B. E. MECHANICAL ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - IV

COMPLEX ANALYSIS, PROBABILITY AND STATISTICAL METHODS
(Common to all programmes)
[As per Choice Based Credit System (CBCS) scheme]

Course Code	**18MAT41**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(2:2:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To provide an insight into applications of complex variables, conformal mapping and special functions arising in potential theory, quantum mechanics, heat conduction and field theory.
- To develop probability distribution of discrete, continuous random variables and joint probability distribution occurring in digital signal processing, design engineering and microwave engineering.

Module-1

Calculus of complex functions: Review of function of a complex variable, limits, continuity, and differentiability. Analytic functions: Cauchy-Riemann equations in Cartesian and polar forms and consequences.
Construction of analytic functions: Milne-Thomson method-Problems.

Module-2

Conformal transformations: Introduction. Discussion of transformations:$w = Z^2, w = e^z, w = z + \frac{1}{z}, (z \neq 0)$.Bilinear transformations- Problems.
Complex integration: Line integral of a complex function-Cauchy's theorem and Cauchy's integral formula and problems.

Module-3

Probability Distributions: Review of basic probability theory. Random variables (discrete and continuous), probability mass/density functions. Binomial, Poisson, exponential and normal distributions- problems (No derivation for mean and standard deviation)-Illustrative examples.

Module-4

Statistical Methods: Correlation and regression-Karl Pearson's coefficient of correlation and rank correlation -problems. Regression analysis- lines of regression –problems.
Curve Fitting: Curve fitting by the method of least squares- fitting the curves of the form-
$y = ax + b, y = ax^b and y = ax^2 + bx + c.$

Module-5

Joint probability distribution: Joint Probability distribution for two discrete random variables, expectation and covariance.
Sampling Theory: Introduction to sampling distributions, standard error, Type-I and Type-II errors. Test of hypothesis for means, student's t-distribution, Chi-square distribution as a test of goodness of fit.

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

- Use the concepts of analytic function and complex potentials to solve the problems arising in electromagnetic field theory.
- Utilize conformal transformation and complex integral arising in aerofoil theory, fluid flow visualization and image processing.
- Apply discrete and continuous probability distributions in analyzing the probability models arising in engineering field.
- Make use of the correlation and regression analysis to fit a suitable mathematical model for the statistical data.
- Construct joint probability distributions and demonstrate the validity of testing the hypothesis.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.

- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Advanced Engineering Mathematics	E. Kreyszig	John Wiley & Sons	10th Edition,2016
2	Higher Engineering Mathematics	B. S. Grewal	Khanna Publishers	44th Edition, 2017
3	Engineering Mathematics	Srimanta Pal et al	Oxford University Press	3rd Edition,2016
Reference Books				
1	Advanced Engineering Mathematics	C. Ray Wylie, Louis C.Barrett	McGraw-Hill	6th Edition 1995
2	Introductory Methods of Numerical Analysis	S.S.Sastry	Prentice Hall of India	4th Edition 2010
3	Higher Engineering Mathematics	B. V. Ramana	McGraw-Hill	11th Edition,2010
4	A Text Book of Engineering Mathematics	N. P. Bali and Manish Goyal	Laxmi Publications	2014

Web links and Video Lectures:

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://academicearth.org/
4. VTU EDUSAT PROGRAMME - 20

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - IV

APPLIED THERMODYNAMICS

Course Code	**18ME42**	CIE Marks	40
Teaching Hours /Week (L:T:P)	3:2:0	SEE Marks	60
Credits	04	Exam Hours	03

Course Learning Objectives:

- To understand the applications of the first and second laws of Thermodynamics to various gas processes and cycles.
- To understand fundamentals of I. C. Engines, Construction and working Principle of an Engine and Compare Actual, Fuel-Air and Air standard cycle Performance.
- To study Combustion in SI and CI engines and its controlling factor in order to extract maximum power.
- To know the concepts of testing of I. C. Engines and methods to estimate Indicated, Brake and Frictional Power and efficiencies.
- To understand theory and performance Calculation of Positive displacement compressor.
- To understand the concepts related to Refrigeration and Air conditioning.
- To get conversant with Psychrometric Charts, Psychrometric processes, human comfort conditions.

Module-1

Air standard cycles: Carnot, Otto, Diesel, Dual and Stirling cycles, p-v and T -s diagrams, description, efficiencies and mean effective pressures. Comparison of Otto and Diesel cycles.
I.C.Engines: Classification of IC engines, Combustion of SI engine and CI engine, Detonation and factors affecting detonation, Performance analysis of I.C Engines, Heat balance, Morse test, IC Engine fuels, Ratings and Alternate Fuels.

Module-2

Gas power Cycles: Gas turbine (Brayton) cycle; description and analysis. Regenerative gas turbine cycle. Inter-cooling and reheating in gas turbine cycles. Introduction to Jet Propulsion cycles.

Module-3

Vapour Power Cycles: Carnot vapour power cycle, drawbacks as a reference cycle. Simple Rankine cycle; description, T-S diagram, analysis for performance. Comparison of Carnot and Rankine cycles. Effects of pressure and temperature on Rankine cycle performance.
Actual vapour power cycles. Ideal and practical regenerative Rankine cycles, open and closed feed water heaters. Reheat Rankine cycle. Characteristics of an Ideal working fluid in vapour power cycles.

