FACULTY OF ENGINEERING

Scheme of Instruction & Examination

and

Syllabi

B.E III Year

of

Four Year Degree Programme

in

Mechanical Engineering

(With effect from the academic year 2016-17)

(As approved in Faculty Meeting held on 18 June 2016)

Issued by

Dean, Faculty of Engineering

Osmania University, Hyderabad

With effect from academic year 2016-2017

SCHEME OF INSTRUCTION & EXAMINATION

B.E. III YEAR

(MECHANICAL ENGINEERING)

SEMESTER – I

Sl. No.	Course Code	Course Title	Scheme of Instructions		Scheme of Examination		
			Periods per Week		Duration in Hours	Maximum Marks	
			L	T/D/P		Sessionals	University Exams
1.	ME 301	Applied Thermodynamics	4	-	3	25	75
2.	ME 302	Dynamics of Machines	4	1	3	25	75
3.	ME 303	Design of Machine Elements	4	-	3	25	75
4.	ME 304	Hydraulic Machinery & Systems	4	-	3	25	75
5.	ME 305	Manufacturing Processes	4	-	3	25	75
6.	ME 331	Thermodynamics Lab.	-	3	3	25	50
7.	ME 332	Hydraulic Machinery & Systems Lab.	-	3	3	25	50
8.	ME 333	Manufacturing Processes Lab.	-	3	3	25	50
		Total	**20**	**10**		**200**	**525**

L – Lecture, T – Tutorial, D – Drawing, P - Practical

ME 301

APPLIED THERMODYNAMICS

Instruction per Week	:	4 Periods
Duration of University Examination	:	3 Hours
Sessionals	:	25 Marks
University Examination	:	75 Marks

Course Objectives:

1. To familiarize with the types of air compressors, working principle of two stroke & four stroke IC engine
2. To know combustion phenomena in IC engine & various ignition systems and testing of IC engine
3. Analyze different types of steam cycles and estimate efficiency in a steam power plant

UNIT-I

Reciprocating Air Compressors: Uses of compressed air, Classification of compressors-single stage and multistage compressors, Derivation of work done with and without clearance volume, Work done of multistage compressors-effect of clearance volume on work done -Inter-cooling and After-cooling

UNIT-II

Internal Combustion Engines: Classification, working principle, Deviation of actual cycles from air standard cycles, Index of compression and expansion for variable specific heats, Battery and Magneto ignition systems, Multipoint fuel injection system, Lubrication systems, Cooling systems, Carburetors-Simple and Zenith carburetors-Valve and Port-timing diagrams. Performance of I.C. engines-Methods for Determination of Indicated power, brake power, frictional power, brake thermal efficiency, mechanical efficiency, indicated thermal efficiency, relative efficiency, and volumetric efficiency, specific fuel consumption based on brake power and indicated power, Wilson line, Heat balance sheet.

UNIT-III

Combustion & Combustion chambers of IC Engine: Introduction, Homogenous mixture, Heterogeneous mixture. Combustion in SI engine, stages of combustion in SI Engine. Factors influencing flame speed, abnormal combustion. Phenomena of knock in SI engine. Effects of engine variables on knock. Combustion in CI Engine, stages of combustion in CI engine, Factors effecting delay period. Phenomena of knock in CI engine. Combustion chambers for SI & CI engine. Air pollution, Effects and control of Exhaust.

UNIT-IV

Steam Boilers: Classification of boilers-Fire tube boilers- Cochran boiler, Locomotive boiler, Water tube boilers-Babcock and Wilcox boiler, super critical boilers-Benson, Fluidized bed combustion boilers, Boiler mountings and accessories. Boiler performance and boiler draught-Chimney design, Condition for maximum discharge Types of condensers Jet and Surface condensers, introduction to cooling towers.

UNIT-V

Steam power plant: Layout, Working Carnot and Rankin cycles, cycle analysis, Modified Rankin cycle, Cycle efficiency improvement methods, Reheating, Regeneration and Cogeneration.

Steam nozzles: Types of nozzles, Nozzle efficiency, Velocity of steam flowing through the nozzle. Mass of steam discharged from the nozzle, Condition for maximum discharge, Critical pressure ratio. Diameters of nozzle throat and exit for maximum discharge.

Suggested Reading:

1. Heywood. J.B, *"Internal Combustion Engine Fundamentals* ", Tata McGraw Education Pvt. Ltd., New Delhi 2011.
2. Chattopadhyay, "Engineering Thermodynamics" Oxford University Press, New Delhi, 2015
3. Ganeshan.V, *"Internal Combustion Engines*", Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2010.
4. Ballaney, P.L, *"Thermal Engineering"*, Khanna Publishers, New Delhi, 2010.
5. Rajput. R. K, *"Thermal Engineering"* Laxmi Publishers, New Delhi, 2004.
6. Mahesh M Rathor, *"Thermal Engineering"* Tata McGraw Education Pvt. Ltd., New Delhi 2010.

E 302

DYNAMICS OF MACHINES

Instruction per Week	:	4 Theory + 1Tutorial
Duration of University examination:	:	3 Hours
Sessionals	:	25 Marks
University Examination	:	75 Marks

Course Objectives:

1. To know effect of inertia of links, and external forces on the input torque, and forces developed at joints in typical mechanisms in motion; understand the gyroscopic couple and its effect on vehicles in motion.
2. To know the working principles and characteristics of typical governors, as also the function of flywheels
3. To know he concept of unbalance and methods of balancing rotating and reciprocating masses in single and multi-cylinder in-line and radial engines.
4. To understand the phenomena of free and forced, including the effect of damping for single d.o.f systems, and concepts of isolating vibration
4. To determine natural frequencies of undamped, damped and forced vibrating systems of one, two and multi degree freedom systems.

UNIT-I

Static and Dynamic Force Analysis: Force analysis of four bar and slider crank mechanisms. Study of Dynamically Equivalent system. Inertia forces on connecting rod.

