanskrit Alphabets-vowels-consonants-significance of Amarakosa-parts of speech-Morphology-creation of new words-significance of synonyms-sandhi-samasa-sutras-active and passive voice-Past/Present/Future Tense-syntax-Simple Sentences (elementary treatment only)

**UNIT-II**

**Role of Sanskrit in Basic Sciences:** Brahmagupthas lemmas (second degree indeterminate equations), sum of squares of n-terms of AP- sulba\_sutram or baudhayana theorem (origination of pythagorous theorem)-value of pie-Madhava's sine and cosine theory (origination of Taylor's series).

The measurements system-time-mass-length-temp, Matter elasticity-optics-speed of light (origination of michealson and morley theory).

**UNIT-III**

**Role of Sanskrit in Engineering-I (Civil, Mechanical, Electrical and Electronics Engineering):**

Building construction-soil testing-mortar-town planning-Machine definition-crucible-furnace-air blower- Generation of electricity in a cell-magnetism-Solar

system-Sun: The source of energy, the earth-Pingala chandasutram (origination of digital logic system)

#### UNIT-IV

**Role of Sanskrit in Engineering-II (Computer Science Engineering & Information Technology):** Computer languages and the Sanskrit languages-computer command words and the vedic command words-analogy of pramana in memamsa with operators in computer language-sanskrit analogy of physical sequence and logical sequence, programming.

#### UNIT-V

**Role of Sanskrit in Engineering-III (Bio-technology and Chemical Engineering):** Classification of plants-plants, the living-plants have senses-classification of living creatures, Chemical laboratory location and layout-equipment-distillation vessel-kosthi yanthram

#### Text Books:

1. M Krishnamachariar, "History of Classical Sanskrit Literature", TTD Press, 1937.
2. M.R. Kale, "A Higher Sanskrit Grammar: For the Use of School and College Students", Motilal Banarsidass Publishers, ISBN-13: 978-8120801783, 2015

#### Suggested Reading:

1. Kapail Kapoor, "Language, Linguistics and Literature: The Indian Perspective", ISBN- 10: 8171880649, 1994.
2. "Pride of India", Samskrita Bharati Publisher, ISBN: 81-87276-27-4, 2007
3. Shri RamaVerma, "Vedas the source of ultimate science", Nag publishers, ISBN:81-7081-618-1,2005

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**20EC A101****VALUE EDUCATION**

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	<hr/>
Credits	0

**Objectives:** This course aims to:

1. Understand the need and importance of Values for self-development and for National development.
2. Imbibe good human values and Morals
3. Cultivate individual and National character.

**Outcomes:** After completion of the Course, students will be able to:

1. Gain necessary Knowledge for self-development
2. Learn the importance of Human values and their application in day to day professional life.
3. Appreciate the need and importance of interpersonal skills for successful career and social life
4. Emphasize the role of personal and social responsibility of an individual for all-round growth.
5. Develop a perspective based on spiritual outlook and respect women, other religious practices, equality, non-violence and universal brotherhood.

**UNIT-I**

**Human Values, Ethics and Morals:** Concept of Values, Indian concept of humanism, human values; Values for self-development, Social values, individual attitudes; Work ethics, moral and non-moral behaviour, standards and principles based on religion, culture and tradition.

**UNIT-II**

**Value Cultivation, and Self-management:** Need and Importance of cultivation of values such as Sense-of Duty, Devotion to work, Self-reliance, Confidence, Concentration, Integrity & discipline, and Truthfulness.

**UNIT-III**

**Spiritual outlook and social values:** Personality and Behavior, Scientific attitude and Spiritual (soul) outlook; Cultivation of Social Values Such as Positive

Thinking, Punctuality, Love & Kindness, Avoiding fault finding in others, Reduction of anger, forgiveness, Dignity of labour, Truefriendship, Universal brotherhood and religious tolerance.

#### UNIT-IV

**Values in Holy Books** : Self-management and Good health; internal & external cleanliness, Holy books versus Blind faith, Character and Competence, Equality, Nonviolence, Humility, Role of Women.

#### UNIT-V

**Dharma, Karma and Guna**: Concept of soul; Science of Reincarnation, Character and Conduct, Concept of Dharma; Cause and Effect based Karma Theory; The qualities of Devine and Devilish; Satwic, Rajasic and Tamasic gunas.

