

**B.E. Mechanical Engineering**

**IV SEMESTER**

Sl. No	Subject Code	Title	Teaching Hours /Week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (Hours)	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15MAT41	Engineering Mathematics – III	04			03	80	20	100	04
2	15ME42	Kinematics of Machinery	03	02		03	80	20	100	04
3	15ME43	Applied Thermodynamics	03	02		03	80	20	100	04
4	15ME44	Fluid mechanics	03	02		03	80	20	100	04
5	15ME45A/	Metal Casting and Welding	04			03	80	20	100	04
	15ME45B	Machine Tools and Operations								
6	15ME46 A/	Computer Aided Machine Drawing	02		4	03	80	20	100	03
	15ME46B	Mechanical Measurements and Metrology	04							
7	15MEL47A	Materials Testing Lab/	1		2	03	80	20	100	02
	15MEL47B	Mechanical Measurements and Metrology Lab								
8	15MEL48A	Foundry and Forging Lab	1		2	03	80	20	100	02
	15MEL48B	Machine Shop/								
<b>TOTAL</b>			<b>19/21</b>	<b>06</b>	<b>08/04</b>		<b>640</b>	<b>160</b>	<b>800</b>	<b>27</b>

## KINEMATICS OF MACHINES

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Kinematics of Machines	15ME42	04	3-2-0	80	20	3Hrs

### Course objectives

Students will

1. Familiarize with mechanisms and motion analysis of mechanisms.
2. Understand methods of mechanism motion analysis and their characteristics.
3. Analyse motion of planar mechanisms, gears, gear trains and cams.

### MODULE - 1

**Introduction:** Definitions: Link, kinematic pairs, kinematic chain, mechanism, structure, degrees of freedom, Classification links, Classification of pairs based on type of relative motion, Grubler's criterion, mobility of mechanism, Grashoff's criteria, inversions of Grashoff's chain.

**Mechanisms:** Quick return motion mechanisms- Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism. Oldham's coupling, 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.

**10 Hours**

### MODULE -2

**Velocity and Acceleration Analysis of Mechanisms (Graphical Method):** Velocity and acceleration analysis of four bar mechanism, slider crank mechanism. Mechanism illustrating Coriolis 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.

**Klein's Construction:** Analysis of velocity and acceleration of single slider crank mechanism.

**10 Hours**

### 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.

**10 Hours**

## Module – 4

**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, back lash, condition for minimum number of teeth to avoid interference, expressions for arc of contact and path of contact

**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.

**10 Hours**

**Cams:** Types of cams, types of followers. displacement, velocity and acceleration curves for uniform velocity, Simple Harmonic Motion, Uniform Acceleration Retardation, Cycloidal motion. Cam profiles: disc cam with reciprocating / oscillating follower having knife-edge, roller and flat-face follower inline and offset.

**Analysis of Cams:** Analysis of arc cam with flat faced follower.

**10 Hours**

*Graphical Solutions may be obtained either on the Graph Sheets or in the Answer Book itself.*

## Course outcomes

Students will be able to

1. Identify mechanisms with basic understanding of motion.
2. Comprehend motion analysis of planar mechanisms, gears, gear trains and cams.
3. Carry out motion analysis of planar mechanisms, gears, gear trains and cams.

## TEXT BOOKS:

1. Rattan S.S, Theory of Machines, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 4<sup>th</sup> Edition, 2014.
2. Ambekar A. G., Mechanism and Machine Theory, PHI, 2009.

## REFERENCE BOOKS:

1. Michael M Stanisc, Mechanisms and Machines-Kinematics, Dynamics and Synthesis, Cengage Learning, 2016.
2. Sadhu Singh, **Theory of Machines**, Pearson Education (Singapore) Pvt. Ltd, Indian Branch New Delhi, 2nd Edi. 2006.

## APPLIED THERMODYNAMICS

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Applied Thermodynamics	15ME43	04	3-2-0	80	20	3Hrs

### Course learning objectives:

- To have a working knowledge of basic performance of Gas power cycles.
- To Calculate the forces exerted by a fluid at rest on submerged surfaces and understand the force of buoyancy
- To understand and evaluate the performance of steam power cycles their various Engineering applications
- To know how fuel burns and their thermodynamic properties.
- To Understand mechanism of power transfer through belt, rope, chain and gear drives in I C Engines
- To determine performance parameters of refrigeration and air-conditioning systems.
- Evaluate the performance parameters of reciprocating air compressor as a function of receiver pressure.