Gyroscope: Gyroscopic couple, gyroscopic effects in vehicles.

UNIT-II

Governors: Classification of governors, Watt, Porter, Hartnell and Hartung governors, Controlling Force, Stability, Isochronism, Sensitivity, Power and Effort of governors.

Flywheels: Functions, Differences between flywheel and governor. Turning moment diagrams, flywheel analysis for I-C Engines and presses.

UNIT-IIİ

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

UNIT-IV

Vibrations: Vibrations of Single degree, freedom system (axial, transverse and torsional), Equivalent system of combination of springs, Stepped shaft, Whirling speed of shafts.

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

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

UNIT-V

Vibration Analysis of Multi Degree Freedom Systems: Torsional Vibrations of Two rotor, three rotor and Geared systems. Natural frequencies of two degree freedom systems. Modes of vibration. Approximate methods for determining natural frequencies: Dunkerley's method, Rayleigh's method and Holzer's method for multi rotor system.

Suggested Reading:

1. S.S. Rattan, *Theory of Machines*, McGraw Hill, 2010..
2. Thomas Bevan, *The Theory of Machines,* CBS Publishers & Distributors, 2004.
3. John J.Uicker, Jr., Gordon R. Pennock, Joseph E.Shigley, *Theory of Machines and Mechanisms,* Oxford University Press, 2003.
4. I.S. Rao and Gupta, T*heory and Practice of Mechanical Vibrations,* Prentice Hall, 1984.
5. R.L.Nortan, "Kinematics and Dynamics of Machinery", Tata McGraw Education Pvt.Ltd, New Delhi, 2009.
6. Ghosh and Mallik, *Theory of Mechanisms nd Machines,* Affiliated Est-West Press, 1988.

ME 303

DESIGN OF MACHINE ELEMENTS

Instruction per Week	:	4 Periods
Duration of University Examination	:	3 Hours
Sessionals	:	25 Marks
University Examination	:	75 Marks

Course Objectives:

1. To understand the basics of mechanics of materials and design of a machine for static and fatigue strength, rigidity and wear criterions, use of codes and standards.
2. To know the principles of ergonomic design and use of theories of failure for safe design.
3. To learn the principles to design shafts, keys, belt drives, joints and couplings.

UNIT-I

Design considerations of Machine Elements: Materials used in machine design and their specifications according to Indian Standards. Codes and standards used in design. Important mechanical properties of materials used in design. Preferred numbers. Manufacturing considerations in design. Review of types of loads and simple stresses. Stresses due to Biaxal and Triaxal loads. Factor of safety. Theories of failures. Design of components subjected to impact loading.

UNIT-II

Design for Fatigue: Fluctuating stresses, fatigue strength and endurance limit, Stress concentration factor and Notch sensitivity. Factor effecting fatigue strength. S-N diagram, Soderberg and Modified Goodman's diagrams for fatigue design. Cumulative fatigue – Miner's rule.

UNIT-III

Design of shafts: Solid, hallow and splined shafts under torsion and bending loads. Design of keys.

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

UNIT-IV

Design of Joints: Cotter and Knuckle joints. Design of bolts and nuts, Locking devices for nuts, Bolts of uniform strength. Bolted joints under eccentric loads. Design of gasket joints.

Chain drives: Design of chains drives.

Pulleys: Design of Pulleys.

UNIT-V

Design of Screws: Design of Power screws and screw jack. Differential and Compound Screws.

Riveted & Welded Joints: Design of riveted and welded joints under direct and eccentric loads.

Suggested Reading:

1. M.F. Spotts, *Design of Machine Elements,* Pearson Edu, 7th Ed. 2003.
2. V.B. Bhandari, *Machine Design,* Tata McGraw – Hill Publ, 2010.
3. P.C. Sharma & D.K. Aggarwal, *Machine Design,* S.K. Kataria& Sons, 10th ed, 2003.
4. P. Kannaiah, *Machine Design,* Scu-Tech Publ., 2009.
5. J.E..Shigley & Charles R. Mischke, *Mechanical Engineering Design,* Tata McGraw-Hill, 6th ed., 2010.

ME 304

HYDRAULIC MACHINERY AND SYSTEMS

Instruction per Week	:	4 Periods
Duration of University Examination	:	3 Hours
Sessionals	:	25 Marks
University Examination	:	75 Marks

Course Objectives:

1. To learn the Fluid properties and fundamentals of Fluid statics and fluid flow
2. To introduce the concepts of flow measurements and flow through pipes
3. To introduce the concepts of fluid flow to solve fluid flow problems
4. To understand working principle of various hydraulic devices.

UNIT-I

Hydraulic Machines: Classification– Impulse momentum equation– Layout of hydraulic power plant – Working principle - Impact of jets on Flat & Curved plates – Force exerted by a jet striking on a i) Fixed:-flat, Curved plates(Symmetrical & Un Symmetrical) ii) Moving:-Flat, Hinged & Curved Plates (Symmetrical & Un Symmetrical).

UNIT-II

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

Other types of pumps: Working principles and characteristics of gear pump and jet pump.

UNIT-III

Centrifugal pumps: Classification – Working principle – Comparison over reciprocating pumps, Velocity triangles, Manometric head – Work done per second – Head equivalent of work done – Manometric, mechanical and overall efficiencies – Pressure rise in the impeller. Minimum starting speed – Specific speed – Physical significance of specific speed – Model testing – Conditions of similarity of CF pumps – Priming – Performance characteristic curves – Troubles (operational difficulties), reasons and remedies in CF pumps – Cavitation – Effects of Cavitation – Precautions against Cavitation,

UNIT-IV

Hydraulic Turbines: Classification of impulse and reaction turbines – Construction and working of Pelton wheels, Francis turbine and Kaplan turbine – Velocity triangles – Work done (power developed) – Hydraulic, Mechanical and Overall efficiencies – Maximum efficiency – Comparison between Impulse and reaction turbines – Comparison between Francis and Kaplan turbines – Specific speed – Physical significance of specific speed – Unit quantities – Model testing of turbines – Conditions for similarity of turbines – Draft tubes – functions and types of draft tubes – Surge tanks – Functions and types of surge tanks – Performance characteristic curves.

