CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

Choice Based Credit System
B.E (Mechanical 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	4
2	16ME C21	Applied Thermodynamics and Heat Transfer	3/1	-	3	30	70	4
3	16ME C22	Design of Machine Elements	3/1	-	3	30	70	4
4		Professional Elective-I	3	-	3	30	70	3
5		Professional Elective-II	3	-	3	30	70	3
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	16ME C25	Industrial Visit	Excellent / Very Good / Good / Satisfactory / Unsatisfactory					
Total			**18**	**9**	**-**	**225**	**500**	**24**

L: Lecture T: Tutorial D: Drawing P: Practical
CIE - Continuous Internal Evaluation SEE - Semester End Examination

		Professional Elective-I	Professional Elective-II	
SNo.	**Subj Code**	**Name of the Subject**	**Subj Code**	**Name of the Subject**
1	16ME E01	Refrigeration and Air Conditioning	16ME E03	Fuels, Combustion and Environment
2	16ME E02	Mechanical Vibrations	16PE E03	Non Destructive Testing and Evaluation
3	16PE E01	Principles of Industrial Engineering	16PE E04	Plastics, Ceramics and Composite Materials
4	16PE E02	Product Design and Process Planning	16MT E04	Probability and Numerical Methods

16ME C20

DYNAMICS OF MACHINES

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

Course Objectives:

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

Course Outcomes:

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

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

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

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

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

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

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

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

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

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

16ME C21

APPLIED THERMODYNAMICS AND HEAT TRANSFER

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

Course Objectives:

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

Course Outcomes: Students will be able to

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

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

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

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

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

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

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

Heat Exchangers:
Classification, LMTD and NTU Concepts.

Text Books

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

Suggested Reading

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

16ME C22

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

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

Course Objectives:

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

Course Outcomes: Students will able to

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

UNIT-I: Introduction:

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

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

UNIT-II: Design for Fatigue and Impact loads:

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

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

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

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

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

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

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

16ME E01

REFRIGERATION AND AIR CONDITIONING (Professional Elective-I)

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

Course Objectives: Students will

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

Course Outcomes: Students will be able to

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

UNIT-I: Introduction to Refrigeration:

Application of Refrigeration, Definition of COP, Tonne of Refrigeration, Designation, Carnot cycle, Eco-friendly Refrigerants, Properties of Refrigerants.

Air Refrigeration Systems:

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

UNIT-II: Vapour Compression System:

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

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

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

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

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

Text Books

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

Suggested Reading

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

16ME E02

MECHANICAL VIBRATIONS (Professional Elective-I)

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

Course Objectives:

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

Course Outcomes: Students aquire the

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

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

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

UNIT-II: Harmonically Excited Vibration:

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

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

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

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

Text Books:

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

Suggested Reading:

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

16PE E01

PRINCIPLES OF INDUSTRIAL ENGINEERING (Professional Elective-1)

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

Course Objectives: Student will learn the

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

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

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

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

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

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

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

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

Text Books:

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

Suggested Readings:

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

16PE E02

PRODUCT DESIGN AND PROCESSES PLANNING
(Professional Elective-I)

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

Course Objectives:

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

Course Outcomes:

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

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

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

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

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

UNIT-V: Process Selection and Planning:

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

Text Books:

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

Suggested Reading:

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

16ME E03

FUELS, COMBUSTION AND ENVIRONMENT (Professional Elective-II)

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

Course Objectives: Student will understand

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

Course Outcomes: A student will be able to

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

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

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

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

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

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

Text Books:

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

Suggested Reading:

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

16PE 03

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

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

Course Objectives: Student has to understand the

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

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

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

UNIT-I: Liquid Penetrate Inspection:

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

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

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

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

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

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

Text Books:

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

Suggested Reading:

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

16PE E04

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

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

Course Objectives: To make the students to

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

Course Outcomes: Students should able to

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

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

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

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

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	3 Hours
End Exam	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives:

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

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

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

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

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

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

UNIT IV: Numerical Differentiation & Integration: Numerical differentiation using numerical forward & backward interpolation formula, Numerical integration: Simpson's $3/8^{th}$ 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.
2. M.K.Jain, S.R.K Iyengar and R.K.Jain: Numerical methods for Scientific and Engineering Computation. New Age International publications, 2008.

