CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY(A)

Choice Based Credit System (CBCS)

(Modified – 05/10/2018)

Name of the Programme (UG): B.E Syllabus

for

V - Semester and VI - Semester

With effect from 2018 - 2019

Specialization /Branch: Production Engineering

Chaitanya Bharathi Institute of Technology (A) Chaitanya Bharathi (P.O),
Gandipet Hyderabad-500075, Telangana State.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY(A)

Choice Based Credit System (CBCS)

B.E (Production Engineering)

SEMESTER – V

S.No.	Course Code	Title of the Course	Scheme of Instruction		Scheme of Examination			Credits
			Hours per week		Duration in Hours	Maximum Marks		
			L/T	P/D		CIE	SEE	
THEORY								
1	16ME C20	Dynamics of Machines	3/1	-	3	30	70	3
2	16ME C21	Applied Thermodynamics and Heat Transfer	3/1	-	3	30	70	3
3	16ME C22	Design of Machine Elements	3/1	-	3	30	70	3
4		Professional Elective-I	3	-	3	30	70	3
5		Professional Elective-II	3	-	3	30	70	2
PRACTICALS								
6	16ME C23	Dynamics and Vibrations Lab	-	3	3	25	50	2
7	16ME C24	Applied Thermodynamics and Heat Transfer Lab	-	3	3	25	50	2
8	16EE C22	Electrical Machines and Microcontroller Applications Lab	-	3	3	25	50	2
9	16PE C05	Industrial Visit			Excellent/Very Good/Good/Satisfactory/ Not Satisfactory			
Total			**18**	**9**	**-**	**225**	**500**	**20**

L: Lecture T: Tutorial D: Drawing P: Practical

CIE - Continuous Internal Evaluation SEE - Semester End Examination

ELECTIVES

		Professional Elective-I (3/3)	**Professional Elective-II (3/3)**		
SNo.	**Subj Code**	**Name of the Subject**	**SNo**	**Subj Code**	**Name of the Subject**
1	16ME E01	Refrigeration and Air Conditioning	5	16ME E04	Hydraulic Machines
2	16ME E02	Mechanical Vibrations	6	16PE E03	Non Destructive Testing and Evaluation
3	16PE E01	Powder Processing	7	16PE E04	Plastics, Ceramics and Composite Materials
4	16PE E02	Product Design and Process Planning	8	16MT E04	Probability and Numerical Methods

Assessment Procedures for Awarding Marks

The distribution of marks is based on CIE by concerned teacher and the Semester end examination shall be as follows:

Course (in terms of credits)	CIE	Semester end Examination(Marks)	Remarks	Duration of Semester End Examination
Three(3) Credits/ Four(4) Credits	30*	70**	Theory Course/ Engg. Graphics	3 Hours
Two(2) Credits	20*	50***	Theory	2 Hours
Two(2) Credits	25	50	Lab Course/ Workshop	3 Hours
One(1) Credit	15	35	Lab Course	2 Hours
Two(2) Credits	50	—-	Project Seminar/ Seminar	——
Six(6) Credits	50	100	Project	Viva
One(1) Credit	—-	50***	Environmental Studies, Professional Ethics and Human values	2 Hours
One(1) Credit	50		Mini Project	——-

CIE: Continuous Internal Evaluation

*Out of 30/20 sessional marks(CIE), 10/5 marks are allotted for slip-tests (Three slips test will be conducted, each of 10/5 marks, best two average is considered) and the remaining 20/15 marks are based on the average of two tests, weightage for each test is 20/15 marks.

**The question paper will be in two parts, Part-A and Part-B. Part A is for Ten(10) questions and is compulsory, covers the entire syllabus, and carries 20 marks. Part- B carries 50 marks and covers all the units of the syllabus (student has to answer five out of seven questions).

***The question paper will be in two parts, Part-A and Part-B. Part A is for Ten(10) questions and is compulsory, covers the entire syllabus, and carries 15 marks. Part- B carries 35 marks and covers all the units of the syllabus (student has to answer five out of seven questions).

Note: A course that has CIE (sessional marks) but no semester end examination as per scheme, is treated as Pass/Fail for which pass marks are 50% of CIE.

A candidate has earned the credits of a particular course, if he/she secures not less than the minimum marks/grade as prescribed. Minimum pass marks for theory course is 40% of total marks i.e., CIE plus semester end examinations where as for the lab course/project is 50%.

16ME C20

DYNAMICS OF MACHINES

Instruction	3 Hours + 1 Tutorial per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives:

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

Course Outcomes:

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

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

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

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

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

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

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

UNIT-V:Two degree freedom systems: Natural frequencies and modes of vibration

Approximate Methods: Dunkerley and Rayleigh's methods

Multi rotor system : Holzers method

Text Books:

1. S.S. Rattan, *Theory of Machines*, Tata-Mc Graw Hill, 1995.
2. John.J.Vicker, Gordon R. Pennock, Joseph E. Shigley, *Theory of Machines & Mechanisms*, Oxford University Press, 2003.
3. Benson H. Tangue, Principles of Vibration, 2nd Edn., Oxford University Press, 2007

Suggested Reading:

1. A. Ghosh and Mallick, *Theory of mechanisms and machines*, Affiliated to E-W Press, 1988.
2. Ashok G Ambedkar, Mechanism and Machine Theory, PHI, 2013
3. Robert L. Norton, *Design of Machinery*, Tata Mc Graw Hill, 2005.
4. J.S. Rao and Gupta, 'Theory and Practice of Mechanical Vibrations, PHI, 1984
5. Theory of Vibration with Application, J.J. Thompson, Dec-2002

16ME C21

APPLIED THERMODYNAMICS & HEAT TRANSFER

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives:

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

Course Outcomes: Students will be able to

1. Estimate power required for reciprocating air compressor, used for many engineering applications.
2. Evaluate the performance of diesel and petrol engines and suggest some suitable methods for remedy of abnormal combustion
3. Understand the importance of accessories of IC engines
4. Apply appropriate equations depending on mode of heat transfer
5. Distinguish the radiation heat transfer from other modes of heat transfer
6. Design heat exchangers with the basic knowledge acquired in heat exchangers

UNIT-I: Reciprocating Air Compressors:

Single stage and multi stage compressors with and without clearance volume, work done, various Efficiencies of multi stage compression.

UNIT-II: Internal Combustion Engines:

Classification, Working principles of 2 stroke, 4 stroke SI and CI engines. Performance of IC Engines. Heat balance sheet.