UNIT-V

Industrial Hydraulics: Basic components of hydraulic circuits; Properties and types of hydraulic oils; Working principles of external Pumps - gear, lobe, vane, radial piston and axial piston; Construction details and actuating methods of sliding spool directional control valves. Specification of D.C. valve; Working of - flow control, pressure relief, pressure reducing and sequencing valves; Working and construction details of single acting and double acting actuator and hydraulic motor; Symbolic representation of various components; Circuit for control of single & double acting actuators; Regenerative circuit; Speed control methods of actuators: meter-in, meter-out, and bleed off; Working of various servo systems-hydro

mechanical, hydraulic – hydraulic, electro hydraulic; Construction details of oil reservoir and selection criteria for pumps and actuators.

Suggested Reading:

1. Bansal, R.K., *"A text book of Fluid Mechanics and Hydraulic Machines"*, Laxmi Publication (P) Ltd., New Delhi, 2004
2. Modi, P.N., and Seth, S.M., "*Hydraulic and Fluid Machines*", Standard Book House, New Delhi, 2004
3. Ramamrutham, S., *"Hydraulics, Fluid Mechanics and Fluid machines"*, Dhanpat Rai & Sons, New Delhi, 2004
4. Kumar, D.S, *"Fluid Mechanics and Fluid Power Engineering"*, S.K. Kataria & Sons, 2008
5. Majumdar, S.R., *"Oil Hydraulic Systems – Principles and Maintenance"*, Tata McGrawHill, 2004, New Delhi.
6. Kaleem Khan, : Fluid mechanics and machinery", Oxford University Press, 2015

ME 305

MANUFACTURING PROCESSES

Instruction per Week	: 4 Periods
Duration of University Examination	: 3 Hours
Sessionals	: 25 Marks
University Examination	: 75 Marks

Course Objectives:

1. To understand the basic principles of the major manufacturing processes such as metal casting, welding and forming of engineering materials
2. To know the advantages and limitations of each process.
3. To be able to select the optimal process to produce a product.
4. To know the basic principles of advanced forming processes.

UNIT-I

Casting Process : Casting terms, pattern materials, types of patterns, pattern allowances, colour code for patterns, Moulding sands, core sands, properties of moulding sand and its ingredients, different types of moulding machines, Directional solidification, use of chaplets, chills, riser and gating design.

UNIT-II

Special Casting Processes: Shell moulding, Co_2 moulding, die casting, centrifugal casting, investment or lost wax process; Casting defects, causes and remedies, Inspection and testing of casting.

Processing of Plastics: Extrusion, Injection moulding, Blow moulding and Thermoforming, Introduction to Ceramics and MEMS.

UNIT-III

Welding Processes: Introduction, Classification of welding processes, Principle of Gas welding, equipment and techniques, Types of flames and applications, advantages, limitations and applications of gas welding; Arc welding- equipment, electrode materials and specifications, polarity, types of arc welding- SMAW, SAW,

GMAW, GTAW, , Atomic hydrogen welding, principle of Electro slag welding; Soldering and Brazing, Gas cutting.

Advanced Welding Processes: Laser beam welding, Electron beam welding, PAW and Ultrasonic welding.

UNIT-IV

Solid State Welding Processes - Forge welding, Friction welding, Friction stir welding and Explosive welding

Resistance welding processes - Spot welding, Seam welding, Projection welding, percussion welding, Butt welding, weldability, Welding defects.

UNIT-V

Forming Processes: Cold & Hot working, Yield criteria, Process description of Forging, Rolling, Extrusion, Wire drawing.

Sheet Metal Operations: Blanking, Piercing, Bending, Deep drawing, Stretch forming, Spinning.

Introduction to unconventional forming processes: Explosive forming, Electro-magnetic forming, Electro-hydraulic and rubber pad forming.

Suggested Reading:

1. P.N.Rao, "*Manufacturing Technology*," Vol. 1, Tata McGraw Hill Publ., 3nd Ed., 2011.
2. Amitabh Ghosh & Mallick, "*Manufacturing Science*", Assoc. East west Press Pvt. Ltd. 4th Ed., 2011.
3. Roy A. Lindberg, "*Materials & Process of Manufacturing*", Prentice Hall of India, 5th Ed.l992.
4. Serope Kalpakjian, "*Manufacturing Engineering and Technology*", Addison, Wesley Publishing Company, 2006
5. George.E. Dieter, "*Mechanical Metallurgy*", SI Metric Edition McGraw-Hill Book Company
6. Pakirappa, "Production Technology", Durga Publishing House, Hyderabad

ME 331

THERMODYNAMICS LAB.

Instruction per Week	:	3	Periods
Duration of University Examination	:	3	Hours
Sessionals	:	25	Marks
University Examination	:	50	Marks

Course Objectives:

1. To provide knowledge in testing of properties of fuels and lubricating oils
2. To demonstrate and conduct experiments, interpret and analyze data and report results of IC engine testing

List of Experiments:

1. To determine volumetric efficiency, isothermal efficiency and mass flow rate of a two stage reciprocating air compressor.
2. To determine valve/ port timing diagram of a Petrol/Diesel engine.
3. To conduct performance test on single cylinder Diesel engine.
4. To conduct heat balance test on a Diesel engine.
5. To conduct Morse test on multi cylinder Petrol engine.
6. To conduct performance test on multi cylinder Petrol engine.
7. To conduct performance test on a two-stroke Petrol engine.
8. To conduct performance test on multi cylinder Diesel engine.
9. To study the performance of a Petrol engine under different compression ratios.
10. Exhaust gas analysis of Petrol engine for carbon-monoxide and unburnt hydrocarbons.
11. Exhaust gas analysis of Diesel engine for carbon deposits using smoke meter.
12. Determination of viscosity of lubricating oil.
13. Determination of flash and fire points of a fuel.
14. Study of IC Engine parts by using Cut Sections.
15. Study of boilers by using models.