### Module - I

**Gas Power Cycles :** 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. Gas turbine (Brayton) cycle; description and analysis. Regenerative gas turbine cycle. Inter-cooling and reheating in gas turbine cycles.

Jet propulsion: Introduction to the principles of jet propulsion, turbojet, turboprop, Ramjet and turbofan engines and their processes . Principles of rocket propulsion, Introduction to rocket engine. 10 Hours

### Module –II

**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, Binary Vapour cycles

10 Hours

### Module –III

**Combustion Thermodynamics:** Theoretical (Stoichiometric) air for combustion of fuels. Excess air, mass balance, Exhaust gas analysis, A/F ratio. Energy balance for a chemical reaction, enthalpy of formation, enthalpy and internal energy of combustion. Combustion efficiency. Dissociation and equilibrium, emissions.

**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. Automotive Pollutions and its effects on environment.

10 Hours

#### Module –IV

**Refrigeration Cycles:** Vapour compression refrigeration system; description, analysis, refrigerating effect. Capacity, power required, units of refrigeration, COP, Refrigerants and their desirable properties, alternate Refrigerants. Any one case study on cold storage or industrial refrigerator. Air cycle refrigeration; reversed Carnot cycle, reversed Brayton cycle, Vapour absorption refrigeration system. Steam jet refrigeration.

**Psychrometrics and Air-conditioning Systems:** Properties of Atmospheric air, and 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.

10 Hours

#### Module –V

**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.

10 Hours

#### Course outcomes

Students will be able to

- Apply thermodynamic concepts to analyze the performance of gas power cycles including propulsion systems.
- Evaluate the performance of steam turbine components.
- Understand combustion of fuels and combustion processes in I C engines including alternate fuels and pollution effect on environment.
- Apply thermodynamic concepts to analyze turbo machines.
- Determine performance parameters of refrigeration and air-conditioning systems.
- Understand the principles and applications of refrigeration systems.
- Analyze air-conditioning processes using the principles of psychrometry and Evaluate cooling and heating loads in an air-conditioning system.
- Understand the working, applications, relevance of air and identify methods for performance improvement.

Text Books:

1. Thermodynamics an engineering approach, by Yunus A. Cengel and Michael A. Boles. Tata McGraw hill Pub. Sixth edition, 2008.

2. Basic and Applied Thermodynamics” by P .K. Nag, Tata McGraw Hill, 2nd Edi. 2009
3. Fundamentals of Thermodynamics by G.J. Van Wylen and R.E. Sonntag, Wiley Eastern. Fourth edition 1993.

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, 8<sup>th</sup> Edition
3. An Introduction to Thermo Dynamics by Y.V.C.Rao, Wiley Eastern Ltd, 2003.
4. Thermodynamics by Radhakrishnan. PHI, 2<sup>nd</sup> revised edition.
5. I.C Engines by Ganeshan.V. Tata McGraw Hill, 4rth Edi. 2012.
6. I.C.Engines by M.L.Mathur & Sharma. Dhanpat Rai& sons- India

**E- Learning**

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

**Scheme of Examination:**

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

## FLUID MECHANICS

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Fluid Mechanics	15ME44	04	3-2-0	80	20	3Hrs

### Course 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 the main properties of laminar and turbulent pipe flow and appreciate their differences and the concept of boundary layer theory.
- Understand the concept of dynamic similarity and how to apply it to experimental modeling
- 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 center of pressure for horizontal plane, vertical plane surface and inclined plane surface submerged in static fluid. Buoyancy, center of buoyancy, meta center and meta centric height its application in shipping, stability of floating bodies.

10Hrs

## MODULE -2

### **Fluid Kinematics and Dynamics:**

**Fluid Kinematics:** Types of Flow-steady , unsteady, uniform, non-uniform, laminar, turbulent, one,two and three dimensional, compressible, incompressible, rotational, irrotational, stream lines, path lines, streak lines, velocity components, convective and local acceleration, velocity potential, stream function, continuity equation in Cartesian co-ordinates. Rotation, vorticity and circulation, Laplace equation in velocity potential and Poisson equation in stream function, flow net, Problems.