UNIT-III: Combustion Phenomena:

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

UNIT-IV: Modes of heat transfer:

General 3-D conduction equation in Cartesian and cylindrical coordinates, one dimensional steady state conduction through slabs, hollow cylinders without heat generation, critical radius of insulation for cylinders.

Convection: Free and forced convection, dimensionless numbers and their physical significance, simple problems on free and forced convection

UNIT-V: Radiation: Various laws of radiation, concept of black-body, surface resistance, space resistance, radiation shield.

Heat Exchangers: Classification, LMTD and NTU Concepts
Concept of Condensation and boiling

Text Books:

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

Suggested Reading:

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

16ME C22

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

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	4

Course Objectives:

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

Course Outcomes: Students will able to

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

UNIT-I : Introduction:

Materials used in machine design and their specifications to Indian standards. . Codes and standards used in design. Reliability, Principles of good Ergonomic Design, Manufacturing considerations. Preferred numbers. Value analysis. Analysis of Stress and Strain: Definition of stress and strain, Types of loading, direct normal stress, Bending stress, Torsional stress, Crushing and bearing stresses, Biaxial stress and triaxial stress. Theories of elastic failure, Stress concentration factor, Factor of safety, Design of components for static loads.

UNIT-II: Design for Fatigue and Impact Loads:

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

UNIT-III: Design of keys:

Design of Shafts, Solid, hollow, stepped shafts and splined shafts under torsion and bending loads.

Design of couplings – Muff and Split muff Couplings, Flange, Flexible and Marine type of couplings.

Design of belt drive systems , selection of belts and design of pulleys.

UNIT-IV: Design of Riveted Joints:

Types of joints, efficiency of the joints, structural joints, and joints subjected to direct and eccentric loads.

Design of welded joints - types of joints, joints subjected to direct and eccentric loading.

UNIT-V: Design of Machine Elements:

Design of cotter and knuckle joints.
Design of bolts and nuts, locking devices, bolt of uniform strength, design of gasket joints.
Design of power screws and screw jack.

Text Books:

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

Suggested Reading

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

Machine Design Data Books:

1. Design Data Hand book for Mechanical Engineers, K. Mahadevan, K. Balaveera Reddy, CBS Publisher 3rd Edition.
2. Design Data book by PSG College – 2012

16ME E01

REFRIGERATION AND AIR CONDITIONING (Elective-I)

Instruction	3Hours per week
Duration of Semester End Examination	3Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives:

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

Course Outcomes:

1. Students will be able to differentiate refrigeration from air conditioning
2. Students will be able to understand merits and demerits of vapor compression refrigeration system over air refrigeration system
3. Student will be able to know the importance of absorption refrigeration system over vapor refrigeration system
4. Students will be able to apply a suitable sychrometric process depending on requirement or application
5. Student will be able to know the condition necessary for comfort condition
6. Student will be able to estimate the load required for AC system depending on application

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

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

UNIT-II: Vapour compression system:
Working principle and analysis of Simple vapor compression Refrigeration cycle.
Effect of operating conditions like evaporating pressure, condenser pressure, Liquid sub-cooling and Vapor super heating, Performance of the system. Low temperature refrigeration system (with single load system), Compound compression with water inter cooler and Flash intercooler, Cascade refrigeration system-Analysis and advantages

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**, A**nalysis of the system, Advantages, limitations and applications.

UNIT-IV: Psychrometry:
Psychrometric properties, Psychrometric chart, construction, Representation of **Various** Psychrometric processes on the chart,

Introduction to Air Conditioning:
Requirements of comfort air conditioning, Thermodynamics of human body, ASHRE comfort chart, Effective temperature

UNIT-V: Cooling Load Calculations in Air Conditioning:
Concept of by pass factor, Sensible heat factor, Apparatus Dew Point, Various Heat Load
Design of air conditioning systems:
Simple Problems on Summer, Winter and Year Round Air conditioning systems Energy conservation in air conditioned building,

Air Conditioning Systems:
Components of air conditioner equipments, Humidifier, Dehumidifier, Filter.

Text Books

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

Suggested Reading

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

16ME E02

MECHANICAL VIBRATIONS (Professional Elective-I)

Instruction	4 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives:

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

Course Outcomes:

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

UNIT-I: Free Vibration Analysis-Single Degree of Freedom Systems Undamped and Damped Translation and Torsional Systems:
Different methods for equation of motion- Energy method, Rayleigh method, principal of virtual work, principal of conservation energy, Rayleigh's method. Viscously damped free vibration, logarithmic decrement, coulomb damping,

UNIT-II: Harmonically Excited Vibration:
Forced harmonic vibration, Rotating unbalance, whirling of rotating shafts, support motion, vibration isolation, energy dissipated by damping. Equivalent viscous damping, structural damping.

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

UNIT-IV: Vibrations of Continuous Systems:
Vibrations of strings, bars and beams, formulation of equation of motion, characteristic equation, identification of node and mode shape.

UNIT-V: Vibration Measurements and Applications:
Vibration pickup, Vibrometer, accelerometer. Transducers, piezoelectric transducers, Electrodynamic transducers. Vibration exciters, mechanical and electro dynamic shakers. Frequency measuring instruments.

Text Books:

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

Suggested Reading:

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

16PE E01

POWDER PROCESSING – (Professional Elective-I)

Instruction	: 3 Hours per week
Duration of Semester End Examination	: 3 Hours
Semester End Examination	: 70 Marks
Continuous Internal Evaluation	: 30 Marks
Credits	: 3

Course Objectives: To understand the different

1. Powder processing methods
2. Powder properties & characteristics
3. Powder mixing & compaction methods.
4. Powder Sintering methods.
5. Post Sintering processes
6. Testing's of sintered parts.

Course Outcomes: Students will be able to

1. Know the fundamentals in powder manufacturing methods
2. Characterize the Powders in different techniques
3. Suggest appropriate compaction technique for a particular powder
4. Suggest appropriate sintering technique for a particular powder
5. Choose correct post sintering processes
6. Have ability to choose the appropriate testing for sintered parts.

UNIT-I : Introduction:
Importance and advantages of powder processing.
Powder Manufacture: Comminution, solid state reduction, electrolysis, thermal decomposition, and Atomization (water atomization, oil atomization, gas atomization, centrifugal atomization).

UNIT-II : Powder Properties, Characterization, And Mixing:
Chemical composition, particle shape, powder density, particle size, size distribution compressibility, green strength. Blending and mixing. Compaction: Compact size, tool materials, design of sintered part, Olivetti process hot pressing, injection moulding, cold iso-static pressing, and hot iso-static pressing.