Note: Minimum 12 experiments are to be conducted in a semester

Suggested Reading:

1. Ganeshan.V, "*Internal Combustion Engines*", Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2010.
2. Ballaney. P.L, "*Thermal Engineering*", Khanna Publishers, New Delhi, 2010.
3. Rajput. R. K, "*Thermal Engineering*" Laxmi Publishers, New Delhi, 2004.

ME 332

HYDRAULIC MACHINERY AND SYSTEMS LAB

Instruction per Week	:	3 Periods
Duration of University Examination	:	3 Hours
Sessionals	:	25 Marks
University Examination	:	50 Marks

Course Objectives:

1. To provide knowledge on performance testing and drawing characteristic curves of various pumps.
2. To provide knowledge on performance testing and drawing characteristic curves of various Turbines 3) to provide knowledge on hydraulic & pneumatic circuits

List of Experiments:

1. Determining the coefficient of discharge of venturimeter, orificemeter.
2. Performance and characteristic curves of reciprocating pump.
3. Performance and characteristic curves of centrifugal pump.
4. Performance and characteristic curves of self priming pump.
5. Performance and characteristic curves of gear pump
6. Impact of jet on fixed flat vanes and curved vanes
7. Performance and characteristic curves of Pelton wheel
8. Performance and characteristic curves of Francis Turbine
9. Performance and Characteristic curves of Kaplan turbine.
10. Study of hydraulic circuits
11. Study of pneumatic circuits.
12. Study of positive displacement and roto dynamic pumps with the help of models.

Suggested Reading:

1. Bansal, R.K., *"A text book of Fluid Mechanics and Hydraulic Machines"*, Laxmi Publication (P) Ltd., New Delhi, 2004
2. Modi, P.N., and Seth, S.M., *"Hydraulic and Fluid Machines"*, Standard Book House, New Delhi, 2004
3. Majumdar, S.R., *"Oil Hydraulic Systems – Principles and Maintenance"*, Tata McGrawHill, 2004, New Delhi.

ME 333

MANUFACTURING PROCESSES LAB.

Instruction per Week	:	3 Periods
Duration of University Examination	:	3 Hours
Sessionals	:	25 Marks
University Examination	:	50 Marks

Course Objectives:

1. To gain knowledge and skill in various manufacturing processes such as casting, welding and forming.
2. To understand and perform operations like pattern making, sand testing and casting.
3. To join metal pieces by various welding techniques and gain hands on experience.
4. To understand the working principle and produce some components by various metal forming techniques.

List of Experiments:

Foundry

1. Single piece pattern making with wood as material considering allowances (Draft, Shrinkage and Machining)
2. Testing of green sand properties
3. Green sand mould making processes with complete sprues, gates, riser design.
4. Melting and casting of aluminum metal

Welding

I. Evaluation of strength and hardness of a

1. Butt joint prepared by gas welding using different types of flames.
2. Lap joint by resistance welding process
3. V-joint by Arc welding process

II. Exercises using TIG and MIG welding processes

Forming

1. Evaluation of formability using Erichsen cupping test
2. Performing wire drawing operation on different materials (ex. Cu, Al etc)
3. Performing blanking and piercing operations using hydraulic / fly presses
4. Manufacturing of a simple component using Plastic Injection moulding machine

Suggested Reading:

1. P.N.Rao, "*Manufacturing Technology*," Vol. 1, Tata McGraw Hill Publ., 3nd Ed., 2011.
2. Serope Kalpakjian, "*Manufacturing Engineering and Technology*", Addison, Wesley Publishing Company, 2006
3. Harvey D Miner and John G Miller, "Exploring pattern making & Foundry ", East West Press Pvt. Ltd, New Delhi

SCHEME OF INSTRUCTION & EXAMINATION

B.E. III YEAR

(MECHANICAL ENGINEERING)

SEMESTER – II

Sl. No.	Course Code	Course Title	Scheme of Instructions		Scheme of Examination		
			Periods per Week		Duration in Hours	Maximum Marks	
			L	T/D/P		Sessionals	University Exams
1.	ME 351	Machine Design	4	-	3	25	75
2.	ME 352	Metal Cutting & Machine Tool Engineering	4	-	3	25	75
3.	ME 353	CAD / CAM	4	-	3	25	75
4.	ME 354	Heat Transfer	4	-	3	25	75
5.	ME 355	Control Systems Theory	4	-	3	25	75
6.	ME 356	Refrigeration & Air Conditioning	4	-	3	25	75
7.	ME 381	Metal Cutting & Machine Tool Engineering Lab.	-	3	3	25	50
8.	ME 382	CAD / CAM Lab.	-	3	3	25	50
9.	ME 383	Industrial Visit / Study	-	-	-	*Grade	
		Total	**24**	**6**	-	**200**	**550**

L- Lecture , T-Tutorial, D-Drawing, P- Practical

***Grade:** *Excellent / Very Good / Good / Satisfactory / Unsatisfactory*

ME 351

MACHINE DESIGN

Instruction per Week	:	4 Periods
Duration of University Examination	:	3 Hours
Sessionals	:	25 Marks
University Examination	:	75 Marks

Course Objectives:

1. To know the design of helical and leaf springs for various load considerations from stress and energy consideration;
2. To understand the design of gears such as spur, bevel and worm gears from strength and wear considerations; types of gear failure and preventive measures;
3. To understand the types of bearings used in different applications and classification;
4. To know the application of different design concepts to the design of the various components of an IC engine such as – piston, connecting rod, crankshaft etc.
5. To know the theory of bending for members with initial curvature and for various sections to design crane hooks or C- clamps.