### **Fluid Dynamics:**

Momentum equation, Impacts of jets- force on fixed and moving vanes, flat and curved. Numericals.Euler's equation, Integration of Euler's equation to obtain Bernoulli's equation, Bernoulli's theorem, Application of Bernoulli's theorem such as venture meter, orifice meter, rectangular and triangular notch, pitot tube, orifices etc., related numericals.

12 Hrs

## MODULE -3

**Laminar and turbulent flow:** Reynods Number, Entrance flow and Developed flow, Navier-Stokes Equation (no derivation), Laminar flow between parallel plates, Poiseuille equation – velocity profile, Couette flow, Fully developed laminar flow in circular pipes, Hagen - Poiseuille equation, related numericals.

Energy consideration in pipe flow, Loss of Pressure Head due to Fluid Friction, Darcy Weishach formula, major and minor losses in pipes, Commercial pipe, Colebrook equation, Moody equation/ diagram. Pipes in series, parallel, equivalent pipe, Related Numericals and simple pipe design problems.

10 Hrs

## MODULE -4

**Flow over bodies:** Development of boundary layer, Prandtl's boundary layer equations, Blasius solution, laminar layer over a flat plate, boundary layer separation and its control.

Basic concept of Lift and Drag, Types of drag, Co-efficient of drag and lift,streamline body and bluff body, flow around circular bodies and airfoils, Lift and drag on airfoil, Numericals.

Dimensional analysis: Need for dimensional analysis, Dimensions and units, Dimensional Homogeneity and dimensionless ratios, methods of dimensional analysis, Rayleigh's method, Buckingham Pi theorem, Similitude and Model studies. Numericals.

10 Hrs

## 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.

08 Hrs

### Course outcomes:

Students will be able to

- CO1: Identify and calculate the key fluid properties used in the analysis of fluid behavior.
- CO2: Understand and apply 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: Understand and apply the principles of fluid kinematics and dynamics.
- CO5: Understand the concept of boundary layer in fluid flow and apply dimensional analysis to form dimensionless numbers in terms of input output variables.
- CO6: Understand the basic concept of compressible flow and CFD

### Text Books:

1. Fluid Mechanics (SI Units), Yunus A. Cengel John M.Cimbala, 3rd Ed., Tata McGraw Hill, 2014.
2. Fluid Mechanics, F M White, McGraw Hill Publications Eighth edition. 2016
3. Mechanics of Fluids, Merle C. Potter, Devid C. Wiggerrt, Bassem H. Ramadan, Cengage learning, Fourth editions 2016.

### Reference Books:

1. Fundamentals of Fluid Mechanics by Munson, Young, Okiishi & Huebsch, John Wiley Publications. 7<sup>th</sup> edition.
2. Fluid Mechanics, Pijush.K.Kundu, IRAM COCHEN, ELSEVIER, 3rd Ed. 2005.
3. Fluid Mechanics, John F.Douglas, Janul and M.Gasiosek and John A.Swaffield, Pearson Education Asia, 5th ed., 2006.
4. Introduction to Fluid Mechanics by Fox, McDonald, John Wiley Publications, 8<sup>th</sup> edition.

### E- Learning

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

### Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

## METAL CASTING AND WELDING

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Metal Casting And Welding	15ME35A / 45A	04	4-0-0	80	20	3Hrs

### COURSE OBJECTIVE

- To provide detailed information about the moulding processes.
- To provide knowledge of various casting process in manufacturing.
- To impart knowledge of various joining process used in manufacturing.
- To provide adequate knowledge of quality test methods conducted on welded and casted components.

### 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 molding:** Types of base sand, requirement of base sand. Binder, Additives definition, need and types

**Preparation of sand molds:** Molding machines- Jolt type, squeeze type and Sand slinger. Study of important molding process: Green sand, core sand, dry sand, sweep mold, CO2 mold, shell mold, investment mold, plaster mold, cement bonded mold. Cores: Definition, need, types. Method of making cores, concept of gating (top, bottom, parting line, horn gate) and risering (open, blind) Functions and types

10 Hours

### 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 molds:** Gravity die casting, pressure die casting, centrifugal casting, squeeze casting, slush casting, thixocasting, and continuous casting processes

10 Hours

### 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:** Aluminum castings - Advantages, limitations, melting of aluminum 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.

10 Hours

### MODULE -4

## WELDING PROCESS

**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.

10 Hours

## MODULE -5

### SOLDERING , BRAZING AND METALLURGICAL ASPECTS IN WELDING

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.