UNIT-III: Sintering:
Theory of sintering, Sintering practice – furnace design, furnace atmospheres, vacuum sintering, control of shrinkage, liquid phase sintering, activated sintering, and loose powder sintering.

UNIT-IV: Post-Sintering Operations: Re-press and re-enter, hot re-press, hot forge in a closed die, sizing, coining, HIP, steam treatment, infiltration, and impregnation. Heat treatment, hardening, and tempering, surface hardening, electro-plating, and other coatings. Deburring, machining and joining. Sinter forging.

UNIT-V: Testing of Sintered Parts and Applications:
Porous bearings, filters Magnetic Materials, super alloys, High speed steels, Stainless steels, ODS materials, Production of Near-net shapes, rapidly solidified powders, and spray forming. Manufacturing of Cutting tools, forming dies using powder metallurgy.

Text books:

1. J. S. Hirsch horn: Introduction to Powder Metallurgy, American Powder Metallurgy Institute, Princeton, NJ, 1976.
2. P. C. Angelo and R. Subramanian: Powder Metallurgy- Science, Technology and Applications, PHI, New Delhi, 2008.
3. E.P. DeGarmo, J.T. Black, R.A. Kosher, Materials and processes in manufacturing – 8th Ed., PrenticeHall, 1997.

Suggested Reading:

1. Roy A. Lindberg, Processes and materials of manufacture – 4th Ed., Prentice Hall of India Pvt. Ltd., NewDelhi, 1995
2. H.H. Hausner – Hand book of powder metallurgy.
3. ASM Hand Book, vol. 7: Powder Metallurgy, ASM International.
4. Powder Metallurgy Technology, Cambridge International Science Publishing, 2002

16PE E02

PRODUCT DESIGN AND PROCESSES PLANNING (Professional Elective-I)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives:

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

Course Outcomes:

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

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

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

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

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

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

Text Books:

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

Suggested Reading:

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

16 ME E04

HYDRAULIC MACHINES (Professional Elective-II)

Instruction	3	Hours per week
Duration of Semester End Examination	3	Hours
Semester End Examination	70	Marks
Continuous Internal Evaluation	30	Marks
Credits	3	

Course Objectives: The student will

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

Course Outcomes: Student will

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

UNIT-I: Hydraulic Machines:

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

UNIT-II: Reciprocating Pumps:

Classification- working principle- single and double acting pumps- discharge, work done and power required to drive the pumps- slip, % slip and negative slip- Variation of pressure head in the suction and delivery pipes due to acceleration of piston- Variation of pressure head due to friction in the suction and delivery pipes- Indicator diagrams- Ideal and actual diagrams- Effect of piston acceleration and pipe friction on indicator diagram- Maximum speed at which the pump must run to avoid separation during suction and delivery strokes- Air vessels- Function of air vessels- Work saved by fitting air vessels to single and double acting pumps- Discharge of liquid into and out of air vessels- Performance characteristic curves

UNIT-III: Centrifugal Pumps:

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

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

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

Text Books:

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

Suggested Reading:

1. Kumar, K.L., "Engineering Fluid Mechanics", Eurasia Publishing House (P) Ltd., New Delhi,2004
2. White, Frank. M., Fluid Mechanics, 5th Edn., McGraw Hill 2003.
3. Madan Mohan Das., "Fluid Mechanics and Turbo machines", PHI Learning Private Limited, New Delhi, 2009

16PE E03

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

Instruction	3	Hours per week
Duration of Semester End Examination	3	Hours
Semester End examination	70	Marks
Continuous Internal Evaluation	30	Marks
Credits	3	

Course Objectives: Student has to understand the

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

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

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

UNIT-I: Liquid Penetrate Inspection:

Principles of penetrate inspection, characteristics of a penetrate, water washable system, post emulsification system , solvent removable system, surface preparation and cleaning, penetrate application, development, advantages limitations, and applications.

Magnetic Particle Instruction:

Principle, magnetization methods, continuous and residual methods, sensitivities, demagnetization, magnetic particles, applications advantages and limitations.

UNIT-II: Eddy Current Testing:

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

UNIT-III: Ultrasonic Testing:

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

UNIT-IV: Radiography:

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

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

Text Books:

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

Suggested Reading:

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

16PE E04

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

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives: To make the students to

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

Course Outcomes: Students should able to

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

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

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

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

UNIT IV: White wares:
Classification and type of White wares, Elementary idea of manufacturing process technology including body preparation, basic properties and application area;. Ceramic Coatings : Types of glazes and enamels, Elementary ideas on compositions, Process of enameling & glazing and their properties. Glass: Definition of glass, Basic concepts of glass structure, glass manufacturing processes, Different types of glasses. Application of glasses.

UNIT V: Fundamentals of composites:

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

Text Books:

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

Suggested Reading:

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

16MT EO4

PROBABILITY AND NUMERICAL METHODS (Professional Elective-II)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Exam	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3 Credits

Course Objectives:

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

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

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

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

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

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

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

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

Text Books:

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

Suggested Reading:

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

16ME C23

DYNAMICS AND VIBRATIONS LAB

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
Continuous Internal Evaluation	25 Marks
Credits	02

Course Objectives:

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

Course Outcomes: Students will be able to

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

List of experiments:

(1) To study the motion of follower with the given profile of the cam. (To plot the n-q (Follower displacement Vs Angle of rotation) curves for different cam follower pairs.

(2) To study the gyroscopic effect on a rotating disc.

(3) Determination of the frequency of torsional vibration.

(4) Static and Dynamic balancing in a Rotating mass system.

(5) Study the effect of varying mass on the centre of sleeve in porter governor.

(6) Study the effect of varying the initial spring compression in Hartnell governor.

(7) Undamped torsional vibrations of double rotor system.

(8) To study the longitudinal vibrations of helical coiled spring.

(9) To study the undamped forced vibration of spring mass system.

(10) To study the force damped vibration of spring mass system.

(11) Determination of critical speed of the given shaft with the given end conditions. (Whirling of Shafts)

(12) Frequency response of spring mass system with damping.

Text Books:

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

16ME C24

APPLIED THERMODYNAMICS & HEAT TRANSFER LAB

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
Continuous Internal Evaluation	25 Marks
Credits	2

Course Objectives

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

Course Outcomes: Students will be able to

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

Applied Thermodynamics:

1. Determination of Valve timing diagram and Port diagram of IC engine.
2. Determination of Performance characteristics of a multi-cylinder petrol engine.
3. To conduct Morse test on multi cylinder petrol engine.
4. To conduct performance test on a variable compression ratio petrol engine.
5. To conduct performance test on single cylinder diesel engine.
6. To conduct heat balance test on single cylinder diesel engine.
7. To determine volumetric efficiency, isothermal efficiency of multi -stage reciprocating air compressor.