UNIT –I

Mechanical Springs: Types of springs and materials used. Design of Helical springs on stress, deflection and energy considerations. Design for fluctuating loads. Concentric springs. **Leaf Springs**: Stresses and Deflection. Nipping of leaf springs.

UNIT–II

Gears: Types of gears and materials used. Standard for gear specifications. Design of Spur, Helical, Bevel and Worm Gears- Strength and Wear considerations. Types of failure of gear tooth and preventive measures.

UNIT – III

Bearings: Materials used for bearings, Classification of bearings, Viscosity of lubricants. Theory of hydrostatic and hydrodynamic lubrication. Design of sliding contact bearings-for axial and thrust loads.

Rolling Contact Bearings: Different types of rolling element bearings and their constructional details, Static and Dynamic load carrying capacity. Load- life relationship Design for cyclic loads.

UNIT – IV

I.C. Engine Parts: Design of Piston, connecting rod and crank shafts(single throw and overhang).Design of Flywheels for I.C. Engines and presses.

UNIT – V

Theory of Bending: Theory of bending of members with initial curvature-rectangular, circular, Trapezoidal & I sections. Design of crane Hooks, Machine flames and C-clamps.

Suggested Reading:

1. M.F.Spotts,"Design of Machine Elements", Pearson Edu,2003
2. V.Bhandari, *"Machine Design"*, Tata McGraw Hill publication,2010.
3. P.Kannaiah, *"Machine Design"*, Sci-Tech Publ,2009..
4. P.C.Sharma and D.K.Aggarwal, *"Machine Design"*, S.K.Kataria& sons, 2003
5. J.E.Shigley, C.R.Mischke, *"Mechanical Engineering Design"* Tata McGraw hill publications, 2003.
6. PSG Design Handbook,PSG College of Technology,Coimbatore,2009.

ME 352

METAL CUTTING & MACHINE TOOL ENGINEERING

Instruction per Week	:	4 Periods
Duration of University Examination	:	3 Hours
Sessionals	:	25 Marks
University Examination	:	75 Marks

Course Objectives:

1. To understand the geometry of tooling used on various metal cutting machines;
2. To analyze the effects of heat, lubrication and various cutting tool materials on the metal cutting process.
3. To understand the basic working and constructional features associated with common machining tools.
4. To understand the advantages and limitations of each process and equipment.
5. To understand the practical applications of a variety of machining processes and basics on modern machining operations.

UNIT-I

Cutting Tool Materials: High carbon steel, HSS, Stellites, Carbides, Coated carbides, Diamonds, CBN. Tool material properties.

Tool Geometry: Nomenclature of single point cutting tool by ASA & ORS systems. Geometry of drills, milling cutters.

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

Machining: Orthogonal and oblique cutting, Mechanics of metal cutting, Merchant's analysis, Shear angle, Solutions of Merchant and Lee & Shafer.

UNIT-II

Thermal Aspects of Metal Cutting: Sources of heat and heat distribution, various methods of measurement of temperature, Cutting fluids and applications.

Tool Wear, Tool Life and Machinability: Types of wear, mechanism of tool wear, Tool life & Machinability, Machinability index. Taylor's tool life equation.

Economics of Machining: Tool life for maximum production, minimum cost.

UNIT-III

Machine Tools: Constructional features, types and specifications of various machine tools, operations on Lathe, Shaper, Planer, Slotter, Drilling, Milling and, Boring machines. Indexing methods; Quick return mechanisms; Tool holding and work holding devices; Jig Boring-principle and operation.

UNIT-IV

Grinding Machines: Working principle, classification and operation of grinding machines, Abrasives and bonds used for grinding wheels. Specification and selection of grinding wheels. Broaching, Lapping, Honing, Polishing, Buffing and super finishing, Burnishing.

Screws and Gear Manufacturing: Tapping, Chasers, Thread rolling, Thread milling, thread grinding. Gear shaping, Gear hobbing, Gear shaving and grinding.

UNIT-V

Jigs and Fixtures: Design principles for location and clamping. Quick clamping devices. Types of Jigs and fixtures.

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

Suggested Reading:

1. B.L. JuneJa and Shekon, "*Fundamentals of Metal Cutting & Machines Tools*", Wiley Eastern Ltd. 1987.
2. P.N. Rao, "*Manufacturing Technology – Metal Culling & Machine Tools*", Vol. 2, Tata McGraw Hill Education Pvt. Ltd, 2010.
3. Amitab Ghosh and Mallick, "*Manufacturing Science*", Affiliated East West Press 1985.
4. P.C, Pandey & Shan HS, "*Modern Machining Process*", Tata McGraw-Hill Education 1980.
5. A. Bhattacraryya, "*Metal Cutting Theory and Practice*" New Central Book Agency (P) Ltd., Calcutta, 1996.
6. Pakirappa, "Metal Cutting and Macine Tool Engineering", 3rd Edition, 2015-16,Durga Publishing House, Hyderabad

ME 353

CAD/CAM

Instruction per Week	:	4 Periods
Duration of University Examination	:	3 Hours
Sessionals	:	25 Marks
University Examination	:	75 Marks

Course Objectives:

1. To know the basic design process, design criteria to find alternative solution; understand parametric representation of cubic spline, Bezier and B-spline curves along with concepts of NURBS.
2. To understand the concepts of surface modeling, analytical surface, solid modeling and their different approaches like C-rep and B-rep along with mass property calculations, mechanical tolerance.
3. To know the principles of CAD database and its structure and learn the different neutral file formats, like IGES and PDES.
4. To know the different types of numerical control machine tools, its features and elements; the basic concept of part families, its layout along with CAD/CAM integration and rapid prototyping concepts.