Suggested Reading:

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

16ME C23

DYNAMICS AND VIBRATIONS LAB

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

Course Objectives:

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

Course Outcomes: Students will be able to

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

List of experiments:

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

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 AND HEAT TRANSFER LAB

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

Course Objectives:

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

Course Outcomes: Students will be able to

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

Applied Thermodynamics

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

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

Course Objectives:

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

Course Outcomes: The student will be able to

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

List of Experiments:
Cycle -I

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

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

Cycle -II

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

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

Text Books:

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

16ME C25

INDUSTRIAL VISIT

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

Excellent / Very Good / Good / Satisfactory / Unsatisfactory.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY(A)

Choice Based Credit System
B.E (Mechanical 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	16ME C27	Metal Cutting and Machine Tool Engineering	3	-	3	30	70	3
3	16ME C28	Thermal Turbo Machines	3	-	3	30	70	3
4	16ME C29	Machine Design	3/1	-	3	30	70	4
5		Professional Elective-III	3	-	3	30	70	3
6		Professional Elective-IV	3	-	3	30	70	3
PRACTICALS								
7	16ME C30	CAD and CAM Lab	-	3	3	25	50	2
8	16ME C31	Metal Cutting and Machine ToolEngineering Lab	-	3	3	25	50	2
9	16ME C32	Thermal Engineering Lab	-	3	2	25	50	2
Total			**19**	**9**	**-**	**255**	**570**	**25**

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.	**Sub.j Code**	**Name of the Subject**	**SNo**	**Subj. Code**	**Name of the Subject**
1	16ME E04	Advanced IC Engines	5	16ME E07	Heat and Mass Transfer
2	16ME E05	Computational Fluid Dynamics	6	16ME E08	Object Oriented Programming With C++
3	16ME E06	Automobile Engineering	7	16PE E06	Modern Machining and Forming Methods
4	16PE E05	Digital Manufacturing	8	16PE E07	Surface Engineering

16ME C26

CAD and CAM

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

Course Objectives:

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

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

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

UNIT-I: Design Process:

Design criteria, Alternative solutions, Alternative design, Computer aided design and review.

Drafting techniques: Basic geometric elements and their creation.

Geometric modeling: Wire frame entities and their definition, interpolation and approximation curves. Concept of Parametric and non-parametric representation of circle and helix curves,

properties of splines. Synthetic curves: parametric representation of cubic spline, Bezier and B-spline curves, continuity, properties and characteristics. Introduction to NURBS.

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. C. Elanchezhian, T . Sunder Selwyn , G . Shanmuga Sunder, Computer Aided manufacturing , Laxmi Publications (P) Ltd, 2nd edition, New Delhi 2007.

16ME C27

METAL CUTTING AND MACHINE TOOL ENGINEERING

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

Course Objectives: Student will learn the

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

Course Outcomes: Students are able to

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

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

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

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

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

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

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

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

UNIT-IV: Boring Machines:
Horizontal, Vertical and Jig boring machines and constructional features. Differences between Shaper, Planner and slotter, Quick return mechanisms.

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

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

UNIT-V: Jigs and Fixtures:
Design principles for location and clamping. Quick clamping devices. Types of jigs and fixtures.

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

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

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

16ME C28

THERMAL TURBO MACHINES

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

Course Objectives:

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

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

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

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

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

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

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

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

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

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

Text books:

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

Suggested Reading:

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

16ME C29

MACHINE DESIGN

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

Course Objectives:

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

Course Outcomes:

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

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

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

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

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

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

Design of Sliding Contact Bearings:
Hydrostatic and Hydrodynamic bearings.

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

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

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

Text Books:

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

Suggested Reading:

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

Machine Design Data Books:

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

16ME E04

ADVANCED IC ENGINES (Professional Elective – III)

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

Course Objective (s): Student will understand the

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

Course Outcome (s): Student will be able to

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

UNIT-I : Fundamentals of IC Engines:

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

UNIT-II: Combustion Phenomena:

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

UNIT-III: Pollutant Formation And Control:

Engine Variables Affecting Pollutants and their remedies Working Principles of Smoke Analyser, CO/UBHC Analyser and NO_x Analyser–Introduction to emission norms.