Module-4

Refrigeration Cycles: Vapour compression refrigeration system; description, analysis, refrigerating effect. Capacity, power required units of refrigeration, COP, Refrigerants and their desirable properties, alternate Refrigerants. Air cycle refrigeration; reversed Carnot cycle, reversed Brayton cycle, vapour absorption refrigeration system.
Pscychrometrics and Air-conditioning Systems: Psychometric properties of Air, Psychometric Chart, Analyzing Air-conditioning Processes; Heating, Cooling, Dehumidification and Humidification, Evaporative Cooling. Adiabatic mixing of two moist air streams. Cooling towers.

Module-5

Reciprocating Compressors: Operation of a single stage reciprocating compressors. Work input through p-v diagram and steady state steady flow analysis. Effect of Clearance and Volumetric efficiency. Adiabatic, Isothermal and Mechanical efficiencies. Multi-stage compressor, saving in work, Optimum intermediate pressure, Inter-cooling, Minimum work for compression.
Steam nozzles: Flow of steam through nozzles, Shape of nozzles, effect of friction, Critical pressure ratio, Supersaturated flow.

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

CO1: Apply thermodynamic concepts to analyze the performance of gas power cycles.
CO2: Apply thermodynamic concepts to analyze the performance of vapour power cycles.

CO3: Understand combustion of fuels and performance of I C engines.
CO4: Understand the principles and applications of refrigeration systems.
CO5: Apply Thermodynamic concepts to determine performance parameters of refrigeration and air-conditioning systems.
CO6: Understand the working principle of Air compressors and Steam nozzles, applications, relevance of air and identify methods for performance improvement.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Engineering Thermodynamics	P.K. Nag	Tata McGraw Hill	6th Edition 2018
2	Applications of Thermodynamics	V.Kadambi, T. R.Seetharam, K. B. Subramanya Kumar	Wiley Indian Private Ltd	1st Edition 2019
3	Thermodynamics	Yunus A, Cengel, Michael A Boles	Tata McGraw Hill	7th Edition
Reference Books				
1	Thermodynamics for engineers	Kenneth A. Kroos and Merle C. Potter	Cengage Learning	2016
2	Principles of Engineering Thermodynamics	Michael J, Moran, Howard N. Shapiro	Wiley	8th Edition
3	An Introduction to Thermo Dynamics	Y.V.C.Rao	Wiley Eastern Ltd	2003.
4	Thermodynamics	Radhakrishnan	PHI	2nd revised edition
5	I.C Engines	Ganeshan.V	Tata McGraw Hill	4th Edi. 2012
6	I.C.Engines	M.L.Mathur& Sharma.	Dhanpat Rai& sons-India	

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SEMESTER – IV

FLUID MECHANICS

Course Code	**18ME43**	CIE Marks	40
Teaching Hours /Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To have a working knowledge of the basic properties of fluids and understand the continuum approximation.
- To calculate the forces exerted by a fluid at rest on submerged surfaces and understand the force of buoyancy.
- To understand the flow characteristic and dynamics of flow field for various engineering applications.
- To know how velocity changes and energy transfers in fluid flows are related to forces and torques and to understand why designing for minimum loss of energy in fluid flows is so important.
- To discuss laminar and turbulent flow and appreciate their differences and the concept of boundary layer theory.
- To understand the concept of dynamic similarity and how to apply it to experimental modelling.
- To appreciate the consequences of compressibility in gas flow and understand the effects of friction and heat transfer on compressible flows.

Module-1

Basics: Introduction, Properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, surface tension, capillarity, vapour pressure, compressibility and bulk modulus. Concept of continuum, types of fluids etc., pressure at a point in the static mass of fluid, variation of pressure. Pascal's law, absolute, gauge, atmospheric and vacuum pressures; pressure measurement by simple, differential manometers and mechanical gauges.

Fluid Statics: Total pressure and centre of pressure for horizontal plane, vertical plane surface and inclined plane surface submerged in static fluid.

Module-2

Buoyancy, center of buoyancy, meta center and meta centric height its application.

Fluid Kinematics: Velocity of fluid particle, types of fluid flow, description of flow, continuity equation, Coordinate free form, acceleration of fluid particle, rotational & irrotational flow, Laplace's equation in velocity potential and Poisson's equation in stream function, flow net.

Module-3

Fluid Dynamics; Introduction. Forces acting on fluid in motion. Euler's equation of motion along a streamline. Integration of Euler's equation to obtain Bernoulli's equation, Assumptions and limitations of Bernoulli's equation. Introduction to Navier-Stokes equation. Application of Bernoulli's theorem such as venturi-meter, orifice meter, rectangular and triangular notch, pitot tube.

Laminar and turbulent flow: Flow through circular pipe, between parallel plates, Power absorbed in viscous flow in bearings, Poiseuille equation – velocity profile loss of head due to friction in viscous flow. Reynolds's experiment, frictional loss in pipe flow. Introduction to turbulence, characteristics of turbulent flow, laminar-turbulent transition major and minor losses.

Module-4

Flow over bodies: Development of boundary layer, Prandtl‟s boundary layer equations, Blasius solution, integral momentum equation, drag on a flat plate, boundary layer separation and its control, streamlined and bluff bodies -flow around circular bodies and aero foils, calculation of lift and drag.

Dimensional analysis: Introduction, derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh's method, Buckingham Pi-theorem, dimensionless numbers, similitude, types of similitude.

Module-5

Compressible Flows: Introduction, thermodynamic relations of perfect gases, internal energy and enthalpy, speed of sound, pressure field due to a moving source, basic Equations for one-dimensional flow, stagnation and sonic properties, normal and oblique shocks.