#### Text Books:

1. Chakroborty, S.K. "Values & Ethics for organizations Theory and practice", Oxford University Press, New Delhi, 1998.

#### Suggested Reading:

1. Jaya Dayal Goyandaka, "Srimad Bhagavad Gita with Sanskrit Text, Word Meaning and Prose Meaning", Gita Press, Gorakhpur, 2017.

  
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**20IT A101****PEDAGOGY STUDIES**

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	<hr/>
Credits	0

**Course Objectives:**

1. To present the basic concepts of design and policies of pedagogy studies.
2. To provide understanding of the abilities and dispositions with regard to teaching techniques, curriculum design and assessment practices.
3. To familiarize various theories of learning and their connection to teaching practice.
4. To create awareness about the practices followed by DFID, other agencies and other researchers.
5. To provide understanding of critical evidence gaps that guides the professional development.

**Course Outcomes:** Upon completing this course, students will be able to:

1. Illustrate the pedagogical practices followed by teachers in developing countries both in formal and informal classrooms.
2. Examine the effectiveness of pedagogical practices.
3. Understand the concept, characteristics and types of educational research and perspectives of research.
4. Describe the role of classroom practices, curriculum and barriers to learning.
5. Understand Research gaps and learn the future directions.

**UNIT-I**

**Introduction and Methodology:** Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions - Overview of methodology and Searching.

**UNIT-II**

**Thematic Overview:** Pedagogical practices followed by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.



**UNIT-III**

**Evidence on the Effectiveness of Pedagogical Practices:** Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and Practicum) and the school curriculum and guidance material best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and pedagogic strategies.

**UNIT-IV**

**Professional Development:** alignment with classroom practices and follow up support - Support from the head teacher and the community – Curriculum and assessment - Barriers to learning: Limited resources and large class sizes.

**UNIT-V**

**Research Gaps and Future Directions:** Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment – Dissemination and research impact.

**Text Books:**

1. Ackers J, Hardman F, "Classroom Interaction in Kenyan Primary Schools, Compare", 31 (2): 245 – 261, 2001.
2. Agarwal M, "Curricular Reform in Schools: The importance of evaluation", Journal of Curriculum Studies, 36 (3): 361 – 379, 2004.

**Suggested Reading:**

1. Akyeampong K, "Teacher Training in Ghana – does it count? Multisite teacher education research project (MUSTER)", Country Report 1. London: DFID, 2003.
2. Akyeampong K, Lussier K, Pryor J, Westbrook J, "Improving teaching and learning of Basic Maths and Reading in Africa: Does teacher Preparation count?", International Journal Educational Development, 33 (3): 272-282, 2013.
3. Alexander R J, "Culture and Pedagogy: International Comparisons in Primary Education", Oxford and Boston: Blackwell, 2001.
4. Chavan M, "Read India: A mass scale, rapid, 'learning to read' campaign", 2003.

**Web Resources:**

1. [https://onlinecourses.nptel.ac.in/noc17\\_ge03/preview](https://onlinecourses.nptel.ac.in/noc17_ge03/preview)
2. [www.pratham.org/images/resources%20working%20paper%202.pdf](http://www.pratham.org/images/resources%20working%20paper%202.pdf).

**20EG A103****STRESS MANAGEMENT BY YOGA**

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	_____
Credits	0

**Objectives:** The Course will introduce the students to

1. Creating awareness about different types of stress and the role of yoga in the management of stress.
2. Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).
3. Prevention of stress related health problems by yoga practice.

**Outcomes:** After successful completion of the course, the students will be able to

1. Understand yoga and its benefits.
2. Enhance Physical strength and flexibility.
3. Learn to relax and focus.
4. Relieve physical and mental tension through asanas
5. Improve work performance and efficiency.

**UNIT - I**

**Meaning and Definition of Yoga-** Historical perspective of Yoga- Principles of Astanga Yoga by Patanjali.

**UNIT - II**

**Meaning and Definition of Stress - Types of stress - Eustress and Distress, Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.**

**UNIT- III**

**Concept of Stress According to Yoga - Stress assessment methods - Role of Asana, Pranayama and Meditation in the management of stress**

**UNIT - IV**

**Asanas- ( 5 Asanas in each posture) - Warm up - Standing Asanas - Sitting Asanas - Prone Asanas - Supine asanas - Surya Namaskar**

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**UNIT - V**

**Pranayama-** Anulom and Vilom Pranayama - Nadishudhi Pranayama - Kapalabhati Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama.