10 Hours

## COURSE OUTCOMES

CO No.	Course Outcomes	Blooms level	PO
CO1	Describe the casting process, preparation of Green, Core, dry sand molds and Sweep, Shell, Investment and plaster molds.	U	PO1
CO2	Explain the Pattern, Core, Gating, Riser system and Jolt, Squeeze, Sand Slinger Molding Machines.	U	PO1
CO3	Compare the Gas fired pit, Resistance, Coreless, Electrical and Cupola Metal Furnaces.	U	PO1
CO4	Compare the Gravity, Pressure die, Centrifugal, Squeeze, slush and Continuous Metal mold castings.	U	PO1
CO5	Explain the Solidification process and Casting of Non-Ferrous Metals.	U	PO1
CO6	Describe the Metal Arc, TIG, MIG, Submerged and Atomic Hydrogen Welding processes used in manufacturing.	U	PO1
CO7	Explain the Resistance spot, Seam, Butt , Projection, Friction, Explosive, Thermit, Laser and Electron Beam Special type of welding process used in manufacturing.	U	PO1
CO8	Describe the Metallurgical aspects in Welding and inspection methods for the quality assurance of components made of casting and joining process.	U	PO1

## TEXT BOOKS:

1. **“Manufacturing Process-I”**, Dr.K.Radhakrishna, Sapna Book House,5th Revised Edition 2009.
2. **“Manufacturing & Technology: Foundry Forming and Welding”**,P.N.Rao, 3rd Ed., Tata McGraw Hill, 2003.
3. **“ Introduction to Manufacturing Process”** – John A.Schey , 3<sup>rd</sup> Edition ,McGraw Hills Education.

## REFERENCE BOOKS:

1. **“Machining And Machine Tools”** – A.B.Chattopadhyay, FNA (E) Wiley.
2. **“Process and Materials of Manufacturing”**, Roy A Lindberg, 4th Ed.Pearson Edu. 2006.
3. **“Manufacturing Technology, Vol 1, P N Rao, McGraw Hill Education, 4<sup>th</sup> Edition**
4. **“Principles of metal casting”**, Rechar W. Heine, Carl R. Loper Jr., Philip C. Rosenthal, Tata McGraw Hill Education Private Limited

**MACHINE TOOLS AND OPERATIONS**

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Machine Tools and Operations	15ME35B / 45B	04	4-0-0	80	20	3Hrs

**COURSE OBJECTIVES:**

- To introduce students to different machine tools in order to produce components having different shapes and sizes.
- To enrich the knowledge pertaining to relative motion and mechanics required for various machine tools.
- To develop the knowledge on mechanics of machining process and effect of various parameters on economics of machining.

**MODULE 1****MACHINE TOOLS**

Introduction, Classification, construction and specifications of lathe, drilling machine, milling machine, boring machine, broaching machine, shaping machine, planing machine, grinding machine [**Simple sketches showing major parts of the machines**]

10 hours

**MODULE 2****MACHINING PROCESSES**

Introduction, Types of motions in machining, turning and Boring, Shaping, Planing and Slotting, Thread cutting, Drilling and reaming, Milling, Broaching, Gear cutting and Grinding, Machining parameters and related quantities.

[**Sketches pertaining to relative motions between tool and work piece only**]

10 Hours

**MODULE 3****CUTTING TOOL MATERIALS, GEOMETRY AND SURFACE FINISH**

Introduction, desirable Properties and Characteristics of cutting tool materials, cutting tool geometry, cutting fluids and its applications, surface finish, effect of machining parameters on surface finish.

**Machining equations for cutting operations:** Turning, Shaping, Planing, slab milling, cylindrical grinding and internal grinding, Numerical Problems

Hours

10

**MODULE 4****MECHANICS OF MACHINING PROCESSES**

Introduction, Chip formation, Orthogonal cutting, Merchant's model for orthogonal cutting, Oblique cutting, Mechanics of turning process, Mechanics of drilling process, Mechanics of milling process, Numerical problems.

10 Hours

**MODULE 5**

**TOOL WEAR, TOOL LIFE:** Introduction, tool wear mechanism, tool wear equations, tool life equations, effect of process parameters on tool life, machinability, Numerical problems

**ECONOMICS OF MACHINING PROCESSES:** Introduction, choice of feed, choice of cutting speed, tool life for minimum cost and minimum production time, machining at maximum efficiency, Numerical problems

10 Hours

**COURSE OUTCOMES:**

- Explain the construction & specification of various machine tools.
- Describe various machining processes pertaining to relative motions between tool & work piece.
- Discuss different cutting tool materials, tool nomenclature & surface finish.
- Apply mechanics of machining process to evaluate machining time.