Introduction to CFD: Necessity, limitations, philosophy behind CFD, applications.

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

CO1: Identify and calculate the key fluid properties used in the analysis of fluid behavior.

CO2: Explain the principles of pressure, buoyancy and floatation

CO3: Apply the knowledge of fluid statics, kinematics and dynamics while addressing problems of mechanical and chemical engineering.

CO4: Describe the principles of fluid kinematics and dynamics.

CO5: Explain the concept of boundary layer in fluid flow and apply dimensional analysis to form dimensionless numbers in terms of input output variables.

CO6: Illustrate and explain the basic concept of compressible flow and CFD

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	A Text Book of Fluid Mechanis And Hydraulic Machines	Dr R.K Bansal	Laxmi Publishers	
2	Fluid Mechanics	F M White	McGraw Hill Publications	Eighth edition. 2016
3	Fluid Mechanics (SI Units)	Yunus A. Cengel John M.Cimbala	TataMcGraw Hill	3rd Ed.,2014.
Reference Books				
1	Fluid Mechanics	F M White	McGraw Hill Publications	Eighth edition. 2016
2	Fundamentals of Fluid Mechanics	Munson, Young, Okiishi&Huebsch,	John Wiley Publications	7^{th} edition
3	Fluid Mechanics	Pijush.K.Kundu, IRAM COCHEN	ELSEVIER	3rd Ed. 2005
4	Fluid Mechanics	John F.Douglas, Janul and M.Gasiosek and john A.Swaffield	Pearson Education Asia	5th ed., 2006
5	Introduction to Fluid Mechanics	Fox, McDonald	John Wiley Publications	8^{th} edition.

E- Learning

- Nptel.ac.in
- VTU, E- learning
- MOOCS
- Open courseware

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SEMESTER – IV

KINEMATICS OF MACHINES

Course Code	**18ME44**	CIE Marks	40
Teaching Hours /Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To understand the concept of machines, mechanisms and related terminologies.
- To expose the students to various mechanisms and motion transmission elements used in Mechanical Engineering.
- To analyze a mechanism for displacement, velocity and acceleration at any point in a moving link.
- To understand the theory of cams, gears and gear trains.

Module-1

Mechanisms: Definitions: Link , types of links, joint, types of joints kinematic pairs, Constrained motion, kinematic chain, mechanism and types , degrees of freedom of planar mechanisms, Equivalent mechanisms, Groshoff's criteria and types of four bar mechanisms, , inversions of of four bar chain, slider crank chain, Doubler slider crank chain and its inversions, Grashoff's chain. Mechanisms: Quick return motion mechanisms-Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism. Straight line motion mechanisms, Peaucellier's mechanism and Robert's mechanism. Intermittent Motion mechanisms: Geneva wheel mechanism, Ratchet and Pawl mechanism, toggle mechanism, pantograph, condition for correct steering, Ackerman steering gear mechanism.

Module-2

Velocity and Acceleration Analysis of Mechanisms (Graphical Method): Velocity and acceleration analysis of four bar mechanism, slider crank mechanism. Mechanism illustrating Corioli's component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing. Velocity Analysis by Instantaneous Center Method: Definition, Kennedy's theorem, Determination of linear and angular velocity using instantaneous center method.

Module-3

Velocity and Acceleration Analysis of Mechanisms (Analytical Method): Velocity and acceleration analysis of four bar mechanism, slider crank mechanism using complex algebra method. Freudenstein's equation for four bar mechanism and slider crank mechanism. Function Generation for four bar mechanism.

Module-4

Cams: Classification of cams, Types of followers, Cam nomenclature, Follower motions and motion analysis, of SHM, Motion with uniform acceleration and deceleration, uniform velocity, cycloidal motion, Cam profile with offset knife edge follower, roller follower, flat faced follower.

Module-5

Spur Gears: Gear terminology, law of gearing, path of contact, arc of contact, contact ratio of spur gear. Interference in involute gears, methods of avoiding interference, condition and expressions for minimum number of teeth to avoid interference.

Gear Trains: Simple gear trains, compound gear trains. Epicyclic gear trains: Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains, torque calculation in epicyclic gear trains.

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

CO1: Knowledge of mechanisms and their motion.

CO2: Understand the inversions of four bar mechanisms.

CO3: Analyse the velocity, acceleration of links and joints of mechanisms.

CO4: Analysis of cam follower motion for the motion specifications.

CO5: Understand the working of the spur gears.

CO6: Analyse the gear trains speed ratio and torque.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Theory of Machines Kinematics and Dynamics	Sadhu Singh	Pearson	Third edition 2019
2	Mechanism and Machine Theory	G. Ambekar	PHI	2009
Reference Books				
1	Theory of Machines	Rattan S.S	Tata McGraw-Hill Publishing Company	2014
2	Mechanisms and Machines-Kinematics, Dynamics and Synthesis	Michael M Stanisic	Cengage Learning	2016

B. E. MECHANICAL ENGINEERING
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SEMESTER – IV

METAL CUTTING AND FORMING

Course Code	**18ME35A/45A**	CIE Marks	40
Teaching Hours /Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To enrich the knowledge pertaining to relative motion and mechanics required for various machine tools.
- To introduce students to different machine tools to produce components having different shapes and sizes.
- To develop the knowledge on mechanics of machining process and effect of various parameters on machining.
- To acquaint with the basic knowledge on fundamentals of metal forming processes
- To study various metal forming processes.