**Meditation Techniques:** Om Meditation - Cyclic meditation : Instant Relaxation technique (QRT), Quick Relaxation Technique ( QRT), Deep Relaxation Technique (DRT)

**Text Books:**

1. "Yogic Asanas for Group Training - Part-I": Janardhan Swami Yogabhyasi Mandal, Nagpur.
2. Swami Vivekananda, "Rajayoga or Conquering the Internal Nature", Advaita Ashrama (Publication Department), Kolkata.

**Suggested Reading:**

1. Nagendra H.R nad Nagaratna R, "Yoga Perspective in Stress Management", Swami Vivekananda Yoga Prakashan, Bangalore,

**Online Resources:**

1. [https://onlinecourses.nptel.ac.in/noc16\\_ge04/preview](https://onlinecourses.nptel.ac.in/noc16_ge04/preview)
2. <https://freevideolectures.com/course/3539/indian-philosophy/11>

  
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**20ME C108****COMPUTER AIDED ENGINEERING LAB**

Instruction	4 Hours per week
Duration of SEE	---
SEE	---
CIE	50 Marks
Credits	2

**Objectives:** To make the students

1. Model one and two-dimensional elements in ANSYS
2. Understand vibration, harmonic and transient analysis
3. Carry out buckling analysis
4. Analyze forming and sheet metal operations by FEA
5. Model crackelement

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

1. Understand the applications of one and two-dimensional elements
2. Solve engineering problems
3. Find buckling factors
4. Understand industrial applications of forming and sheet metal operations
5. Find fracture toughness

**List of Exercises:**

1. Introduction to Finite Element Analysis Software
2. Statically indeterminate reaction force analysis and determination of Beam stresses and Deflection
3. Static analysis of a corner bracket
4. Analysis of cylindrical shell under pressure
5. **Bending of a circular plate using axisymmetric shell element.**
6. Vibration analysis of a simply supported beam
7. Harmonic analysis of plates and shells
8. Transient analysis of vehicle crash
9. Buckling analysis of shells
10. Analysis of forming
11. Analysis of sheet metal operation
12. **Stress intensity factor in cracked plates**

**Note:** Out of the above 12 experiments, any **ten (10)** experiments have to be carried out.

**Text Books:**

1. R. Tirupathi, Chandrupatla and B.D. Ashok, "Introduction of Finite Element in Engineering", Prentice Hall of India, 2004
2. David.V.Hutton, "Fundamentals of Finite Element Analysis", Tata McGrawHill,2003

**Suggested Reading:**

1. Robert Cook, "Concepts and applications of finite element analysis", 4/e, JohnWiley and sons,2009
2. S.S. Rao, ,"The Finite Element Methods in Engineering", 2 /e, Pergamon Press,2001.

  
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**20ME C206****COMPUTATIONAL FLUID DYNAMICS LAB**

Instruction	4 Hours per week
Duration of SEE	---
SEE	---
CIE	50 Marks
Credits	2

**Objectives:** To acquaint the student with

1. Basic steps in a CFD simulation: ANSYS Workbench design modular and meshing
2. Simulation of laminar, turbulent, internal flow, steady and unsteady problems
3. Simulation of steady and unsteady problems
4. Physics setup involves boundary conditions
5. Solution of thermal related problems

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

1. Analyze laminar flow problems in plates and pipes
2. Solve steady and unsteady flow past a cylinder
3. Perform analysis for free and forced convection
4. Evaluate the effect of angle of attack and velocity on NACA aerofoil
5. Simulate compressible flow in a nozzle, premixed combustion

**List of Experiments:**

1. Laminar Flow over Flat plate
2. Laminar PipeFlow
3. Steady Flow past aCylinder
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 Aerofoil.
9. Study of compressible flow through a nozzle
10. Partially premixed combustion analysis
11. Supersonic flow over a wedge
12. Study of flow over wind turbine blade/flow through bifurcation artery

**Note:** Out of the above 12 experiments, any **ten (10)** experiments have to be carried out.

**Text Books:**

1. John D Anderson, “Computational Fluid Dynamics”, Mc Graw Hill, Inc., 2015.
2. H.K. Versteeg and Malala Shekara, “Introduction to Finite Volume Method”, Pearson, 2015