Analyze tool wear mechanisms and equations to enhance tool life and minimize machining cost.

**TEXT BOOKS:**

1. Fundamentals of metal cutting and Machine Tools, B.L. Juneja, G.S. Sekhon and Nitin Seth, New Age International Publishers 2<sup>nd</sup> Edition, 2003
2. All about Machine Tools, Heinrich Gerling, New Age International Publishers revised 2<sup>nd</sup> Edition, 2006

**REFERENCE BOOKS:**

1. Fundamental of Machining and Machine Tools, Geoffrey Boothroyd and Winston A. Knight, CRC Taylor & Francis, Third Edition.
2. **“Manufacturing Technology**, Vol 2, P N Rao, McGraw Hill Education, 3<sup>rd</sup> Edition
3. Metal cutting principles, Milton C. Shaw, Oxford University Press, Second Edition,2005.

**Scheme of Examination:**

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

## COMPUTER AIDED MACHINE DRAWING

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Computer Aided Machine Drawing	15ME36A / 46A	03	2-0-4	80	20	3Hrs

### Course Objectives:

1. To improve the visualisation skills and understand the conventions used in engineering drawing.
2. To inculcate understanding of the theory of projection and make drawings using orthographic projections and sectional views.
3. To impart fundamental knowledge of drawing of different machine parts.
4. To enable the students with concepts of dimensioning and standards related to drawings.
5. To enable the students draw the assembly of various machine components.
6. Recognize to use engineering tools, software for drawing and engage in life long learning.

### Introduction to Computer Aided Sketching

Review of graphic interface of the software. Review of basic sketching commands and navigational commands.

02 Hours

### PART A

#### Unit I

**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 section.

04 Hours

**Orthographic views :** Conversion of pictorial views into orthographic projections of simple machine parts with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings), Hidden line conventions, Precedence of lines.

04 Hours

#### Unit II

**Thread forms :** Thread terminology, sectional views of threads. ISO Metric (Internal & External), BSW (Internal and External), square, Acme and 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.

08Hours

### PART B

#### Unit III

**Keys and Joints:** Parallel, Taper, Feather Key, Gibhead key and Woodruff key

**Riveted joints:** Single and double riveted lap joints, Butt joints with single/double cover straps (Chain and zigzag using snap head riveters).

**Joints:** Cotter joint (socket and spigot), Knuckle joint (pin joint) for two rods.

08 Hours

#### Unit IV

**Couplings** : Split muff coupling, Protected type flange coupling, Pin (bush) type flexible coupling, Oldham's coupling and Universal coupling (Hook's Joint).

06 Hours

### **PART C**

**Limits, Fits and Tolerances** : Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, Types of fits with symbols and applications, Geometrical tolerances on drawings, Standards followed in industry.

03 Hours

**Assembly Drawings: (Part drawings shall be given)**

1. Plummer block (Pedestal Bearing)
2. Rams Bottom Safety Valve
3. I.C. Engine connecting rod
4. Screw jack (Bottle type)
5. Tailstock of lathe
6. Machine vice
7. Lathe square tool post

17 Hours

**Course Outcomes: Students will be able to**

1. Improve their visualization skills.
2. Understand the theory of projection.
3. Make component drawings.
4. Produce the assembly drawings using part drawings.
5. Engage in life long learning using sketching and drawing as communication tool.

**Text Books :**

1. 'A Primer on Computer Aided Machine Drawing-2007', Published by VTU, Belgaum.
2. 'Machine Drawing', N.D.Bhat & V.M.Panchal, Published by Charotar Publishing House, 1999.
3. 'Machine Drawing', N.Siddeshwar, P.Kannaih, V.V.S. Sastri, published by Tata Mc.Grawhill, 2006.

**Reference Book :**

1. "A Text Book of Computer Aided Machine Drawing", S. Trymbakaa Murthy, CBS Publishers, New Delhi, 2007.
2. 'Machine Drawing', K.R. Gopala Krishna, Subhash publication.

**Note :**

**Internal Assessment: 20 Marks**

Sketches shall be in sketch books and drawing shall through use of software on A3/A4 sheets. Sketch book and all the drawing printouts shall be submitted.