UNIT-I

Design Processes: Computer Aided Design and Computer Aided Manufacturing, Design Process, Product life cycle. Design criteria, Alternative design, CAD Hardware and Workstation.

Drafting Techniques: Basic geometric elements and their creation.

Geometric Modeling: Wire frame entities and their definition, Interpolation and Approximation curves. Concept of parametric and non-parametric representation of a circle and helix curves, properties of splines.

Synthetic Curves: Parametric representation of cubic spline, Bezier and B-spline curves, continuity, properties and characteristics. Concept of NURBS.

UNIT-II

Surface Modeling: Analytic surfaces: Definitions of planar, surface of revolution, Tabulated cylinder, synthetic surfaces: Cubic and Bezier surfaces and coons surface.

Solid Modeling: C-rep and B-rep approaches, feature based and parametric modeling.

Design Applications: Mass property calculations, Mechanical tolerance, Finite Element Analysis, Design Review.

2D Transformations: Translation, Scaling and Rotation about arbitrary points, shearing and Reflection, Homogeneous representations, concatenation.

UNIT-III

CAD Database and Data Exchange: CAD Database and structure, **CAD Exchange format:** IGES, STEP and STL format.

Numerical Control Machine Tools: Features and elements of NC, Positional, paraxial and contouring types. Definitions of axes. Definitions of interpolation, post-processor, preparatory and miscellaneous functions, canned cycles, Tool length and cutter radius compensation. Manual and computer aided part programming (APT) for simple components, programming with MACROS.

UNIT-IV

Computer Numerical Control: CNC, DNC and Adaptive control systems. Typical configurations and relative features. Machining centers, introduction to FANUC, SINUMERIC controllers.

Industrial Robots: Robot Anatomy, Configurations, Controls, Drivers, Programming methods and Applications.

UNIT-V

GT: Part families, layout, part classification and coding system. Opitz, MICLASS, CODE system.

CAPP: Variant and Generative process planning.

FMS & CMS: Building blocks of Flexible Manufacturing systems and their control, Elements of CIMS.

Computer Aided Inspection and QC: Coordinate Measuring Machine, Non-contact inspection: Machine vision, Scanning Laser Beam Devices, Quality control.

CAD/CAM Integration, Turnkey CAD/CAM Systems, Introduction to Rapid Prototyping Technique, Reverse Engineering.

Suggested Reading:

1. Arvid R. Eide, Roland D. Jenison, Lane H. Mashaw, Larry: / Mprtji[. *"Introduction to Engineering Desing'* McGraw Hill; 1998.
2. Ibrahim Zeid, *CAD/CAM, Theory and Practice,* McGraw Inc. New York, 1991.
3. Grover, MP and Zimmeers E.W. *CAD/CAM,* Prentice Hall of India, 1989.
4. Rao, P.N/ *CAD/CAM: Principles and applications,* 2nd Edition, Tata McGraw Hill, New Delhi, 2004.
5. YoramKoren, *Computer Control of Manufacturing Systems,* McGraw Hill Int., New York, 1994.
6. Elanchezhian, C. Sunder Selwyn, T. Shanmuga Sunder, G. *computer Aided Manufacturing,* Laxmi Publications (P) Ltd., 2nd Edition, New Delhi, 2007.

ME 354

HEAT TRANSFER

Instruction per Week	:	4 Periods
Duration of University Examination	:	3 Hours
Sessionals	:	25 Marks
University Examination	:	75 Marks

Course Objectives:

1. To understand the basic concepts of heat transfer.
2. To study the concepts of conduction, convection, radiation and heat exchangers applicable for commercial and industrial use
3. To understand the applications of various experimental heat transfer correlations in engineering applications
4. To learn thermal analysis and sizing of heat exchanger.
5. To study and solve problems on different modes of heat transfer which are related to thermal power plants, refrigeration and air conditioning.

UNIT-I

Modes of Heat Transfer, Laws of Heat Transfer: Fourier, Newton, Stefan-Boltzmann General conduction equation in cartesian, cylindrical and spherical coordinates, One dimensional steady state conduction through slabs, hollow cylinders and spheres with and without heat generation, Effects of variable thermal conductivity in heat transfer of one dimensional steady state conduction of plate, cylinders and spheres, Steady state heat transfer through composite slabs, cylinders and spheres, Critical radius of insulation, Two dimensional analysis of steady state heat transfer in a plate with prescribed temperature on one boundary, Application of finite difference technique to two dimensional steady state conduction of a plate.

UNIT-II

Fins: Heat transfer analysis of tips with heat dissipation environment - rectangular straight and pin fins, Application of fin to temperature measurement, unsteady state conduction, Lumped parameter, analysis of a body with negligible internal temperature gradients, Transient heat transfer analysis of finite slab with specified

temperature and convective boundary conditions, Use of Grober and Heisler charts for solving problems of infinite slabs, cylinders and spheres.

UNIT-III

Convection: Dimensional analysis and its use in free and forced convection, Buckingham theorem, Physical significance of different dimensionless numbers, Application of Von-Karman integral equation for the analysis of thermal boundary layer in forced convection of flat plate, Reynold's analogy for flow over plane surfaces, calculation of heat transfer for flow over plates, cylinders and for flow through tubes in free and forced convection using empirical formulae.

UNIT-IV

Radiation: Definition of absorptivity, reflectivity and transmissivity, Concept of black-body and emissivity. Kirchoffs law, Planck's black body spectral distribution, Wien's and Steffan Boltzmann law, Monochromatic and total emissive power, radiant heat exchange between two gray surfaces, Shape factor, Thermal circuit for radiant heat exchange between infinite parallel plates and between concentric, cylinders, Enclosures with black and gray surfaces, Radiation shields and re-radiation surfaces.