**Suggested Reading:**

1. J.H. Ferziger and M. Peric, “Computational Methods for Fluid Dynamics”, Springer.
2. K. Muralidhar and T. Sundararajan T, “Computational Fluid flow and Heat transfer”, Narosa Publishing House, 2003

  
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**20ME C207****MINI PROJECT WITH SEMINAR**

Instruction	4 Hours per week
Duration of SEE	---
SEE	---
CIE	50 Marks
Credits	2

**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
5. Write the documentation in standard format

**Guidelines:**

1. As part of the curriculum in the II- semester of the programme each student shall do a mini project, generally comprising about three to four weeks of prior reading, twelve weeks of active research, and finally a presentation of their work for assessment.
2. Each student will be allotted to a faculty supervisor for mentoring.
3. 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.
4. Mini projects shall have interdisciplinary/ industry relevance.
5. The students can select a mathematical modeling based/Experimental investigations or Numerical modeling.
6. All the investigations are clearly stated and documented with the reasons/explanations.
7. The mini-project shall contain a clear statement of the research objectives, background of work, literature review, techniques used, prospective deliverables, and detailed discussion on results, conclusions and references.

Department committee: Supervisor and two faculty coordinators

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Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks:50		
Evaluation by	Max .Marks	Evaluation Criteria / Parameter
Supervisor	20	Progress and Review
	05	Report
Department Committee	05	Relevance of the Topic
	05	PPT Preparation
	05	Presentation
	05	Question and Answers
	05	Report Preparation

  
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**20ME E212**

**EXPERIMENTAL METHODS IN THERMAL ENGINEERING**

(Programme Elective - V)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

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

1. Understand the concepts of errors in measurements.
2. Recognize different techniques of temperature measurement.
3. Manage with different pressure and flow measuring instruments.
4. Understand working of radiation measuring equipment.
5. Familiarize with advanced measurement techniques.

**UNIT - I**

**Basics of Measurements:** Introduction, General measurement system, Signal flow diagram of measurement system, Inputs and their methods of correction, Presentation of experimental data, Errors in measurement, Propagation of errors, Uncertainty analysis, Regression analysis, Design of experiments.

**UNIT - II**

**Temperature Measurement:** Bimetallic thermometers, Liquid-in-glass, Pressure thermometer, Semiconductor sensors, Digital thermometers, Pyrometers

**Thermal Analysis Techniques:** Measurements in combustion: Species concentration, Reaction rates, Flame visualization, charged species diagnostics, Particulate size measurements.

**UNIT - III**

**Fluid pressure measurement:** Mechanical & Electrical types, High pressure & Low pressure measurements, Differential Pressure Transmitters.

**Flow measurements:** Industrial flow measuring devices, selection and calibration, 2d/3d flow measurement and turbulence measurement, Anemometers, Weirs and flumes, Laser Doppler anemometer, Ultrasonic flow meter, Flow visualization techniques, Totalizer for Industrial Liquids

#### UNIT - IV

**Thermal and Transport Property Measurement:** Measurement of thermal conductivity of solids and fluids, Diffusivity, Viscosity, Humidity and gas composition

**Nuclear and Thermal Radiation Measurement:** Nuclear radiation and neutron detection, Measurement of reflectivity, Transmissivity and emissivity, Solar radiation measurements.

#### UNIT - V

**Advancement in measurements:** Data logging and acquisition, Use of sensors for error reduction, Elements of micro computer interfacing, Intelligent instruments and their use, Basics of P, PI, PID controllers, Pneumatic and hydraulic controllers, Electronic controllers

#### Text Books:

1. Thomas G Beckwith., Mechanical Measurements, Pearson publications, 2007.
2. Ernest O Doebelin., Measurement systems, Tata McGraw Hill publications, 2006.

#### Suggested Reading:

1. J P Holman., Experimental Methods for Engineers, Tata McGraw Hill publications, 2004.
2. C.S. Raman, G.R. Sharma and V.S.V. Mani., Instrumentation Devices and Systems, 2nd Edition, Tata McGraw-Hill., 2001.
3. A.S. Morris., Principles of Measurements and Instrumentation, 3rd Edition, Butterworth-Heinemann, 2001.