Module-1

Introduction to Metal cutting: Orthogonal and oblique cutting. Classification of cutting tools: single, and multipoint; tool signature for single point cutting tool. Mechanics of orthogonal cutting; chip formation, shear angle and its significance, Merchant circle diagram. Numerical problems.
Cutting tool materials and applications.
Introduction to basic metal cutting machine tools: Lathe- Parts of lathe machine, accessories of lathe machine, and various operations carried out on lathe. Kinematics of lathe. Turret and Capstan lathe.

Module-2

Milling: Various Milling operation, classification of milling machines, Vertical & Horizontal milling, up milling & down milling. Indexing: need of indexing, simple, compound & differential indexing.
Drilling: Difference between drilling, boring & reaming, types of drilling machines. Boring operations & boring machines.
Shaping, Planing and Slotting machines-machining operations and operating parameters.
Grinding: Grinding operation, classification of grinding processes: cylindrical, surface & centerless grinding.

Module-3

Introduction to tool wear, tool wear mechanisms, tool life equations, effect of process parameters on tool life, machinability. Cutting fluid-types and applications, surface finish, effect of machining parameters on surface finish. Economics of machining process, choice of cutting speed and feed, tool life for minimum cost and production time. Numerical problems.

Module-4

MECHANICAL WORKING OF METALS Introduction to metal forming processes & classification of metal forming processes. Hot working & cold working of metals.
Forging: Smith forging, drop forging & press forging. Forging Equipment, Defects in forging.
Rolling: Rolling process, Angle of bite, Types of rolling mills, Variables of rolling process, Rolling defects.
Drawing & Extrusion: Drawing of wires, rods & pipes, Variables of drawing process. Difference between drawing & extrusion. Various types of extrusion processes.

Module-5

Sheet Metal Operations: Blanking, piercing, punching, drawing, draw ratio, drawing force, variables in drawing, Trimming, and Shearing.
Bending — types of bending dies, Bending force calculation, Embossing and coining.
Types of dies: Progressive, compound and combination dies.

Course Outcomes:

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

CO1: Explain the construction & specification of various machine tools.
CO2: Discuss different cutting tool materials, tool nomenclature & surface finish.
CO3: Apply mechanics of machining process to evaluate machining time.
CO4: Analyze tool wear mechanisms and equations to enhance tool life and minimize machining cost.

CO5: Understand the concepts of different metal forming processes.
CO6: Apply the concepts of design of sheet metal dies to design different dies for simple sheet metal components.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl. N	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Manufacturing Technology Vol I & II	P.N.Rao	Tata McGraw Hill Pub. Co. Ltd., New Delhi	1998
2	A textbook of Production Technology Vol I and II	Sharma, P.C.,	S. Chand & Company Ltd., New Delhi	1996
3	Manufacturing Science	Amithab Gosh &A.K.Malik	East-West press	2001
Reference Books				
3	Workshop Technology Vol. I and II	Chapman W. A. J.	Arnold Publisher New Delhi	1998
4	Elements of Manufacturing Technology Vol II,	Hajra Choudhary, S. K. and Hajra Choudhary, A. K.	Media Publishers, Bombay	1988
5	Metal Forming Handbook	Schuler	Springer Verlag Publication	
6	Metal Forming: Mechanics and Metallurgy	Hosford,WF and Caddell,R.M	Prentice Hall	1993
7	Manufacturing Engineering and Technology	Kalpakjian	Addision Wesley Congmen Pvt. Ltd.	2000
8	Production Technology	HMT		

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SEMESTER – IV

METAL CASTING AND WELDING

Course Code	**18ME35B/45B**	CIE Marks	40
Teaching Hours /Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To provide adequate knowledge of quality test methods conducted on welded and cast components.
- To provide knowledge of various casting process in manufacturing.
- To provide in-depth knowledge on metallurgical aspects during solidification of metal and alloys.
- To provide detailed information about the moulding processes.
- To impart knowledge of various joining process used in manufacturing.
- To impart knowledge about behaviour of materials during welding, and the effect of process parameters in welding,

Module-1

Introduction & basic materials used in foundry:
Introduction: Definition, Classification of manufacturing processes. Metals cast in the foundry-classification, factors that determine the selection of a casting alloy.
Introduction to casting process & steps involved:
Patterns: Definition, classification, materials used for pattern, various pattern allowances and their importance.
Sand moulding: Types of base sand, requirement of base sand. Binder, Additives definition, need and types; preparation of sand moulds. Melding machines- Jolt type, squeeze type and Sand slinger.
Study of important moulding process: Green sand, core sand, dry sand, sweep mould, CO_2mould, shell mould, investment mould, plaster mould, cement bonded mould.
Cores: Definition, need, types. Method of making cores,
Concept of gating (top, bottom, parting line, horn gate) and risers (open, blind) Functions and types.

Module-2

MELTING & METAL MOLD CASTING METHODS:
Melting furnaces: Classification of furnaces, Gas fired pit furnace, Resistance furnace, Coreless induction furnace, electric arc furnace, constructional features & working principle of cupola furnace.
Casting using metal moulds: Gravity die casting, pressure die casting, centrifugal casting, squeeze casting, slush casting, thixocasting, and continuous casting processes.