UNIT-V

Heat Exchangers: Introduction Classification and applications of heat exchangers in industry, Analysis and design of counter flow and parallel flow heat exchanger by **LMTD Method**, Fouling factors, **Effectiveness NTU Method for heat exchanger shell and tube type heat exchanger** solving problems for multi pass heat exchanger using non dimensional parameter plots. **Concept of heat pipe.**

Change of Phase: Boiling-pool boiling regimes nucleate pool boiling, effect of surface wettability on bubble contact angle, Critical heat flux, boiling in forced convection, Condensation: Film condensation, Drop wise condensation, Condensation film thickness, Heat transfer coefficient in film condensation.

Suggested Reading:

1. Holman, J.P., *"Heat Transfer"*, McGraw Hill Publication, New Delhi, 2010
2. Rajput, R.K., *"Heat and Mass Transfer"*, S. Chand & Company Ltd, New Delhi, 2004.
3. Yadav, R., Sanjay. and Rajay., *"Heat and Mass Transfer '*, Central Publishing House, Allahabad, 2004
4. Sachdeva,R.C., *"Fundamentals of Engineering Heat and Mass Transfer* ", New Age International (P) Ltd Publishers, New Delhi,
5. Arora, S.C. and Domkandwar., *"A course in Heat and Mass Transfer* ", Dhanpat Rai & Sons, New Delhi, 2004.

Note: During Examination necessary Charts and Tables will be supplied

ME 355

CONTROL SYSTEMS THEORY

Instruction per Week	:	4 Periods
Duration of University Examination	:	3 Hours
Sessionals	:	25 Marks
University Examination	:	75 Marks

Course Objectives:

1. To know the development of input-output relations using block diagrams, signal flow graphs of mechanical, electromechanical systems etc.; and methods of obtaining time and frequency response.
2. To understand the stability and margins for stability from characteristic equation, root-locus method or frequency response; and methods
3. To know the development of the alternative state space models of dynamic systems, and their importance in predicting time response of multiple variables of the system.

UNIT-I

Control Systems Classification: Open Loop & Closed Loop Systems. Mathematical models and Transfer functions from governing equations of mechanical, electrical, hydraulic, pneumatic, thermal systems. AC, DC servomotors & Electromechanical servo systems.

UNIT-II

Block Diagrams: Block diagram reduction. Signal flow graphs, Mason's gain formula. Transient response. Time domain specifications of 1st and 2nd order systems. Steady state error, Error coefficients, sensitivity Performance indices.

UNIT-III

Routh Criteria: Root Locus method. Frequency Response: Bode, Polar plots. Correlation between transient and frequency response. Bandwidth. Experimental determination of transfer functions.

UNIT-IV

Nyquist Criteria: Gain and phase margins, Lead, Lag and Lead-lag compensator design, PID controller, linearization of Non linear systems,

UNIT-V

State-Space Representation of Linear Control Systems: State transition matrix. Solution of state equations: Zero input response and Zero state response. Concept of controllability and observability.

Suggested Reading:

1. Dorf, R. C., *"Modern Control Systems "*, Addison-Wesley 1989.
2. M. Gopal, *"Control Systems "*, Tata McGraw Hill, 2004.
3. Ogata, K., *"Modern Control Engineering"*, Prentice Hall, 2004.
4. Norman S. Nise, *"Control Systems Engineering "*, John Wiley & Sons, Inc., 2001.

ME 356

REFRIGERATION AND AIR CONDITIONING

Instruction per Week	:	4 Periods
Duration of University Examination	:	3 Hours
Sessionals	:	25 Marks
University Examination	:	75 Marks

Course Objectives:

1. To understand the basic concepts of refrigeration and air conditioning systems.
2. To study the methods of refrigeration for commercial and industrial applications.
3. To understand the topics related to Air-conditioning , Psychrometry, Psychrometric process
4. To understand the Design of air-conditioning systems.
4. To solve the problems related to cooling and heating system

UNIT-I

Introduction to Refrigeration: Definition of Refrigeration & Air Conditioning, Necessity of Refrigeration & its Applications. Methods of Refrigeration, Unit of Refrigeration & COP. Reversed Carnot Cycle & its Limitations.

Refrigerants: Survey, Classification, Designation & Desirable properties of refrigerants. Alternative refrigerants to reduce Ozone depletion & Global Warming.

Air Refrigeration System: Analysis of Bell Coleman cycle, Applications to air craft refrigeration system

UNIT-II

Vapour Compression System: Working principle and essential components of Simple vapor compression Refrigeration cycle, Compressor, condenser, evaporator, and expansion devices, Analysis of cycle, C.O.P, Representation of the cycle on T-S,

P-H and H-S charts. Performance improvement of simple vapour compression refrigeration cycle by means of flash chamber and accumulator.

Dry and wet compression, Effect of operating conditions like evaporating pressure, condenser pressure, Liquid sub-cooling and Vapor super heating, Performance of the system.

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

UNIT-III

Vapour Absorption Refrigeration System: Simple absorption systems, COP, Practical ammonia absorption refrigeration system, Lithium bromide absorption system, Electrolux refrigerator, Common refrigerants and absorbents properties, Comparison with vapor compression refrigeration system

Steam Jet Refrigeration : Principle of working, Analysis of the system, Advantages, limitations and applications.

Non-Conventional Refrigeration Systems: Principle and operation of Thermoelectric Refrigeration Systems, Seebeck effect - Peltier effect - Thomson effect, Pulse tube refrigeration system.

UNIT-IV

Psychrometry: Psychrometric properties, Psychrometric chart, construction, Representation of Psychrometric processes on the chart, Heating and Cooling with Humidification and Dehumidification, Adiabatic dehumidification, adiabatic chemical dehumidification and mixing processes

Air Conditioning Systems: Types & Components of Air Conditioning Systems, Ducting System.