**Scheme of Evaluation for Internal Assessment (20 Marks)**

- (a) Class work (Sketching and Computer Aided Machine drawing printouts in A4/A3 size sheets): 10Marks.
- (b) Internal Assessment test in the same pattern as that of the main examination(Better of the two Tests): 10 marks.

**Scheme of Examination:**

Two questions to be set from each PartA, partB and PartC.

Student has to answer one question each from PartA , PartB for 15 marks each and one question from Part C for 50 marks.

Part A	1X15	=	15 Marks
Part B	1X15	=	15 Marks
Part C	1X50	=	<u>50 Marks</u>
Total		=	80 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 part environment should be used for parts assembly drawing and extract 2D views.

## MECHANICAL MEASUREMENTS AND METROLOGY

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Mechanical Measurements and Metrology	15ME36B / 46B	03	3-0-0	80	20	3Hrs

### COURSE OBJECTIVES

#### Students are expected to –

- Understand metrology, its advancements & measuring instruments,
- Acquire knowledge on different standards of length, calibration of End Bars, linear and angular measurements, Screw thread and gear measurement & comparators.
- Equip with knowledge of limits, fits, tolerances and gauging.
- Acquire knowledge of measurement systems and methods with emphasis on different transducers, intermediate modifying and terminating devices.
- Understand the measurement of Force, Torque, Pressure, Temperature and Strain.

### MODULE -1

**Introduction to Metrology:** Definition, objectives and concept of metrology, Need of inspection, Principles, process, methods of measurement, Classification and selection of measuring instruments and systems. Accuracy, precision and errors in measurement.

System of measurement, Material Standard, Wavelength Standards, Subdivision of standards, Line and End standards, Classification of standards and Traceability, calibration of End bars(Numericals), standardization.

#### **Linear Measurement and angular measurements:**

Slip gauges- Indian standards on slip gauge, method of selection of slip gauge, stack of slip gauge, adjustable slip gauge, wringing of slip gauge, care of slip gauge, slip gauge accessories, problems on building of slip gauges (M87, M112).

Measurement of angles- sine bar, sine center, angle gauges, optical instruments for angular measurements, Auto collimator-applications for measuring straightness and squareness.

**10 Hours**

### MODULE -2

#### **System of Limits, Fits, Tolerance and Gauging:**

Definition of tolerance, Specification in assembly, Principle of interchangeability and selective assembly, limits of size, Indian standards, concept of limits of size and tolerances, definition of fits, hole basis system, shaft basis system, types of fits and their designation (IS 919-1963), geometric tolerance, position-tolerances.

Classification of gauges, brief concept of design of gauges (Taylor's principles), Wear allowance on gauges, Types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials.

#### **Comparators:**

Functional requirements, classification, mechanical- Johnson Mikrokator, sigma comparators, dial indicator, electrical- principles, , LVDT, Pneumatic- back pressure gauges, solex comparators and optical comparators- Zeiss ultra-optimizer.

**10 Hours**

### **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, Tool maker's microscope.

Gear tooth terminology, tooth thickness measurement using constant chord method, addendum comparator method and base tangent method, measurement of pitch, concentricity, run out, and involute profile. Gear roll tester for composite error.

#### **Advances in metrology:**

Basic concepts of lasers, advantages of lasers, laser interferometers, types, applications. Basic concepts of Coordinate Measuring Machines- constructional features, applications.

**10 Hours**

### **MODULE -4**

#### **Measurement systems and basic concepts of measurement methods:**

Definition, significance of measurement, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysteresis, repeatability, linearity, loading effect, system response-time delay. Errors in measurement, classification of errors. Transducers, transfer efficiency, primary and secondary transducers, electrical, mechanical, electronic transducers, advantages of each type 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.

**10 Hours**

### **MODULE -5**

#### **Force, Torque and Pressure Measurement:**

Direct methods and indirect method, force measuring inst. Torque measuring inst., Types of dynamometers, Absorption dynamometer, Prony brake and rope brake dynamometer, and power measuring instruments. Pressure measurement, principle, 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, Wheatstone bridge circuit, orientation of strain gauges for force and torque, Strain gauge based load cells and torque sensors.

Resistance thermometers, thermocouple, law of thermocouple, materials used for construction, pyrometer, optical pyrometer.