Module-3

SOLIDIFICATION & NON-FERROUS FOUNDRY PRACTICE: Solidification: Definition, nucleation, solidification variables. Directional solidification-need and methods. Degasification in liquid metals-sources of gas, degasification methods.
Fettling and cleaning of castings: Basic steps involved. Sand Casting defects- causes, features and remedies. Advantages & limitations of casting process
Nonferrous foundry practice: Aluminium castings - advantages, limitations, melting of Aluminium using lift-out type crucible furnace. Hardeners used, drossing, gas absorption, fluxing and flushing, grain refining, pouring temperature. Stir casting set up, procedure, uses, advantages and limitations

Module-4

Welding process: Definition, Principles, classification, application, advantages & limitations of welding. Arc welding: Principle, Metal arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG) Submerged Arc Welding (SAW) and Atomic Hydrogen Welding (AHW).
Special type of welding: Resistance welding principles, Seam welding, Butt welding, Spot welding and Projection welding. Friction welding, Explosive welding, Thermit welding, Laser welding and Electron beam welding.

Module-5

METALLURGICAL ASPECTS IN WELDING, SOLDERING, AND BRAZING

Structure of welds, Formation of different zones during welding, Heat Affected Zone (HAZ), Parameters affecting HAZ. Effect of carbon content on structure and properties of steel, Shrinkage in welds& Residual stresses. Concept of electrodes, filler rod and fluxes. Welding defects- detection causes & remedy.

Soldering, brazing, gas welding: Soldering, Brazing, Gas Welding: Principle, oxy-Acetylene welding, oxy-hydrogen welding, air-acetylene welding, Gas cutting, powder cutting.

Inspection methods: Methods used for inspection of casting and welding. Visual, magnetic particle, fluorescent particle, ultrasonic. Radiography, eddy current, holography methods of inspection.

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

CO1: Describe the casting process and prepare different types of cast products.

CO2: Acquire knowledge on Pattern, Core, Gating, Riser system and to use Jolt, Squeeze, Sand Slinger moulding machines.

CO3: Compare the Gas fired pit, Resistance, Coreless, Electrical and Cupola Metal Furnaces.

CO4: Compare the Gravity, Pressure die, Centrifugal, Squeeze, slush and Continuous Metal mould castings.

CO5: Understand the Solidification process and Casting of Non-Ferrous Metals.

CO6: Describe the Metal Arc, TIG, MIG, Submerged and Atomic Hydrogen Welding processes etc. used in manufacturing.

CO7: Describe methods for the quality assurance of components made of casting and joining process

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
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- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Principles of metal casting	Rechard W. Heine, Carl R. Loper Jr., Philip C. Rosenthal	Tata McGraw Hill Education Private Limited	1976
2	Manufacturing Process-I	Dr. K. Radhakrishna	Sapna Book House,	5th Revised Edition 2009.
3	Manufacturing Technology-Foundry, Forming and Welding	P.N.Rao	Tata McGraw Hill	3rd Ed., 2003.
Reference Books				
4	Process and Materials of Manufacturing	Roy A Lindberg	Pearson Edu	4th Ed. 2006
5	Manufacturing Technology	SeropeKalpakjian Steuen. R Sechmid	Pearson Education Asia	5th Ed. 2006

B. E. MECHANICAL ENGINEERING
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SEMESTER - IV

COMPUTER AIDED MACHINE DRAWING

Course Code	**18ME36A/46A**	CIE Marks	40
Teaching Hours/Week (L:T:P)	1:4:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To acquire the knowledge of CAD software and its features.
- To familiarize the students with Indian Standards on drawing practices.
- To impart knowledge of thread forms, fasteners, keys, joints and couplings.
- To make the students understand and interpret drawings of machine components leading to preparation of assembly drawings manually and using CAD packages.
- To acquire the knowledge of limits, tolerance and fits and indicate them on machine drawings.

Part A

Part A

Introduction:
Review of graphic interface of the software. Review of basic sketching commands and navigational commands. Starting a new drawing sheet. Sheet sizes. Naming a drawing, Drawing units, grid and snap. Conversion of pictorial views into orthographic projections of simple machine parts (with and without section). Hidden line conventions. Precedence of lines.
Sections of Solids: Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on axis inclinations, spheres and hollow solids). True shape of sections.
Conversion of pictorial views into orthographic projections of simple machine parts. Hidden line conventions. Precedence of lines.
Conversion of pictorial views into orthographic projections of simple machine parts (with section planes indicated on the part).
Thread Forms: Thread terminology, sectional views of threads. ISO Metric (Internal & External), BSW (Internal & External) square and Acme. Sellers thread, American Standard thread.
Fasteners: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw.

Part B

Keys: Parallel key, Taper key, Feather key, Gib-head key and Woodruff key.
Joints: Cotter joint (socket and spigot), knuckle joint (pin joint) for two rods.
Couplings: Split Muff coupling, Protected type flanged coupling, pin (bush) type flexible coupling, and universal coupling (Hooks' Joint)

Part C

Limits, Fits and Tolerances: Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, machining symbols, types of fits with symbols and applications, geometrical tolerances on drawings. Standards followed in industry.
Assembly Drawings: (Part drawings shall be given)
1. Plummer block (Pedestal Bearing)
2. Lever Safety Valve
3. I.C. Engine connecting rod
4. Screw jack (Bottle type)
5. Tailstock of lathe
6. Machine vice
7. Tool head of shaper

Course Outcomes: At the end of the course the student will be able to:
CO1: Identify the national and international standards pertaining to machine drawing.