Heat Transfer:

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

Text Books:

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

Note: Minimum 12 Experiments taking 6 from each section

16EE C22

ELECTRICAL MACHINES AND MICROCONTROLLER APPLICATIONS LAB
(Common to BE3/4, Mech. & Prod, V- SEM)

Instruction	1T + 2 Periods per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
Continuous Internal Evaluation	25 Marks
Credits	2

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

Course Outcomes: The student will be able to
1. Test the 1-phase transformer.
2. Know the right instrument and its usage for the given circuit.
3. Identify the suitable machine for required application.
4. Process the data using 805i microcontroller
5. Interface the given device with 8051 microcontroller

List of Experiments:

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

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

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

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

16PE C05

INDUSTRY VISIT

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

Excellent / Very Good / Good / Satisfactory / Unsatisfactory

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY(A)
Choice Based Credit System

B.E (Production Engineering)

SEMESTER – VI

S.No.	Course Code	Title of the Course	Scheme of Instruction		Scheme of Examination			Credits
			Hours per week		Duration in Hours	Maximum Marks		
			L/T	P/D		CIE	SEE	
THEORY								
1	16ME C26	CAD and CAM	3	-	3	30	70	3
2	16PE C06	Machine Tool Engineering	3	-	3	30	70	3
3	16PE C07	Additive Manufacturing	3	-	3	30	70	3
4	16ME C29	Machine Design	3/1	-	3	30	70	3
5		Professional Elective-III	3	-	3	30	70	3
6		Professional Elective-IV	3	-	3	30	70	3
PRACTICALS								
6	16ME C30	CAD and CAM Lab	-	3	3	25	50	2
7	16PE C08	Machine Tool Engineering Lab	-	3	3	25	50	2
8	16PE C09	Additive Manufacturing Lab	-	2	2	25	50	2
Total			**19**	**8**	**-**	**255**	**570**	**24**

L: Lecture T: Tutorial D: Drawing P: Practical

CIE - Continuous Internal Evaluation SEE - Semester End Examination

ELECTIVES

		Professional Elective-III (3/3)		**Professional Elective-IV (3/3)**	
SNo.	Subj Code	Name of the Subject	S No	Subj Code	Name of the Subject
1	16ME E06	Computational Fluid Dynamics	5	16ME E09	Object Oriented Programming With C++
2	16ME E07	Automobile Engineering	6	16ME E10	Turbo Machines
3	16PE E06	Work System Design	7	16PE E08	Modern Machining and Forming Methods
4	16PE E07	Quality and Reliability Engineering	8	16PE E09	Surface Engineering

Assessment Procedures for Awarding Marks

The distribution of marks is based on CIE by concerned teacher and the Semester end examination shall be as follows:

Course (in terms of credits)	CIE	Semester end Examination(Marks)	Remarks	Duration of Semester End Examination
Three(3) Credits/ Four(4) Credits	30*	70**	Theory Course/ Engg. Graphics	3 Hours
Two(2) Credits	20*	50***	Theory	2 Hours
Two(2) Credits	25	50	Lab Course/ Workshop	3 Hours
One(1) Credit	15	35	Lab Course	2 Hours
Two(2) Credits	50	—-	Project Seminar/ Seminar	——
Six(6) Credits	50	100	Project	Viva
One(1) Credit	—-	50***	Environmental Studies, Professional Ethics and Human values	2 Hours
One(1) Credit	50		Mini Project	——-

CIE: Continuous Internal Evaluation

*Out of 30/20 sessional marks(CIE), 10/5 marks are allotted for slip-tests (Three slips test will be conducted, each of 10/5 marks, best two average is considered) and the remaining 20/15 marks are based on the average of two tests, weightage for each test is 20/15 marks.

**The question paper will be in two parts, Part-A and Part-B. Part A is for Ten(10) questions and is compulsory, covers the entire syllabus, and carries 20 marks. Part- B carries 50 marks and covers all the units of the syllabus (student has to answer five out of seven questions).

***The question paper will be in two parts, Part-A and Part-B. Part A is for Ten(10) questions and is compulsory, covers the entire syllabus, and carries 15 marks. Part- B carries 35 marks and covers all the units of the syllabus (student has to answer five out of seven questions).

Note: A course that has CIE (sessional marks) but no semester end examination as per scheme, is treated as Pass/Fail for which pass marks are 50% of CIE.

A candidate has earned the credits of a particular course, if he/she secures not less than the minimum marks/grade as prescribed. Minimum pass marks for theory course is 40% of total marks i.e., CIE plus semester end examinations where as for the lab course/project is 50%.

16ME C26

CAD AND CAM

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives:

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

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

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

UNIT-I: Design Process:
Design criteria, Alternative solutions, Alternative design, Computer aided design and review
Drafting techniques: Basic geometric elements and their creation
Geometric modeling: Wire frame entities and their definition, interpolation and approximation curves. Concept of Parametric and non-parametric representation of circle and helix curves,
properties of splines. Synthetic curves: parametric representation of cubic spline, Bezier and B-spline curves, continuity, properties and characteristics. Introduction to NURBS.

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

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

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

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

UNIT-V: GT:
Part families, layout, part classification and coding system- OPITZ, MICLASS .
CAPP: Variant and generative process planning.
FMS and CIM: F.M.S equipment, FMS layouts, benefits of FMS.. Elements of CIM.
Computer Aided Inspection and QC:
Automated inspection- Off-line, On-line, contact (Co-ordinate measuring machine), Non-contact inspection (Machine Vision, Scanning LASER Beam, Photogrammetry)
CAD/CAM integration, Turnkey CAD/CAM systems, Introduction to rapid prototyping technique.

Text Books:

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

Suggested Reading:

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

(

16PE C06

MACHINE TOOL ENGINEERING

Instruction	3	Hours per week
Duration of Semester End Examination	3	Hours
Semester End Examination	70	Marks
Continuous Internal Evaluation	30	Marks
Credits	3	

Course Objectives: Student will learn the

1. To provide the basic understanding of cutting tools, geometry in machining process
2. To make students familiar with cutting forces in turning drilling, milling operations.
3. To make the students to understand various machine tools, like lathe, drilling, milling shaper, planner
4. To make a knowledge of Thread manufacturing and gear manufacturing

Course Outcomes: Students are able to

1. Select tool geometry for various materials
2. Calculate forces in turning, drilling and milling processes
3. Identify the machine tools for manufacturing various components
4. Understand thread cutting and gear cutting operations
5. Select grinding wheel and Automats
6. Work on shaper, planner and grinding machines

UNIT-I: Orthogonal and Oblique Cutting:
Cutting forces in turning, drilling milling and grinding, Merchant's analysis, Shear angle, friction angles. Experimental methods for estimation of shear angle, cutting forces and power, types of chips. Built up edge phenomena and its effects. Chip breakers. Sources of heat, its distribution and measurement. Different types of cutting fluids.