**10 Hours**

## COURSE OUTCOMES

*At the end of the course students will be able to –*

	Description	CL	POs
CO1	Understand the objectives of metrology, methods of measurement, selection of measuring instruments, standards of measurement and calibration of end bars.	U	PO1, PO6
CO2	Describe slip gauges, wringing of slip gauges and building of slip gauges, angle measurement using sine bar, sine center, angle gauges, optical instruments and straightness measurement using Autocollimator.	U	PO1, PO6
CO3	Explain tolerance, limits of size, fits, geometric and position tolerances, gauges and their design.	U	PO1, PO6
CO4	Understand the principle of Johnson Mikrokator, sigma comparator, dial indicator, LVDT, back pressure gauges, Solex comparators and Zeiss Ultra Optimeter	U	PO1, PO6
CO5	Describe measurement of major diameter, minor diameter, pitch, angle and effective diameter of screw threads by 2 – wire, 3 – wire methods, screw thread gauges and tool maker's microscope.	U	PO1, PO6
CO6	Explain measurement of tooth thickness using constant chord method, addendum comparator methods and base tangent method, composite error using gear roll tester and measurement of pitch, concentricity, run out and involute profile.	U	PO1, PO6
CO7	Understand laser interferometers and Coordinate measuring machines.	U	PO1, PO6
CO8	Explain measurement systems, transducers, intermediate modifying devices and terminating devices.	U	PO1, PO6
CO9	Describe functioning of force, torque, pressure, strain and temperature measuring devices.	U	PO1, PO6

### TEXT BOOKS:

1. **Mechanical Measurements**, Beckwith Marangoni and Lienhard, Pearson Education, 6th Ed., 2006.
2. **Instrumentation, Measurement and Analysis**, B C Nakra, K K Chaudhry, 4<sup>th</sup> Edition, McGraw –Hill
3. **Engineering Metrology**, R.K. Jain, Khanna Publishers, Delhi, 2009.

### REFERENCE BOOKS:

1. **Engineering Metrology and Measurements**, Bentley, Pearson Education.
2. **Theory and Design for Mechanical Measurements, III edition**, Richard S Figliola, Donald E Beasley, WILEY India Publishers.
3. **Engineering Metrology**, Gupta I.C., Dhanpat Rai Publications.
4. **Deoblin's Measurement system**, Ernest Deoblin, Dhanesh manick, McGraw –Hill.
5. **Engineering Metrology and Measurements**, N.V.Raghavendra and L.Krishnamurthy, Oxford University Press.

### Scheme of Examination:

Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

## MATERIALS TESTING LAB

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Material Testing Lab	15MEL47A / 47B	02	1-0-2	80	20	3Hrs

### COURSE OBJECTIVES

#### Students are expected-

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

#### 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:
  - a) Ultrasonic flaw detection
  - b) Magnetic crack detection
  - c) 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. Fatigue Test (demonstration only).

## **COURSE OUTCOMES**

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

1. Acquire experimentation skills in the field of material testing.
2. Develop theoretical understanding of the mechanical properties of materials by performing experiments.
3. Apply the knowledge to analyze a material failure and determine the failure inducing agent/s.
4. Apply the knowledge of testing methods in related areas.
5. Know how to improve structure/behavior of materials for various industrial applications.

Students should make observations on nature of failure and manifestations of failure in each of the experiments apart from reporting values of mechanical properties determined after conducting the tests.

### **Scheme of Examination:**

<b>ONE question from part -A:</b>	<b>25 Marks</b>
<b>ONE question from part -B:</b>	<b>40 Marks</b>
<b>Viva -Voice:</b>	<b>15 Marks</b>
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<b>Total :</b>	<b>80 Marks</b>

## MECHANICAL MEASUREMENTS AND METROLOGY LAB

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Mechanical Measurements and Metrology Lab	15MEL37B / 47B	02	1-0-2	80	20	3Hrs

### COURSE OBJECTIVES:

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

### PART-A: MECHANICAL MEASUREMENTS

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: METROLOGY

1. Measurements using Optical Projector / Toolmaker Microscope.
2. Measurement of angle using Sine Center / Sine bar / bevel protractor
3. Measurement of alignment using Autocollimator / Roller set
4. Measurement of cutting tool forces using
  - a) Lathe tool Dynamometer OR
  - b) Drill tool Dynamometer.
5. Measurements of Screw thread Parameters using two wire or Three-wire methods.
6. Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator
7. Measurement of gear tooth profile using gear tooth Vernier /Gear tooth micrometer
8. Calibration of Micrometer using slip gauges
9. Measurement using Optical Flats