CO2: Understand the importance of the linking functional and visualization aspects in the preparation of the part drawings

CO3: Apply limits and tolerances to assemblies and choose appropriate fits for given assemblies.

CO4: Interpret the Machining and surface finish symbols on the component drawings.

CO5: Preparation of the part or assembly drawings as per the conventions.

Scheme of Examination: Two questions to be set from each Part A, part B and Part C. Student has to answer one question each from Part A and Part B for 25 marks each and one question from Part C for 50 marks.

INSTRUCTION FOR COMPUTER AIDED MACHINE DRAWING (15ME36A/46A) EXAMINATION

1. No restriction of timing for sketching/ computerization of solutions. The total duration is 3 hours.
2. It is desirable to do sketching of all the solutions before computerization.
3. Drawing instruments may be used for sketching.
4. For Part A and Part B, 2D drafting environment should be used.
5. For Part C, 3D environment should be used for parts and assembly, and extract 2D views of assembly.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Machine Drawing	K.R. Gopala Krishna	Subhash Publication	2005
2	Machine Drawing	N.D.Bhat&V.M. Panchal	Charoratar publishing house	2005
Reference Books				
3	A Text Book of Computer Aided Machine Drawing	S. Trymbaka Murthy	CBS Publishers, New Delhi	2007
4	Engineering drawing	P.S.Gill	S K Kataria and Sons	2013
5	Machine Drawing	N. Siddeshwar, P. Kanniah, V.V.S. Sastri	Tata McGraw Hill	2006

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - IV

MECHANICAL MEASUREMENTS AND METROLOGY

Course Code	**18ME36B/46B**	CIE Marks	40
Teaching Hours /Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To understand the concept of metrology and standards of measurement.
- To equip with knowledge of limits, fits, tolerances and gauging
- To acquire knowledge of linear and Angular measurements, Screw thread and gear measurement & comparators.
- To understand the knowledge of measurement systems and methods with emphasis on different Transducers, intermediate modifying and terminating devices.
- To understand the measurement of Force, Torque, Pressure, Temperature and Strain.

Module-1

Introduction to Metrology: Definition, objectives of metrology, Material Standards, Wavelength Standards, Classification of standards, Line and End standards, Calibration of End bars. Numerical examples.

Liner measurement and angular measurements: Slip gauges-Indian standards on slip gauges, Adjustable slip gauges, Wringing of slip gauges, Problems on building of slip gauges (M87, M112), Measurement of angle-sine bar, Sine centre, Angle gauges, Optical instruments for angular measurements. Autocollimator-Applications for measuring straightness and squareness.

Module-2

System of Limits, Fits, Tolerance and Gauging: Definitions, Tolerance, Tolerance analysis (addition & subtraction of tolerances) Inter change ability & Selective assembly. Class &grade of tolerance, Fits, Types of fits, Numerical on limits, fit and tolerance. Hole base system & shaft base system. Taylor's principle, Types of limit gauges, Numerical on limit gauge design.

Comparators: Functional requirements, Classification, Mechanical- Johnson Mikrokator, Sigma comparators, Dial indicator, Electrical comparators, LVDT, Pneumatic comparators- Principle of back pressure, Solex comparators, Optical comparators- Zeiss ultra- optimeter.

Module-3

Measurement of screw thread and gear: Terminology of screw threads, Measurement of major diameter, Minor diameter, Pitch, Angle and Effective diameter of screw threads by 2- wire and 3-wire methods, Best size wire. Screw thread gauges, Toolmaker's microscope.

Gear tooth Measurements: Tooth thickness measurement using constant chord method, Addendum, Comparator method and Base tangent method, Measurement of pitch, Concentricity, Run out and In volute profile. Gear roll tester for composite error.

Module-4

Measurement system and basic concepts of measurement methods: Definition, Significance of measurement, generalized measurement system, Static characteristics- Accuracy, Precision, Calibration, Threshold, Sensitivity, Hysteresis, Repeatability, Linearity, Loading effect, Dynamic characteristics- System response, Time delay. Errors in measurement, Classification of errors.

Transducers: Transfer efficiency, Primary and Secondary transducers, Electrical transducers, Mechanical transducers, Electronic transducers, Relative comparison of each type of transducers.

Intermediate Modifying and Terminating Devices: Mechanical systems, Inherent problems, Electrical intermediate modifying devices, Input circuitry, Ballast circuit, Electronic amplifiers. Terminating devices, Cathode ray oscilloscope,Oscillographs.

Module-5

Applied mechanical measurement: Measurement of force, Torque, Pressure, Types of Dynamometers, Absorption dynamometer, Prony brake and Rope brake dynamometer, and Power Measuring Instruments. Use of elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge.

Measurement of strain and temperature: Theory of strain gauges, Types, Electrical resistance strain gauge, Preparation and mounting of Strain gauges, Gauge factor, Methods of strain measurement, temperature compensation, Resistance thermometers, Thermocouple, Law of thermocouple, Pyrometer, Optical pyrometer.