UNIT-II: Tool Wear and Tool Life:
Criteria for tool wear, flank and crater wear theories, criteria for tool life in roughing and finishing, Measurement of tool wear, Taylor's tool life equation, factors effecting tool life, Machiniability. Single point cutting tool design; Geometry, tool nomenclature, American, DIN, max. rake system. Interrelation between normal rake and orthogonal rake, tool signature, effect of basic tool angles on its performance. Selection of size and angles of S.I. Tools, from tools. Design feature of multipoint cutting tools.

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

Automats:
Single spindle and multiple spindle automats, Swiss type of automats, constructions and features of these machines.

UNIT-IV: Drilling Machines:
Types and constructional features and applications, Radial drilling machine, drilling operations

Milling Machines:
Classifications and types various operations on milling machines, Up and down milling, Types of milling cutters and bars. Dividing head, plain, compound and differential indexing.
Boring machines: Horizontal, Vertical and Jig boring machines and constructional features.
Thread production: Thread rolling, thread chasing , thread milling and thread grinding

UNIT-V : Shaping, Planing & Slotting Machines:
Types, Constructional features, Types of work done on it. Quick return motion, manipulation of cutting speeds and feeds, work and tool holding devices, comparison of these machines.

Gear Cutting Machines:
Methods of gear cutting, types and classification of gear hobbing, gear shaping machines Bevel gear cutting

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

Text Books:

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

Suggested Reading:

1. Hazra Choudary, "Workshop Technology", Vol. II, Media Pub., New Delhi.
2. Kibbe Richand R, Meyer, R.D, Neely etal, 'Machine Tool Practices, 9th Edition, PHI, 2014.
3. Jain & Chitale, Text Book of Production Engineering, 2nd Edition, PHI, 2014

16PE C07

ADDITIVE MANUFACTURING (Professional Elective-III)

Instruction	3	Hours per week
Duration of Semester End Examination	3	Hours
Semester End Examination	70	Marks
Continuous Internal Evaluation	30	Marks
Credits	3	

Course Objectives:

1. To make students understand the basic concepts of various rapid prototyping technologies.
2. To understand and apply criterion for selecting appropriate RPT technique for any given application.
3. To competently use tools to explore digital manufacturing techniques and CAD modeling software
4. To understand the stl file generation and manipulations
5. Explain and summarize the principles and key characteristics of RP technologies and commonly used RP systems.
6. To make students understand typical rapid tooling processes for quick batch production of plastic and metal parts

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

1. Explain the process chain of Additive manufacturing and other rapid manufacturing Processes and their classification, advantages and disadvantages.
2. Critically explore technologies used for Additive manufacturing in terms of their parameters, application, limitations, materials, equipment, outcomes and implications and their comparison.
3. Compare different Additive manufacturing processes and select a subtractive or an AM process for a particular application for product development of engineering components.
4. Describe various CAD issues for rapid prototyping and related operations for STL model manipulation, formulate and solve typical problems on reverse engineering.
5. Identify different post processing techniques involved after rapid prototyping
6. Explore the applications of Additive manufacturing in different industries

UNIT-I: Introduction to rapid manufacturing:

Customization and mass customization, types of mass customization. Classification of fundamental fabrication processes (additive/subtractive/formative), Difference between AM and CNC. Process chain for Additive Manufacturing(AM) processes. Classification of additive (layered) Manufacturing processes. Advantages and Limitations of AM.

UNIT-II: Extruder Deposition System:

Laminated object manufacturing, shaped deposition manufacturing and modular configuration. Photo polymerization, Stereo lithography apparatus & Solid ground curing -Working principles and their applications, advantages and disadvantages. Laser sintering based technologies and their related details. Direct metal laser Sintering process.

UNIT-III: Pre-processing in AM:

Pre-processing of CAD model- STL conversion, STL error diagnostics, STL file Repairs: Generic Solution. Newly Proposed Formats.

Support generation, transformations, slicing, surface preparation of materials, pre-heating of powders.

Rapid Prototyping Software's: Features of various RP software's like Magics, Mimics, Solid View, Rhino, STL View 3 Data Expert and 3 D doctor.

UNIT-IV: Post processing in AM:
Post processing equipment – support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern,
Property enhancements using non–thermal and thermal techniques.
Rapid Tooling:
Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Rapid Tooling Classification: **Indirect Rapid Tooling Methods**: Arc Spray Metal Deposition, Investment Casting, 3D Keltool process. Direct Rapid Tooling: Direct AIM , LOM Tools, EOS Direct Tool Process

UNIT-V: AM Applications:
Application in Design, Engineering, Analysis & Planning. Application in Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture.
RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Forensic Science.

Text Books:

1. Gibson I, Rosen DW and Stucker B; Additive manufacturing methodologies : Rapid prototyping to direct digital manufacturing , Springer , 2010
2. Chee Kai Chua, Kah Fai Leong , 3D printing and additive manufacturing : principles and application: fourth edition of rapid prototyping
3. Venuvinod, PK; Ma, W; Rapid prototyping – Laser based and other technologies, Kluwer , 2004

Suggested Reading:

1 Rapid tooling : Technologies and industrial applications by Jacob, Paul F
2 Andreas Gebhanrdt, Understanding Additive Manufacturing,Hanses,2012
3 Alain Brnard, Georges Talliander,Additive Manufacturing,Wiley,2014

16ME C29

MACHINE DESIGN

Instruction	4 Theory Periods per week
Duration of Semester End Examination	3 Hours
Semester End examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	4

Course Objectives:

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

Course Outcomes:

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

UNIT-I: **Mechanical Springs**:

Introduction, types of springs, Materials used for springs.

Helical Springs:

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

Leaf Springs:

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

UNIT-II: **Gears**:

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

UNIT-III: **Bearings**:

Introduction, classification of bearings, materials used for bearings, properties and types of lubricants.

Design of Sliding Contact Bearings:

Hydrostatic and Hydrodynamic bearings.