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20ME E213

## FLUID POWER SYSTEMS

(Programme Elective - V)

Instruction	3L	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

**Outcomes:** After studying this course, students will be able to:

1. Identify and analyze the functional requirements of a fluid power transmission system for a given application.
2. Visualize how a hydraulic/pneumatic circuit will work to accomplish the function.
3. Design an appropriate hydraulic or pneumatic circuit or combination circuit like electro-hydraulics, electro-pneumatics for a given application.
4. Select and size the different components of the circuit.
5. Develop a comprehensive circuit diagram by integrating the components selected for the given application.

### UNIT – 1:

**Fluid Power System:** Components, Advantages and applications, Transmission of power at static and dynamic states, Pascal's law and its applications

**Fluids for Hydraulic System:** Types, Properties, Selection, Additives, Effect of temperature and pressure on hydraulic fluid, Seals, Sealing materials, Compatibility of seal with fluids, Types of pipes, Hoses, Quick acting couplings, Fluid conditioning through filters, Strainers, Classification of filters, Sources of contamination and contamination control, Heat exchangers.

**UNIT – II:**

**Pumps:** Classification of pumps, Pumping theory of positive displacement pumps, Construction and working of gear pumps, Vane pumps, Piston pumps, Pump performance characteristics, Pump selection factors

**Accumulators:** Types, Working of various types of accumulators

**Actuators:** Classification, Working of various types of hydraulic cylinders (actuators).

**UNIT – III:**

**Components of Hydraulic Circuit:** Classification of control valves, Directional control valves, Symbolic representation, Constructional features of poppet check valve, Pilot operated directional control valve, Shuttle valve, Sliding spool valve, Pressure proportional control valves, Types, Pressure relief valve and pilot operated pressure control valve, silencers, Flow control valves, Compensated and non-compensated flow control valves

**Hydraulic Circuit Design:** Control of single and double acting hydraulic cylinders, Regenerative cylinder circuit, calculation of cylinder size, Meter-in and meter-out circuits, Pump unloading circuit, Double pump hydraulic circuit, Counter balance valve application circuit, Hydraulic cylinder sequencing circuits

**UNIT – IV:**

**Introduction to Pneumatic Systems,** Choice of working medium, Advantages, Limitations, Applications, Structure of a pneumatic power system, Production of compressed air, Working of various types of air compressors, Fluid conditioners, Air filters, Air dryers, Lubricators and air pressure regulator.

**Pneumatic Actuators:** Linear cylinders, Classification, Working, Seals, End position cushioning, Rodless cylinders and advantages

**Pneumatic Control Valves:** Classification, Directional control valves such as poppet, Suspended seat type slide valve, Non return valves, Check valve, Quick exhaust valve and time delay valve

**UNIT – V:**

**Simple Pneumatic Control:** Direct and indirect actuation of pneumatic cylinders, Flow control valve, Speed control of cylinders using flow control valves, Supply air throttling and exhaust air throttling.

**Signal Processing Elements:** Use of Logic gates - OR and AND gates in pneumatic applications, Practical examples involving the use of logic gates.

**Multi Cylinder Application:** Motion and control diagrams, Sequential motion control, Signal elimination methods, Cascade control action, Principle and signal elimination techniques

**Electro Pneumatic Control:** solenoid, Relay and contactors, Solenoid operated directional control valve, Solenoid controlled pilot operated of directional control valves, Control circuit for single acting cylinder

**Text Books:**

1. Anthony Esposito., Fluid Power with applications, Pearson edition, 2011.
2. Majumdar S.R., Pneumatic systems - Principles and Maintenance, Tata McGraw-Hill, New Delhi, 2005

**Suggested Reading:**

1. Andrew Par, Hydraulics and pneumatics, Jaico Publishing House, 2005.
2. Thomson, Introduction to Fluid power, Prentice Hall, 2004
3. John Watton, Fundamentals of Fluid Power Control, Cambridge University press, 2012.

20ME E214

**ENGINE EMISSIONS AND POLLUTION CONTROL**

(Programme Elective - V)

Instruction	3L	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

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

1. Understand the importance of IC engine as prime mover and the combustion phenomenon in SI engine.
2. Understand the phenomenon of combustion in CI engine along with turbocharging and supercharging
3. Understand the formation of different pollutants in IC engines and their effect on environment and human beings.
4. Understand the measurement and control techniques of various pollutants from IC engines.
5. Understand the significance of various alternative liquid and gaseous fuels in IC engines

UNIT - I

**Introduction to IC Engines:** IC engine as a prime mover, Contribution of IC engines for global warming and green house effect.