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

CO1: Understand the objectives of metrology, methods of measurement, standards of measurement & various measurement parameters.
CO2: Explain tolerance, limits of size, fits, geometric and position tolerances, gauges and their design
CO3: Understand the working principle of different types of comparators.
CO3: Describe measurement of major & minor diameter, pitch, angle and effective diameter of screw threads.
CO4: Explain measurement systems, transducers, intermediate modifying devices and terminating devices..
CO5: Describe functioning of force, torque, pressure, strain and temperature measuring devices.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Mechanical Measurements	Beckwith Marangoni and Lienhard	Pearson Education	6th Ed., 2006
2	Instrumentation, Measurement and Analysis	B C Nakra, K K Chaudhry	McGraw–Hill	4th Edition
3	Engineering Metrology	R.K. Jain	Khanna Publishers	2009
Reference Books				
1	Engineering Metrology and Measurements	Bentley	PearsonEducation	
2	Theory and Design for Mechanical Measurements, III edition	Richard S Figliola, Donald E Beasley	WILEY IndiaPublishers	
3	Engineering Metrology	Gupta I.C	Dhanpat RaiPublications	
4	Deoblin's Measurement system,	Ernest Deoblin, Dhanesh manick	McGraw–Hill	
5	EngineeringMetrologyandMeasurements	N.V.RaghavendraandL.Krishnamurthy	Oxford UniversityPress.	

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - IV

MATERIAL TESTING LAB

Course Code	**18MEL37A/47A**	CIE Marks	40
Teaching Hours /Week (L:T:P)	0:2:2	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives:

- To learn the concept of the preparation of samples to perform characterization such as microstructure, volume fraction of phases and grain size.
- To understand mechanical behaviour of various engineering materials by conducting standard tests.
- To learn material failure modes and the different loads causing failure.
- To learn the concepts of improving the mechanical properties of materials by different methods like heat treatment, surface treatment etc.

Sl. No.	Experiments
	PART A
1	Preparation of specimen for Metallographic examination of different engineering materials. To report microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & composites.
2	Heat treatment: Annealing, normalizing, hardening and tempering of steel. Metallographic specimens of heat treated components to be supplied and students should report microstructures of furnace cooled, water cooled, air cooled, tempered steel. Students should be able to distinguish the phase changes in a heat treated specimen compared to untreated specimen.
3	Brinell, Rockwell and Vickers's Hardness tests on untreated and heat treated specimens.
4	To study the defects of Cast and Welded components using Non-destructive tests like: d) Ultrasonic flaw detection e) Magnetic crack detection f) Dye penetration testing.
	PART B
5	Tensile, shear and compression tests of steel, aluminum and cast iron specimens using Universal Testing Machine
6	Torsion Test on steel bar.
7	Bending Test on steel and wood specimens.
8	Izod and Charpy Tests on Mild steel and C.I Specimen.
9	To study the wear characteristics of ferrous and non-ferrous materials under different parameters.
10	Tensile, shear and compression tests of steel, aluminum and cast iron specimens using Universal Testing Machine
11	Fatigue Test (demonstration only).

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

CO1: Acquire experimentation skills in the field of material testing.

CO2: Develop theoretical understanding of the mechanical properties of materials by performing experiments.

CO3: Apply the knowledge to analyse a material failure and determine the failure inducing agent/s.

CO4: Apply the knowledge of testing methods in related areas.

CO5: Understand how to improve structure/behaviour of materials for various industrial applications.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Scheme of Examination:

ONE question from part -A:	30 Marks
ONE question from part -B:	50 Marks
Viva -Voice:	20 Marks
Total:	100 Marks

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - IV

MECHANICAL MEASUREMENTS AND METROLOGY LAB

Course Code	**18MEL37B/47B**	CIE Marks	40
Teaching Hours/Week (L:T:P)	0:2:2	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives:

- To illustrate the theoretical concepts taught in Mechanical Measurements & Metrology through experiments.
- To illustrate the use of various measuring tools & measuring techniques.
- To understand calibration techniques of various measuring devices.

Sl. No.	Experiments
	PART A
1	Calibration of Pressure Gauge
2	Calibration of Thermocouple
3	Calibration of LVDT
4	Calibration of Load cell
5	Determination of modulus of elasticity of a mild steel specimen using strain gauges.
	PART B
6	Measurements using Optical Projector / Toolmakers' Microscope.
7	Measurement of angle using Sine Centre / Sine bar / bevel protractor
8	Measurement of alignment using Autocollimator / Roller set
9	Measurement of cutting tool forces using: Lathe tool Dynamometer Drill tool Dynamometer.
10	Measurements of Screw thread parameters using two wire or three-wire methods.
11	Measurements of surface roughness using Tally Surf/Mechanical Comparator
12	Measurement of gear tooth profile using gear tooth Vernier/Gear tooth micrometer
13	Calibration of Micrometer using slip gauges
14	Measurement using Optical Flats

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

CO1: Understand Calibration of pressure gauge, thermocouple, LVDT, load cell, micrometer.
CO2: Apply concepts of Measurement of angle using Sine Centre/ Sine Bar/ Bevel Protractor, alignment using Autocollimator/ Roller set.
CO3: Demonstrate measurements using Optical Projector/Tool maker microscope, Optical flats.
CO4: Analyse tool forces using Lathe/Drill tool dynamometer.
CO5: Analyse Screw thread parameters using 2-Wire or 3-Wire method, gear tooth profile using gear tooth Vernier/Gear tooth micrometer
CO6: Understand the concepts of measurement of surface roughness.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.

Scheme of Examination:

ONE question from part -A: 30 Marks
ONE question from part -B: 50 Marks
Viva -Voice: 20 Marks
Total: 100 Marks

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - IV

WORKSHOP AND MACHINE SHOP PRACTICE

Course Code	**18MEL38A/48A**	CIE Marks	40
Teaching Hours/Week (L:T:P)	0:2:2	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives:

- To guide students to use fitting tools to perform fitting operations.
- To provide an insight to different machine tools, accessories and attachments.
- To train students into fitting and machining operations to enrich their practical skills.
- To inculcate team qualities and expose students to shop floor activities.
- To educate students about ethical, environmental and safety standards.