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

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

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

Text Books:

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

Suggested Reading:

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

Machine Design Data Books:

1. Design Data book by PSG College –2012
2. Mahadevn .K, Balaveera Reddy. K, 'Design Data Hand Book, 4th Edn., CBS Publishers & Distributors, 2013.
4. Machine Design Data Book, by V.B. Bhandari McGraw hill education, 201

16ME E06

COMPUTATIONAL FLUID DYNAMICS (Professional Elective – III)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives:

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

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

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

UNIT-I: Basic Equations:

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

UNIT-II: Models:

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

Classifications of Partial Differential Equations:

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

UNIT-III: Finite Difference Method:

Forward, backward and central difference

Parabolic partial differential equations:

Euler, implicit and crank Nicholson methods, ADI models, Errors, consistency, stability analysis, Vonnumen analysis, Convergence criteria.

UNIT-IV: Elliptic Partial Differential Equations:

Jacobi, Gauss seidel methods, Viscous incompressible flow, Stream-function-vorticity method
Introduction to grid generation- types of grids O, H, C

UNIT – V: Finite Volume Method:

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

Text Books:

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

Suggested Reading:

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

16ME E07

AUTOMOBILE ENGINEERING (**Professional Elective – III**)

Instruction	4 Hours per week
Duration of Semester End Examination	3 Hours
Semester End examination	70 Marks
Continuous Internal Evaluation	20 Marks
Credits	3

Course Objectives: The student will learn

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

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

1. Identify the different parts of the automobile
2. Explain the working of various parts like engine, transmission, clutch, brakes
3. Describe how the steering and the suspension systems operate.
4. Understand the environmental implications of automobile emissions
5. Develop a strong base for understanding future developments in the automobile industry
6. Formation of pollutants in I.C Engines & Their remedial methods to control them

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

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

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

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

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

Text Books:

1. *Crouse & Anglin, Automotive Mechanics*, TataMcGraw Hill. Publishing Co. Ltd., New Delhi, Tenth Edition – 2004
2. Kirpal singh., *Automobile Engineering Vol. I & II* Standard Publishers, Delhi.
3. R.K. Rajput, *A Textbook of Automobile Engineering*, Laxmi Publications, New Delhi, 2012

Suggested Reading:

1. Joseph Heitner, *Automotive Mechanics*, Affiliated East West Pvt. Ltd.
2. C.P Nakra, *Basic Automobile Engineering*, Dhanpat Rai Publishing Co(P) Ltd., New Delhi, 2003.
3. G.B.S. Narang, *Automobile Engineering*, Khanna Publishers, New Delhi, 2014

16PE E06

WORK SYSTEM DESIGN (Professional Elective – III)

Instruction	3	Hours per week
Duration of Semester End Examination	3	Hours
Semester End examination	70	Marks
Continuous Internal Evaluation	30	Marks
Credits	3	

Course Objectives: Student will

1. Understand work system design concepts
2. Learn method study techniques
3. Conceptualize work measurement tools and techniques
4. Learn job evaluation and merit rating
5. Understand principles of ergonomics
6. Learn the concepts of production planning & control

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

1. Use work study techniques to improve productivity
2. Apply method study recording techniques
3. Implement work measurement and time study tools
4. Execute job evaluation and merit rating techniques
5. Apply ergonomical principles in product design
6. Use concepts of production planning & control in industry

UNIT-I :Work Study:

Introduction, Basic Concepts, importance, Scope, procedure and benefits.
Productivity, Basic Concept and principles, Production Vs productivity, Productivity improvement techniques.

UNIT-II: Method Study:

Introduction, Steps involved in method study
Recording Techniques-Outline Process Chart, Flow process charts, Two handed process chart, Multiple activity chart, SIMO chart. flow diagram, string diagram, Travel chart, Cycle graph and Chronocycle graph, Therbligs. Principle of Motion Economy

UNIT-III: Work Measurement:

Introduction, Techniques of work, Measurement, Time study, Standard data, analytical estimation. Time study-objectives and uses of Time study. Time Study Equipments, Procedure for Time study, Allowances and types, Calculation of standard time.

UNIT-IV: Methods of Job and Performance Evaluation:

Job evaluation and Merit rating, various methods of job evaluation, performance Appraisal system, Wage Incentive systems.
Line balancing: Line balancing in production and assembly lines-Heuristic and other methods of line balancing.

UNIT-V: Ergonomics and economics: Ergonomic design, Ergonomic evaluation methods, cognitive ergonomics, participative ergonomics. Social sustainability for work systems.
Production planning & Control: Objectives of production planning and control- functions of production planning and control. Types of production – continuous and intermittent, job shop, batch and mass production systems.

Text Books:

1. O.P. Khanna, Industrial Engineering and Management, Dhanpat Rai Pub.,
2. M.S. Mahajan Industrial Organization & Management, Nirali Prakashan Pub.
3. Gerald Nadler 'Work System Design: The ideals concept by McGraw Hill Publisher
4. Mikell P. Groover, 'Work system and The Methods Measurement and Management of Work', Pearson Prentice Hall, 2007

Suggested Readings:

1. Industrial Management, Deepak Kumar Bhattacharya, Vikas Pub., 2011.
2. Industrial Engineering & Management by S. Chand
3. Introduction to work study, ILO Publication

16PE E07

QUALITY AND RELIABILITY ENGINEERING (Elective – III)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives: Student will understand the

1. Concepts of quality and associated techniques
2. process control for variables and attributes
3. Conceptualization of design for quality
4. Experimental design & quality techniques
5. Reliability and its influence in engineering
6. Conceptualization of the design for reliability & maintainability

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

1. Apply quality improvement techniques
2. Use control charts for variables and attributes
3. Implement designing for quality
4. Apply experimental design and Taguchi methods
5. Use techniques of reliability engineering
6. Implement reliability & maintainability in industry

UNIT-I: **Introduction**: Introduction, definition of quality, basic concept of quality, definition of SQC, benefits and limitation of SQC, Quality assurance, Quality cost, Quality improvement process through Bar Chart, cause and effect diagram, parato analysis, scatter diagram etc,.

UNIT-II Process Control for Variables and Attributes: Causes of Variation, Control Charts for Variables (Mean and Range) Xchart and R chart, Control Chart Patterns and Corrective Actions, Control Charts for Attributes (p-chart, c-chart,) acceptance Sampling Plans, Producer's Simple and Consumer's risk, types of Sampling Plans and their demerits, operating Characteristic Curve, Average Outgoing Quality Curve), Errors in Making Inferences from Control Charts (Type I and II errors)

UNIT-III: **Designing for Quality**: Introduction to Concurrent Engineering, Quality Function Deployment (QFD) and Failure Mode and Effect Analysis (FMEA) – Concept, methodology and Application Experimental Design and Taguchi method: Fundamentals – factorial experiments – Taguchi method – Loss function – experiments – S/N ratio and performance measure- Orthogonal arrays.