## **COURSE OUTCOMES**

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

	<b>Description</b>	<b>CL</b>	<b>POs</b>
CO1	To calibrate pressure gauge, thermocouple, LVDT, load cell, micrometer.	U	PO1, PO6
CO2	To measure angle using Sine Center/ Sine Bar/ Bevel Protractor, alignment using Autocollimator/ Roller set.	U	PO1, PO6
CO3	To demonstrate measurements using Optical Projector/Tool maker microscope, Optical flats.	U	PO1, PO6
CO4	To measure cutting tool forces using Lathe/Drill tool dynamometer.	U	PO1, PO6
CO5	To measure Screw thread parameters using 2-Wire or 3-Wire method, gear tooth profile using gear tooth vernier/Gear tooth micrometer.	U	PO1, PO6
CO6	To measure surface roughness using Tally Surf/ Mechanical Comparator.	U	PO1, PO6

### **Scheme of Examination:**

<b>ONE question from part -A:</b>	<b>25 Marks</b>
<b>ONE question from part -B:</b>	<b>40 Marks</b>
<b>Viva -Voice:</b>	<b>15 Marks</b>
<b>Total :</b>	<b>80 Marks</b>

## FOUNDRY AND FORGING LAB

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Foundry And Forging Lab	15MEL38A / 48A	02	1-0-2	80	20	3Hrs

### COURSE OBJECTIVES:

- To provide an insight into different sand preparation and foundry equipment's.
- To provide an insight into different forging tools and equipment's.
- To provide training to students to enhance their practical skills.
- To practically demonstrate precautions to be taken during casting and hot working.
- To develop team qualities and ethical principles.

### 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 in Base Sand.

### PART B

#### 2. Foundry Practice

1. Use of foundry tools and other equipment's.
2. Preparation of molding sand mixture.
3. Preparation of green sand molds using two molding boxes kept ready for pouring.
  - Using patterns (Single piece pattern and Split pattern)
  - Without patterns.
  - Incorporating core in the mold. (Core boxes).
  - Preparation of one casting (Aluminum or cast iron-Demonstration only)

### PART C

#### 3. Forging Operations :

**Use of forging tools and other equipment's**

- 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.
- Demonstration of forging model using Power Hammer.

## **COURSE OUTCOMES**

Students will be able to

- Demonstrate various skills of sand preparation, molding.
- Demonstrate various skills of forging operations.
- Work as a team keeping up ethical principles.

### **Question paper pattern:**

One question is to be set from Part-A	15 Marks
One question is to be set from either Part-B or Part-C	35 Marks
Calculation of length of the raw material required for forging model is compulsory irrespective of the student preparing part-B or part-C model	
Calculation of length for Forging	10 Marks
Viva – Voce	20 Marks
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Total	20 Marks

## MACHINE SHOP

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Machine Shop	15MEL38b / 48B	02	1-0-2	80	20	3Hrs

### COURSE OBJECTIVES

- To provide an insight to different machine tools, accessories and attachments
- To train students into 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

### PART – A

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.

### PART – B

Cutting of V Groove/ dovetail / Rectangular groove using a shaper

Cutting of Gear Teeth using Milling Machine

### PART –C

#### For demonstration

Demonstration of formation of cutting parameters of single point cutting tool using bench grinder / tool & cutter grinder. Demonstration of surface milling /slot milling

### COURSE OUTCOMES

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

COs	Description	CL	POs
CO1	Perform turning , facing , knurling , thread cutting, tapering , eccentric turning and allied operations	A	PO1, PO6, PO9
CO2	Perform keyways / slots , grooves etc using shaper	A	PO1, PO6, PO9
CO3	Perform gear tooth cutting using milling machine	A	PO1, PO6, PO9
CO4	Understand the formation of cutting tool parameters of single point cutting tool using bench grinder / tool and cutter grinder	U	PO1, PO6
CO5	Understand Surface Milling/Slot Milling	U	PO1, PO6
CO6	Demonstrate precautions and safety norms followed in Machine Shop	U	PO8
CO7	Exhibit interpersonal skills towards working in a team	U	PO9

One Model from Part – A    40 Marks

One Model from Part – B    20 Marks

Viva – Voce                    20 Marks

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Total                                80 Marks