Sl. No.	**Experiments**
	PART A
1	Preparation of at least two fitting joint models by proficient handling and application of hand tools- V-block, marking gauge, files, hack saw drills etc.
	PART B
2	Preparation of three models on lathe involving - Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning. Exercises should include selection of cutting parameters and cutting time estimation.
	PART C
3	Cutting of V Groove/ dovetail / Rectangular groove using a shaper. Cutting of Gear Teeth using Milling Machine. Exercises should include selection of cutting parameters and cutting time estimation.
	PART D (DEMONSTRATION ONLY)
	Study & Demonstration of power tools like power drill, power hacksaw, portable hand grinding, cordless screw drivers, production air tools, wood cutter, etc., used in Mechanical Engineering.

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

CO1: To read working drawings, understand operational symbols and execute machining operations.

CO2: Prepare fitting models according to drawings using hand tools- V-block, marking gauge, files, hack saw, drills etc.

CO3: Understand integral parts of lathe, shaping and milling machines and various accessories and attachments used.

CO4: Select cutting parameters like cutting speed, feed, depth of cut, and tooling for various machining operations.

CO5: Perform cylindrical turning operations such as plain turning, taper turning, step turning, thread Cutting, facing, knurling, internal thread cutting, eccentric turning and estimate cutting time.

CO6: Perform machining operations such as plain shaping, inclined shaping, keyway cutting, Indexing and Gear cutting and estimate cutting time.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Scheme of Examination:	
One Model from Part-A or Part-C:	30 Marks
One Model from Part-B:	50 Marks
Viva – Voce:	20 Marks
TOTAL:	100 Marks

B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - IV

FOUNDRY, FORGING AND WELDING LAB

Course Code	**18MEL38B/48B**	CIE Marks	40
Teaching Hours/Week (L:T:P)	0:2:2	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives:

- To provide an insight into different sand preparation and foundry equipment.
- To provide an insight into different forging tools and equipment and arc welding tools and equipment.
- To provide training to students to enhance their practical skills in welding, forging and hand moulding.
- To practically demonstrate precautions to be taken during casting, hot working and welding operations.

Sl. No.	Experiments
	PART A
1	**Testing of Molding sand and Core sand.** **Preparation of sand specimens and conduction of the following tests:** 1. Compression, Shear and Tensile tests on Universal Sand Testing Machine. 2. Permeability test 3. Sieve Analysis to find Grain Fineness Number (GFN) of Base Sand 4. Clay content determination on Base Sand. **Welding Practice:** Use of Arc welding tools and welding equipment Preparation of welded joints using Arc Welding equipment L-Joint, T-Joint, Butt joint, V-Joint, Lap joints on M.S. flats
	PART B
2	**Foundry Practice:** **Use of foundry tools and other equipment for Preparation of molding sand mixture.** **Preparation of green sand molds kept ready for pouring in the following cases:** 4. Using two molding boxes (hand cut molds). 5. Using patterns (Single piece pattern and Split pattern). 6. Incorporating core in the mold.(Core boxes). • Preparation of one casting (Aluminium or cast iron-Demonstration only)
	PART C
3	**Forging Operations:** Use of forging tools and other forging equipment. • Calculation of length of the raw material required to prepare the model considering scale loss. • Preparing minimum three forged models involving upsetting, drawing and bending operations.

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

- Demonstrate various skills in preparation of molding sand for conducting tensile, shear and compression tests using Universal sand testing machine.
- Demonstrate skills in determining permeability, clay content and Grain Fineness Number of base sands.
- Demonstrate skills in preparation of forging models involving upsetting, drawing and bending operations.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Scheme of Examination:

1. One question is to be set from Part-A: 30 marks. (20 marks for sand testing+ 10 Marks for welding)
2. One question is to be set from either Part-B or Part-C: 50 Marks
3. Viva – Voce: 20 marks

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

CO1: Understand needs, functions, roles, scope and evolution of Management.

CO2: Understand importance, purpose of Planning and hierarchy of planning and also53nalyse its types.

CO3: Discuss Decision making, Organizing, Staffing, Directing and Controlling.

CO4: Select the best economic model from various available alternatives.

CO5: Understand various interest rate methods and implement the suitable one.

CO6: Estimate various depreciation values of commodities.

CO7: Prepare the project reports effectively.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the	Name of the Publisher	Edition and
Textbook/s				
1	Mechanical estimation and costing	T.R. Banga & S.C. Sharma	Khanna Publishers	17th edition 2015
2	Engineering Economy	Riggs J.L	McGraw Hill	4th
3	Engineering Economy	Thuesen H.G	PHI	2002
4	Principles of Management	Tripathy and Reddy	Tata McGraw Hill	3rd edition 2006
Reference Books				
1	Management Fundamentals - Concepts, Application, Skill Development	Robers Lusier Thomson	Pearson Education	
2	Modern Economic Theory	Dr. K. K. Dewett& M. H. Navalur,	Chand Publications	
3	Economics: Principles of Economics	N Gregory Mankiw,	Cengage Learning	
4	Basics of Engineering Economy	Leland Blank & Anthony Tarquin	McGraw Hill Publication (India) Private Limited	