**Spark Ignition Engines:** Flame Propagation, Combustion phenomena (normal and abnormal), Factors affecting flame speed, Detonation, Ignition quality, Octane number, Carburetion and fuel injection systems for SI Engines, Types of combustion chambers, Performance of leaded and unleaded petrol

UNIT - II

**Compression Ignition Engines:** Advantages of CI engines, Importance of air motion and compression ratio, Normal and abnormal combustion, Ignition quality, Cetane number, Characteristics of a good combustion chamber, Types of combustion chambers, Effect of supercharging and

### UNIT- III

**Pollutant emissions from IC Engines:** Sources of pollutants, Effect of emissions on environment and human beings, Pollutants of carbon monoxide, UBHC, Oxides of Nitrogen (NO-NO<sub>x</sub>), Particulate matter and aldehydes, Mechanism of formation of pollutants, Engine variables those affecting pollutant formation and methods to control pollutants

### UNIT - IV

Measurement of engine emissions-NDIR and FID techniques, Smoke analyzer, NO<sub>x</sub> analyzers, Pollution control strategies, EGR technique, SCRT, Reduction of pollutants by chemical methods, Catalytic converters and thermal reactors, Particulate traps, Fumigation, Secondary air injection, PCV system, Emission norms, EURO and Bharat stage norms.

### UNIT - V

**Alternative Fuels:** Need for alternative fuels, Desirable characteristics of good alternative fuel, Liquid and Gaseous fuels for SI and CI Engines, Alcohols, Manufacturing of Methanol, Ethanol and Butanol, Vegetable oils and manufacturing of biodiesel by single-stage and two-stage methods, LPG, CNG, Bio gas, Hydrogen, performance and emission characteristics with above alternative fuels.

#### Text Books:

1. J.B. Heywood, Internal Combustion Engine Fundamentals, McGraw Hill Co., 2018
2. Obert, E.F., Internal Combustion Engine and Air Pollution, International Text Book Publishers, 1983.

#### Suggested Reading:

1. C.R.Ferguson, A.T. Kirpatrick, IC Engines : Applied Thermosciences, Wiley publications, 2015
2. Gill P.W, Fundamentals of Internal Combustion Engines, Oxford and IBH publishing Co Pvt Ltd, 2007.



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3. B.P. Pundir, Engine Emissions: Fundamentals and advances in control,  
Narosa Publishing House, 2017



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With Effect from the Academic Year

20CEO101

**COST MANAGEMENT OF ENGINEERING PROJECTS**

(Open Elective)

Instruction	3L	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

**Objectives:**

1. To enable the students to understand the concepts of Project management.
2. To provide knowledge on concepts of Project Planning and scheduling.
3. To create an awareness on Project Monitoring and Cost Analysis
4. To provide adequate knowledge to the students on Recourse Management Costing-variance Analysis
5. To train the students with the concepts of Budgetary Control for cost management and to provide a basic platform on Quantitative techniques for cost management.

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

1. Acquire in-depth knowledge about the concepts of project management and understand the principles of project management.
2. Determine the critical path of a typical project using CPM and PERT techniques.
3. Prepare a work break down plan and perform linear scheduling using various methods.
4. Solve problems of resource scheduling and leveling using network diagrams.
5. Learn the concepts of budgetary control and apply quantitative techniques for optimizing project cost.

**UNIT- I:**

**Project Management:** Introduction to project managements, Stakeholders, Roles, Responsibilities and functional relationships, Principles of project management, Objectives and project management system, Project team, Organization, roles and

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responsibilities, Concepts of project planning, Monitoring, Staffing, Scheduling  
and controlling.

UNIT-II:

**Project Planning and Scheduling:** Introduction for project planning, defining activities and their interdependency, time and resource estimation. Work break down structure. Linear scheduling methods-bar charts, Line of Balance (LOB), their limitations. Principles, definitions of network-based scheduling methods: CPM, PERT. Network representation, network analysis-forward and backward passes.

UNIT-III:

**Project Monitoring and Cost Analysis:** introduction-Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making, Time cost tradeoff-Crashing project schedules, its impact on time on time, cost, Project direct and indirect costs.