UNIT-IV

Reliability Engineering: Reliability function, Failures rate, Mean Time Between Failures (MTBF), Mean Time To Failure (MTTF), mortality curve, availability, maintainability, system effectiveness. Introduction to probability distributions.

Time to failure distributions: Reliability evaluation of two-state device networks-series, parallel, Standby redundant systems, Reliability evaluation.

UNIT-V

Design For Reliability and Maintainability: Reliability design process, system effectiveness, economic analysis and life cycle cost, reliability allocation, design methods, parts and material selection, failure analysis, determination of causes, assessments of effects, computation of criticality index, corrective action, system analysis of down-time, reliability under preventive

maintenance, repair vs replacement, replacement models, proactive, preventive, predictive maintenance, optimization techniques for system reliability with redundancy, heuristic methods applied to optimal system reliability.

Text Books:

1. Quality Assurance and Total Quality Management, by K C Jain and A K Chitale, Publisher: Khanna Publishers
2. Statistical *Quality* Control, by M. Mahajan, Publisher: Dhanpat Rai & Co. (P) ltd.
3. Statistical Methods for Quality, Reliability and Maintainability by K. Muralidharan and A. Syamsunder, PH Publications

Text Books:

1. Quality Control & Application, by B. L. Hanson & P. M. Ghare, Publisher: Prentice Hall of India
2. Reliability Engineering, by Srinath L. S., Publisher : Affiliated East West Press.
3. Statistical *Quality* Control, by Eugene L. Grant and Richard S. Leavenworth, Publisher : Tata McGraw-Hill Publishing Company ltd.
4. Quality and Reliability Engineering by Tirupathi R. Chandraputla, Cambridge Univ. Press, New Delhi

16ME E09

Object Oriented Programming through C++ (Professional Elective-IV)

Instruction	3	Hours per week
Duration of Semester End Examination	3	Hours
Semester End Examination	70	Marks
Continuous Internal Evaluation	30	Marks
Credits	3	

Course Objectives:

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

Course Outcomes: Be able to understand

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

UNIT-I: Principles of Object Oriented Programming:

Procedure Vs Object Oriented, Paradigm, Basic concepts, benefits, Applications and Object Oriented Languages.

Introduction:

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

Token, Expression and Control Structures:

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

Functions:

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

UNIT-II: Classes and Objects:

Defining classes and Member functions, creating objects, objects and arrays, objects and functions, const with classes, friends to a class, nesting static members of a class,

Constructors and Destructors:

Type of Constructors, Dynamic Initialization of Objects, Destructors.

UNIT –III: C++ Operator Overloading and Type Conversions:

Fundamentals, restrictions, overloading unary / binary operators, overloading ++ and --, overloading special operators, overloading by member functions and friend functions, type conversions.

UNIT-IV: C++ Inheritance:
Defining derived classes, Types of Inheritance, Virtual Base class Abstract Class, function overriding and containership.
Pointers and Polymorphism:
Pointers and Generic pointer, Pointer to Objects and Derived Classes, this pointer, Virtual Functions, Virtual Destructors.

UNIT-V: C++ Templates:
ntroduction, function templates and class templates
C++ Exception Handling:
Conventional error handling mechanism, C++ error handling mechanism, Try, throw, catch, exception handling in classes.

Text Books:

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

Suggested Reading:

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

16ME E10

TURBO MACHINES (Professional Elective-IV)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Course Objectives: Student will

1. Learn the fundamentals of turbo machinery and its importance
2. Learn principles and equations of turbo machinery
3. Know about velocity triangle and power developed by steam turbines
4. Familiarize the working principles of axial flow compressor
5. Understand the working principle of Centrifugal compressor and its performance
6. Learn the power required for Rotary compressors and power developed by Gas turbines

Course Outcomes: Students are able understand

1. The principle of turbo machinery
2. Apply gas dynamics equations depending upon applications
3. Estimate the power developed by steam turbines
4. Find efficiency, pressure rise and degree of reaction of axial flow compressor
5. Analyze the slip factor and performance of centrifugal compressor
6. Understand cycles and improve the cycle efficiency in gas turbines

UNIT -I Introduction:
Definition and parts of turbo machines and its classifications, Comparison with positive displacement machines, Efficiencies of turbomachines, Static and Stagnation states,overall isotropic efficiency, stage efficiency (their comparison) and poly tropic efficiency for both compression and expansion processes.

UNIT – II Energy Exchange in Turbo Machines:
Euler's turbine equation, Alternate form of Euler's turbine equation, Components of energy transfer, Degree of Reaction, General Analysis of Turbo machines: Radial flow compressors – general analysis and Expression for degree of reaction, Problems.

UNIT-3 Steam Turbines:
Introduction to steam nozzles, design for throat area. Classification of steam turbines, Impulse turbine, compounding of steam turbines, Pressure velocity variations across different compounding turbines, blade efficiency and work done by impulse turbine ,degree of reaction of reaction turbine, blade efficiency and work done by reaction turbine, stage efficiency and nozzle efficiency and simple problems on impulse and reaction turbines

UNIT-4 Rotodynamic Compressors:
Introduction and general classification, Comparison of Reciprocating and Rotary compressors, Positive displacement Rotary compressors, Flow through rotary compressors. Static and total head quantities. Thermodynamic cycles and work done, calculation of various efficiencies. Velocity diagrams and pre-whirl. Euler equation for energy transfer between fluid and rotor, Analysis of Centrifugal compressors and analysis of axial flow compressors, Chocking, Surging and Stalling.

UNIT -5 Gas Turbines :
Application and classification of Gas turbine, Thermal efficiency of joule cycle, Maximum pressure ration in terms of temperature ratio, optimum pressure ratio for maximum work output with or without considering machine efficiencies .Improvements of gas turbine plant performance-Inter cooling, Reheating and regeneration. Simple problems on joule cycle.

Air Craft Propulsion:
Aircraft engine types, Turbo jet engines, ram jet and Pulse jet engines.
Rocket Propulsion:
Types of Propellants, Types of Rocket engines, Rocket propulsion theory-Rocket applications

Text Books:

1. V. Kadambi and Manohar Prasad, An Introduction to Energy Conversion, Volume III, Turbo machinery, , New Age International Publishers, reprint 2008.
2. S. M. Yahya, Turbines, Compressors & Fans, Tata McGraw HillCo. Ltd., 2nd edition, 2002
3. S. L.Dixon,Fluid Mechanics & Thermodynamics of Turbo machines, Elsevier (2005).