UNIT-V

Cooling Load Calculations in Air Conditioning: Concept of bypass factor, Sensible heat factor, Apparatus Dew Point, Room Sensible Heat Factor (RSHF), Gross Sensible Heat Factor (GSHF), Different heating and cooling loads, Problems.

Design of Air Conditioning Systems: All fresh air, Re-circulated air with bypassed air, Design of Summer, Winter and Year round air conditioning systems, Energy conservation in air conditioned building, Case study of one building with all load calculations

Air Conditioning Systems: Types, Components of air conditioner equipments, Humidifier, Dehumidifier, Filter, Grills, Fans and Blowers, Duct layout.

Applications of Refrigeration and Air conditioning: Food Preservation, Transport air conditioning, and Industrial applications

Suggested Reading:

1. Arora C.P., "*Refrigeration and Air conditioning*", Tata McGraw Hill, New Delhi, 2009.
2. Arora, S.C. and Domkundwar, S., "*A Course in Refrigeration and Air conditioning*", Dhanpat Rai & Sons, New Delhi, 2010.
3. Jain, V.K., "*Refrigeration and Air Conditioning*", S Chand & Company, New Delhi, 2010.
4. Stocker, W.S., "*Refrigeration and Air conditioning* ", McGraw Hill, New Delhi, 2009.
5. Jordon & Priester, Principles of Refrigeration and Air Conditioning, Prentice Hall, India, 1965.

ME 381

METAL CUTTING & MACHINE TOOL ENGINEERING LAB.

Instruction per Week	:	3 Periods
Duration of University Examination	:	3 Hours
Sessionals	:	25 Marks
University Examination	:	50 Marks

Course Objectives:

1. To gain knowledge in various machining operations.
2. To perform machining and gain hands on experience on lathe, drilling, milling, planning, shaping slotting and gear cutting.
3. To understand the influence of various machining parameters on tool life.

List of Experiments:

1. Exercise on lathe with operations of step turning, taper turning, thread cutting, knurling and boring.
2. Exercise on shaper to make rectangular and 'V' grooves.
3. Cutting gear teeth using (a) Simple indexing (b) compound indexing (c) Differential indexing
4. Influence of tool material (High carbon steel, high speed steel and carbides) on shear angle by measuring thickness and length of chips.
5. Measuring the forces, by dynamometers and finding friction angle and stress on shear plane and rake plane.
6. Conducting tool life tests and finding the constant and index equation for HSS and carbide tools.
7. Measurement of chip-tool average temperature by thermocouple method.
8. Grinding of HSS tool by tool and cutter grinder to a given geometry.
9. PCD drilling on radial drilling and tapping
10. Grinding of flat surfaces using surface girding / cylindrical grinding machines.
11. Cutting of splines by using a slotting machine.
12. Machining of simple component by Electro Discharge Machining (EDM)

Suggested Reading:

1. P.N. Rao, "*Manufacturing Technology – Metal Culling & Machine Tools*", Vol. 2, Tata McGraw Hill Education Pvt. Ltd, 2010.
2. Amitab Ghosh and Mallick, "*Manufacturing Science*", Affiliated East West Press 1985.
3. Bhattacraryya, "*Metal Cutting Theory and Practice*" New Central Book Agency (P) Ltd., Calcutta, 1996.

ME 382

CAD/CAM LAB.

Instruction per Week	:	3 Periods
Duration of University Examination	:	3 Hours
Sessionals	:	25 Marks
University Examination	:	50 Marks

Course Objectives:

1. To know the full-scale CAD software systems designed for geometric modelling of engineering components using the concepts of sketching and various constraints in preparing the sketch.
2. To understand the various sketching tools, manipulation tools to prepare sketch.
3. To understand the computer numerical control machine tools, its features and elements; classify different types of tool path like positional, paraxial and contouring and practice manual part programming using miscellaneous and preparatory functions (M & G Codes).
4. To know the Introduction of the manufacturing process through Flexible manufacturing system and 3D Printing.

List of Experiments:

1. Practice in the use of some of the packages like: Pro-E / I-DEAS / Solid works / MDT / Inventor / CATIA etc., for Geometric modeling of simple parts (sketching).
2. Part modeling and assembly of simple parts using any of the above packages.
3. Mass properties and Sectional properties of a part and Assembly.
4. Assembly Modeling with Interference detection.
5. Assembly modeling such as Steam Engine Cross Head, Connecting rod, Non-Return Valve/Blow-off cock & Drill Jig etc.
6. Display of Process Sheet & Bill of Materials in Assembly drawings.

7. Geometrical dimensioning and tolerance representation on the drawings with Layouts, standard sectional views, Detailing & Plotting.
8. Facing, Turning, Step turning, Taper turning & Contouring on CNC Lathe.
9. Pocketing and Contouring on CNC Milling.
10. Simulation and Development of NC code using any CAM software.
11. Programming for integration of various CNC machines, robots and material handling systems.
12. Exercises in 3D Printing.

Suggested Reading:

1. Ibrahim Zeid, *CAD/CAM, Theory and Practice,* McGraw Inc. New York, 1991.
2. YoramKoren, *Computer Control of Manufacturing Systems,* McGraw Hill Int., New York, 1994.
3. Elanchezhian, C. Sunder Selwyn, T. Shanmuga Sunder, G. *computer Aided Manufacturing,* Laxmi Publications (P) Ltd., 2nd Edition, New Delhi, 2007.

ME 383

INDUSTRIAL VISIT/ STUDY

At least 3 days in a semester	3x8=24 hours
Sessionals/Examination	Grade*

A minimum of two industrial visits will be arranged by department and students have to attend the visits and prepare a data report of their visits to the industries and submit to the department. Students are required to present a seminar based on their report which is evaluated by Head of the Department and two senior faculties to award the Grade*

* *Excellent / Good / Satisfactory / Unsatisfactory*