UNIT- IV:

**Resources Management and Costing-Variance Analysis:** Planning, Enterprise Resource Planning, Resource scheduling and leveling, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis

**Standard Costing and Variance Analysis:** Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing, Costing of service sector. Just-in-time approach, Material Requirement

UNIT- V:

**Budgetary Control:** Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

**Quantitative techniques for cost management:** Linear Programming, PERT/CPM, Transportation Assignment problems, Simulation, Learning Curve Theory.

Text Books:

1. Charles T Horngren., Cost Accounting A Managerial Emphasis, 14th edition, Pearson Education, 2012,
2. Charles T. Horngren and George Foster., Advanced Management Accounting, 6th revised edition, Prentice Hall, 1987.

Suggested Reading:

1. K. K Chitkara., Construction Project Management: Planning, scheduling

- CBIT (A) AICTE Model Curriculum with effect from the AY 2020 – 2021 and controlling, Tata McGraw Hill Education, 2004.
2. Kumar Neeraj Jha., Construction Project Management Theory and Practice, 2nd edition, Pearson Education India, 2015.
  3. Robert S Kaplan and Anthony A. Atkinson, Management & Cost Accounting, 2nd edition, Pearson, 1996.

  
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**WASTE TO ENERGY**

(Open Elective)

Instruction		3L	Hours per week
Duration of SEE	3	Hours	
SEE		60	Marks
CIE		40	Marks
Credits	3		

**Objectives:**

1. To know the various forms of waste
2. To understand the processes of Biomass Pyrolysis.
3. To learn the technique of Biomass Combustion.

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

1. Understand the concept of conservation of waste
2. Identify the different forms of wastage
3. Chose the best way for conservation to produce energy from waste
4. Explore the ways and means of combustion of biomass
5. Develop a healthy environment for the mankind

**UNIT - I**

**Introduction to Energy from Waste:** Classification of waste as fuel, Agro based, Forest residue, Industrial waste, MSW, Conversion devices, Incinerators, Gasifiers, Digestors

**UNIT – II**

**Biomass Pyrolysis:** Pyrolysis, Types, Slow, Fast, Manufacture of charcoal, Methods, Yields and application, Manufacture of pyrolytic oils and gases, Yields and applications.

**UNIT – III**

**Biomass Gasification:** Gasifiers, Fixed bed system, Downdraft and updraft gasifiers, Fluidized bed gasifiers, Design, Construction and operation, Gasifier burner arrangement for thermal heating, Gasifier engine arrangement and electrical power, Equilibrium and kinetic consideration in gasifier operation.

## UNIT-IV

**Biomass Combustion:** Biomass stoves, Improved chullahs, Types, Some exotic designs, Fixed bed combustors, Types, Inclined grate combustors, Fluidized bed combustors, Design, Construction and operation, Operation of all the above biomass combustors.

## UNIT – V

**Biogas:** Properties of biogas (Calorific value and composition), Biogas plant technology and status, Bio energy system, Design and constructional features, Biomass resources and their classification, Biomass conversion processes, Thermo chemical conversion, Direct combustion, Biomass gasification, Pyrolysis and liquefaction, Biochemical conversion, Anaerobic digestion, Types of biogas plants, Applications, Alcohol production from biomass, Bio diesel production, Urban waste to energy conversion, Biomass energy programme in India.

## Text Books:

1. V. Ashok, Non Conventional Energy, Desai, Wiley Eastern Ltd., 1990.
2. K.C. Khandelwal and S.S. Mahdi., Biogas Technology - A Practical Hand Book, Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.

## Suggested Readings:

1. D.S. Challa., Food, Feed and Fuel from Biomass, IBH Publishing Co. Pvt. Ltd., 1991.
2. C. Y. WereKo-Brobby and E. B. Hagan, Biomass Conversion and Technology, John Wiley & Sons, 1996.

  
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20CSO101

### BUSINESS ANALYTICS

(Open Elective)

Instruction		3L	Hours per week
Duration of SEE	3	Hours	
SEE		60	Marks
CIE		40	Marks
Credits	3		

Course Objectives: The objectives of this course are

1. Understanding the basic concepts of business analytics and applications.
2. Study various business analytics methods including predictive, prescriptive and prescriptive analytics.
3. Prepare the students to model business data using various data mining, decision making methods.