Suggested Reading:

1. D. G. Shepherd Principals of Turbo machines, the Macmillan Company.
2. B.K. Venkanna, Turbo machine,. PHI, New Delhi 2009
3. M. S. Govindgouda and A. M.Nagaraj,Text Book of Turbo machines, M. M. Publications, 4Th Ed, 2008

16PE E08

MODERN MACHINING AND FORMING PROCESSES (Professional Elective-IV)

Instruction	3	Hours per week
Duration of Semester End Examination	3	Hours
Semester End examination	70	Marks
Continuous Internal Evaluation	30	Marks
Credits	3	

Course Objectives: Student will learn

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

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

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

UNIT-I: Mechanical Energy Processes:

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

Abrasive Jet Machining (AJM):

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

Water Jet Machining (WJM):

Schematic diagram, equipment used, advantages and applications

Abrasive Water Jet Machining (AWJM):

Process, advantages, limitations and applications

UNIT-II: Thermal Processes:

Electro Discharge Machining (EDM):

Process description with schematic diagram, process parameters, functions and characteristics of dielectric medium, dielectric fluids, flushing, mechanism of metal removal, types of power supply circuits, mathematical analysis of metal removal rate (MRR), equations for surface finish, characteristics of spark eroded surfaces, advantages, disadvantages and applications

Wire EDM:

Process description and applications

LASER Beam Machining (LBM):

Principle of LASER beam production, materials used, process parameters, advantages, limitations and applications,

Plasma Arc Machining (PAM):

Introduction, equipment used, process description and parameters, types of plasma arc: transferred arc and non transferred arc and process applications,
Electron Beam Machining (EBM): Schematic of the process, process parameters, principle of production of electron beam, equipment used, advantages, disadvantages and applications,

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

UNIT-IV: High Energy Rate Forming Processes (HERF):
Introduction, applications, advantages, **Explosive Forming:**
Principles, explosive materials, Equipment, types of explosive forming, standoff operation and contact operation.
Electro-Hydraulic Forming (EHF): Schematic of process, description and its applications, **Electro-Magnetic Forming (EMF):** Process description, merits, limitations and applications

UNIT-V: Other Forming Processes:
Rubber Pad Forming: Principle of the process, process details and its types, Guerin, wheelon, Mar forming and Hydro forming processes and applications,
Stretch Forming: Introduction, types of stretch forming, stretch draw forming, rotary stretch forming or stretch wrapping, compression forming, radial draw forming.
Tube spinning: introduction, methods of tube spinning, backward spinning, forward spinning.

Text Books:

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

Suggested Reading:

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

16PE E09

SURFACE ENGINEERING (Elective-IV)

Instruction	3 Hours per week
Duration of End Examination	3 Hours
Semester End examination	70 Marks
Continuous Internal Evaluation	30 Marks
Credits	3

Objectives:

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

Outcomes: Students will

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

UNIT I: Friction

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

UNIT II: Wear

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

UNIT III: Corrosion

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

UNIT IV: Surface Treatments

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

UNIT V: Engineering Materials

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

Text Books:

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

Suggested Readings

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

16ME C30

CAD AND CAM LAB

Instruction	3	Hours per week
Duration of Semester End Examination	3	Hours
Semester End Examination	50	Marks
Continuous Internal Evluation	30	Marks
Credits	2	

Course Objectives:

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

Course Outcomes:

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

Detailed Syllabus:

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

4-8 Assembly modeling of the following

(a) Stuffing Box (b) Screw Jack (c) CrossHead (d) Eccentric

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

Text Books:

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

Note: Any 12 experiments need to be conducted

16PE C08

MACHINE TOOL ENGINEERING LAB

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
Continuous Internal Evluationa	30 Marks
Credits	2

Course Objectives: Students will learn

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

Course Outcomes: Student is able to

1. grind single point cutting tool with various angles
2. perform taper turning and knurling on lathe
3. perform drilling and thread cutting operations
4. to manufacture a gear using milling machine
5. do operation on shaper
6. exposed to various unconventional processes

Experiments:

1. Introduction to Machine Tools, like Lathe, Drilling, Milling and Shaper.
2. Plain and step turning operations on Lathe
3. Step turning and Knurling on Lathe machine
4. Taper turning on Lathe
5. Drilling and Boring on Lathe
6. Thread Cutting on Lathe
7. Grinding of Single Point Cutting Tool
8. Gear Cutting using (a) Plain Indexing (b) Compound Indexing
9. Measurement of Cutting forces during machining on Lathe machine and Milling machine
10. Finding Shear angle experimentally in turning operation
11. Step turning and facing on CNC Lathe
12. Taper turning on CNC Lathe
13. Multiple turning in ball shape on CNC Lathe
14. Contouring on CNC milling machine
15. Pocketing (rectangular and circular)
16. Drilling Cycles on Milling machine

Text Books:

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

16PE C09

ADDITIVE MANUFACTURING LAB

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
Continuous Internal Evaluation	30 Marks
Credits	2

Course objectives:

1. Use commercial software for digitizing free-form geometry.
2. Capture digital data from a difficult to design object and make a manufactured model.

Course outcomes: The intended outcomes of the course are:

1. Select and use correct CAD formats in the manufacture of a 3D printed part.
2. Set up and fabricate a 3D part using an additive manufacturing machine.
3. Ability to understand and use modern rapid prototyping systems;
4. Capacity to select the processing parameters best suited to the production of prototype quality
5. Identify, characterize and select the ideal materials for a given Rapid Prototyping system.
6. Gain confidence to operate the 3d printing machine

List of Experiments:

1. Introduction to RP machine , Machine Specifications, Materials
2. Review of modeling of resin and metal parts in cad software.
3. Stl file Generation (stitching, orientation, scaling, etc.,) in magics/Idea maker software.
4. Slicing of stl files
5. Obtaining the tool path data and sending it to RP Machines
6. 3d printing of jigs, fixtures and other manufacturing tools
7. Demonstration of rapid tooling using fused deposition modeling
8. Prototyping of petrol engine Connecting rod
9. Fabrication of Components of Screw jack and assembling them
10. Removing the supports & post processing (cleaning the surfaces)
11. Post curing of fabricated resin parts
12. Reverse engineering: from scanner to model validation (solid works)

Text Books:

1. Gibson I, Rosen DW and Stucker B; Additive manufacturing methodologies : Rapid prototyping to direct digital manufacturing , Springer , 2010
2. Chee Kai Chua, Kah Fai Leong , 3D printing and additive manufacturing : principles and application: fourth edition of rapid prototyping

Note: Any 10 experiments need to be conducted