UNIT-IV: Alternative Fuels

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

UNIT-V: Advances in IC Engines

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

Text books:

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

Suggested Readings:

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

16ME E05

COMPUTATIONAL FLUID DYNAMICS (Professional Elective – III)

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

Course Objectives:

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

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

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

UNIT-I: Basic Equations:

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

UNIT-II: Models:

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

Classifications of Partial Differential Equations:

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

UNIT-III: Finite Difference Method:

Forward, backward and central difference.

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

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

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

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

Text Books:

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

Suggested Reading:

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

16ME E06

AUTOMOBILE ENGINEERING (Professional Elective – III)

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

Course Objectives: The student will learn

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

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

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

UNIT-I: Types of automobiles:

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

UNIT-II: Lubricating Systems:

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

UNIT-III: Steering Systems:

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

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

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

Text Books:

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

Suggested Reading:

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

16PE E05

DIGITAL MANUFACTURING (Professional Elective-III)

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

Course Objectives: Student has to understand the

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

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

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

UNIT-I: Overview of Digital Manufacturing Processes:

Concepts and research and development status of digital manufacturing, definition, features and development of digital manufacturing, Conventional and digital manufacturing.

Theory system of digital manufacturing science: Operation mode and architecture of digital manufacturing system , Operation reference mode of digital manufacturing system – architecture of digital manufacturing system.

UNIT-II: Additive Manufacturing Processes Advanced Materials:

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

UNIT-III: Virtual Prototyping:

Introduction to Virtual Prototyping, Basic theory of Virtual Prototyping, Application of Virtual Prototyping in Manufacturing, Virtual Prototyping and Virtual

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

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

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

Text Books:

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

Suggested reading:

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

16ME E07

HEAT AND MASS TRANSFER (Professional Elective-IV)

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

Course Objectives:

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

Course Outcomes: Students will be able to

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

UNIT-I: Conduction in Heat Transfer:

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

UNIT-II: Convection in Heat Transfer:

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

UNIT-III: Radiation in Heat Transfer:

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

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

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

Text Books:

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

Suggested Reading:

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

16ME E08

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

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

Course Objectives:

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

Course Outcomes: Be able to understand

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

UNIT-I: Principles of Object Oriented Programming:
Procedure Vs Object Oriented, Paradigm, Basic concepts, benefits, Applications and Object Oriented Languages.
Introduction:
Program structure, Creating, Compiling and Linking of C++ program.
Token, Expression and Control Structures:
Tokens, Keywords, Identifiers and Constants, Data Types, Operators, Precedence, Type Compatibility, Control Structures, New Features of C++.
Functions:
Function Prototype and Parameter Passing, Inline Functions, Default, Constant Arguments, Recursion, Function Overloading.

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

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

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

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

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

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

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

Text Books:

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

Suggested Reading:

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

16PE E06

MODERN MACHINING AND FORMING PROCESSES
(Professional Elective-IV)

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

Course Objectives: Student will learn

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

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

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

UNIT-I: Mechanical Energy Processes:

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

Abrasive Jet Machining (AJM):

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

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, 1980.
3. Hassan Abdel-Gawad El-Hofy, Advanced Machining Processes, Nontraditional and Hybrid Machining Processes, McGraw Hill Publishing Co. Ltd., 1984.

Suggested Reading:

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

16PE E07

SURFACE ENGINEERING (Professional Elective-IV)

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

Course Objectives:

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

Course Outcomes: Students will be able to

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

UNIT I: Friction:

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

UNIT II: Wear:

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

UNIT III: Corrosion

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

UNIT IV: Surface Treatments

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

UNIT V: Engineering Materials

Introduction:

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

Text Books:

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

Suggested Readings:

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

16ME C30

CAD and CAM LAB

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

Course Objectives:

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

Course Outcomes:

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

Detailed Syllabus:

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

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

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

Text Books:

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

Note: Any 12 experiments need to be conducted.

16ME C31

METAL CUTTING AND MACHINE TOOL ENGINEERING LAB

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

Course Objectives: Students will learn

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

Course Outcomes: Student is able to

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

Experiments:

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

Text Books:

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

16ME C32

THERMAL ENGINEERING LAB

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

Course Objectives:

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

Course Outcomes: Student will be able to

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

Experiments:

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

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

Text Books:

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