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

1. Identify and describe complex business problems in terms of analytical models.
2. Apply appropriate analytical methods to find solutions to business problems that achieve stated objectives.
3. Interpret various metrics, measures used in business analytics.
4. Illustrate various descriptive, predictive and prescriptive methods and techniques.
5. Model the business data using various business analytical methods and techniques.
6. Create viable solutions to decision making problems.

#### UNIT-I

Introduction to Business Analytics: Introduction to business analytics, Need and science of data driven decision making, **Descriptive, Predictive, Prescriptive analytics and techniques, Big data analytics, Web and social media analytics, Machine learning algorithms, framework for decision making, Challenges in data driven decision making and future.**

#### UNIT-II

Descriptive Analytics: Introduction, Data types and scales, Types of measurement scales, **Population and samples, Measures of central tendency, Percentile, Decile and quadrille, Measures of variation, Measures of shape skewness, Data visualization.**

## UNIT-III

Forecasting Techniques: Introduction, time-series data and components, forecasting accuracy, moving average method, single exponential smoothing, Holt's method, Holt-Winter model, Croston's forecasting method, regression model for forecasting, Auto regression models, auto-regressive moving process, ARIMA, Theil's coefficient.

## UNIT-IV

Decision Trees: CHAID, Classification and regression tree, Splitting criteria, Ensemble and method and random forest, Clustering, Distance and similarity measures used in clustering, Clustering algorithms, K-Means and hierarchical algorithms, Prescriptive analytics, Linear programming and LP model building.

## UNIT-V

Six Sigma: Introduction, Introduction, Origin, 3-Sigma Vs Six-Sigma process, Cost of poor quality, Sigma score, Industry applications, Six sigma measures, DPMO, Yield, Sigma score, DMAIC methodology, Six Sigma toolbox

## Text Books:

1. U. Dinesh Kumar, Data Analytics, Wiley Publications, 1st Edition, 2017.
2. Marc J. Schniederjans, Dara G. Schniederjans and Christopher M. Starkey, Business Analytics Principles, Concepts and Applications with SAS, Associate Publishers, 2015.

## Suggested Reading:

1. S. Christian Albright and Wayne L. Winston, Business Analytics - Data Analysis and Decision Making, 5th Edition, Cengage, 2015.

## Web Resources:

1. <https://onlinecourses.nptel.ac.in/noc18-mg11/preview>
2. <https://nptel.ac.in/courses/110105089/>

  
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**INDUSTRIAL PROJECT / DISSERTATION PHASE - I**

Instruction	20	Hours per week
Duration of SEE	—	
SEE	—	
CIE	100	Marks
Credits	10	

**Outcomes:** At the end of the course:

1. Students will be exposed to self-learning various topics.
2. Students will learn to survey the literature such as books, national/ international refereed journals and contact resource persons for the selected topic of research.
3. Students will learn to write technical reports.
4. Students will develop oral and written communication skills to present.
5. Student will defend their work in front of technically qualified audience.

**Guidelines:**

1. The Project work will preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.
2. Seminar should be based on the area in which the candidate has undertaken the dissertation work.
3. The CIE shall include reviews and the preparation of report consisting of a detailed problem statement and a literature review.
4. The preliminary results (if available) of the problem may also be discussed in the report.
5. The work has to be presented in front of the committee consists of Head, Chairperson-BoS, Supervisor and Project coordinator.
6. The candidate has to be in regular contact with his supervisor and the topic of dissertation must be mutually decided by the guide and student.

**Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 100**

Evaluation by	Max. Marks	Evaluation Criteria / Parameter
Supervisor	30	Project Status / Review(s)
	20	Report
Department Committee	10	Relevance of the Topic
	10	PPT Preparation(s)
	10	Presentation(s)
	10	Question and Answers
	10	Report Preparation

Note: Department committee has to assess the progress of the student for every two weeks.

  
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- The candidate has to be in regular contact with his/her guide/co-guide.

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 100

Evaluation by	Max. Marks	Evaluation Criteria / Parameter
Department Review Committee	05	Review 1
	10	Review 2
	10	Review 3
	15	Final presentation with the draft copy of the report standard format
	10	Submission of the report in a standard format
Supervisor	10	Regularity and Punctuality
	10	Work Progress
	10	Quality of the work which may lead to publications
	10	Analytical / Programming / Experimental Skills Preparation
	10	Report preparation in a standard format

  
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