DEPARTMENT OF MECHANICAL ENGINEERING

Overall Scheme
of

B.E. Working Professional
in
Mechanical Engineering

Academic Years 2024-2025

UNIVERSITY COLLEGE OF ENGINEERING
(AUTONOMOUS)
OSMANIA UNIVERSITY
HYDERABAD–500007, TELANGANA.

SCHEME OF INSTRUCTION EXAMINATION
B.E (Working Professional - Mechanical Engineering)

V Semester A.Y. 2024-2025

S.No.	Course Code	Course Title	Scheme of Instruction			Contact hrs/wk	Scheme of Examination		Credits
			L	T	P		CIE	SEE	
1	PC501ME	Dynamics of Machines	3	-	-	3	40	60	3
2	PC502ME	Fluid Mechanics and Hydraulic Machines	3	-	-	3	40	60	3
3	PC503ME	Heat Transfer	3	-	-	3	40	60	3
4	PC504ME	Machine Design	3	-	-	3	40	60	3
5	PC505ME	Metal Cutting & Machine Tools	3	-	-	3	40	60	3
PRACTICALS									
6	PC 551ME	Fluid Mechanics and Hydraulic Machines Lab	-	-	2	2	25	50	1
7	PC 552ME	Dynamics of Machines Lab	-	-	2	2	25	50	1
Total			15	-	4	19	250	400	17

Course Code	Course Title							Course Type
PC501ME	**DYNAMICS OF MACHINES**							**Core**
Prerequisite	Contact hours per week				**Duration of SEE (Hours)**	**Scheme of Evaluation**		**Credits**
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

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

Course Outcomes: Upon successful completion of this course, the student will be able to:

1 Compare and contrast various methods of static and dynamic analysis of planar and spatial mechanisms.
2 Evaluate Gyroscopic effects on Naval ships, Aeroplanes and Automobile.
3 Analyze balancing problems in rotating and reciprocating machinery.
4 Design systems like governors and flywheels for controlling speed and energy fluctuations.
5 Determine natural frequencies and conditions for resonance of single degree and multi degree systems.

UNIT-I

Static and Dynamic analysis of planar mechanisms: Graphical and analytical methods, Free body diagrams, Method of superposition, Equivalent offset inertia force, Inertia force in reciprocating engines, Flywheels.

UNIT-II

Force analysis of space mechanisms, inertia matrix, Lagrangian and Newton-Euler formulation. Gyroscopic effect in shafts, aero planes, Naval ships, Two & Four wheel automobiles.

UNIT-III

Forces on bearings due to rotating shaft carrying several eccentric rotors, balancing of shafts carrying several rotors, determination of balancing masses from the forces on the bearings shaking forces in a single cylinders engine, partial balancing of reciprocating engine. Balancing of a two-cylinder locomotive engine, determination of unbalanced forces and couples.

UNIT-IV

The role of a centrifugal governor in speed control, Porter and Hartnell type governors, speed vs lift curves, power and stability. Undamped free vibration of a single degree of freedom linear system (axial and torsional), determination of natural frequencies, equivalent system of combination of springs, stepped shafts, gears and rotors. Free response of single degree of freedom damped linear systems, damped natural frequencies, relative damping. Vibration of harmonically forced single degree of freedom systems. Resonance, vibration isolation with coupled damper.

Partial differential equation governing free vibration of a simply supported uniform beam. Derivation of natural frequencies.

UNIT-V

Natural frequencies of two-degree freedom linear systems. Nodes in three rotor systems. Modes of vibration, determining natural frequencies by Holzer's method for multi-rotor systems. Dunkerley's method, Raleigh's method.

Suggested Reading:

1. S.S. Rathan, "Theory of Machines", Tata-Mc Graw Hill, 1995.Thomas Bevan, "Theory of Machines", 3rd edition, Pearson Education, 2005
2. A. Ghosh and Mallick, "Theory of mechanisms and machines", Affiliated to E-W Press, 1988.
3. John.J.Vicker, Gordon R. Pennock, Joseph E. Shigley, "Theory of Machines & Mechanisms", Oxford University Press, 2003.
4. Robert L. Norton, "Design of Machinery", Tata Mc Graw Hill, 2005.

Course Code	Course Title							Course Type
PC502ME	**FLUID MECHANICS AND HYDRAULIC MACHINES**							**Core**
Prerequisite	Contact hours per week				**Duration of SEE (Hours)**	**Scheme of Evaluation**		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

- To understand the properties of fluids and types of fluids.
- To verify the Bernoulli's theorem and its applications.
- To understand the concepts of fluid flow measurement and flow through pipes.
- To introduce the concepts of the working and design aspects of hydraulic machines like turbines and pumps and their applications.
- To determine the basic principles and characteristic curves of turbines and pumps.

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Define the properties of fluids and classify the fluids.
2. Apply conservation laws to fluid flow problems in engineering applications and examine the stability of a floating bodies.
3. Apply Euler's Equation of motion and Bernoulli's equation for flow measuring devices and hydraulic machines.
4. Illustrate the working of Hydraulic machines.
5. Analyze the performance of various types of Hydraulic pumps and turbines.

UNIT-I

Fluid Properties: Viscosity of liquids. Newtonian and non-Newtonian fluids. Surface tension, capillary effect, vapor pressure and cavitation. Ideal and real fluids, Incompressible and Compressible flows. Stream lines, Path lines.

Pressures and pressure head: Types of pressures, Pascal's law of pressure at a point, variation of pressure vertically in a fluid under gravity.

Static Forces on Surface and Buoyancy:

Fluid statics, action of fluid pressure on surface, resultant force and center of pressure on a plane surface under uniform pressure. Equilibrium of floating bodies, stability of a submerged body, stability of floating bodies, determination of the metacentric height, determination of the position of the metacentre relative to the center of buoyancy.

UNIT-II

Laws of fluid flow – Continuity equation. Derivation of Euler's and Bernoull's equations. Application of Bernoulli's equations. Flow measuring devices-Venturi meter, Orifice meter and Pitot static tube. **Viscous Flow:** Reynolds number and Reynolds experiment, flow of viscous fluid through circular pipe-Hagen Poiseuille formula.

Flow through pipes: Head losses in pipes, bends and fittings. Major energy losses, Minor energy losses, Hydraulic gradient and total energy lines, Pipes in series and parallel, Equivalent pipes. Boundary layer theory.

UNIT-III

Reciprocating pumps: Classification, working details, theory and terms used for single and double acting pumps. Effect of acceleration head and friction. Indicator diagrams. Effect of

cavitation and limiting suction head on pump speed. Variation of pressure inside pump cylinder during suction and delivery strokes. Work done, power required and efficiency. Functions of air vessels. Work saved and rate of flow from air vessels. Losses and performance curves for reciprocating pumps. Industrial applications. Types of Positive displacement pumps.

UNIT-IV

Centrifugal pumps: Working and constructional details of single stage centrifugal pump. Priming – significance and methods of priming. Basic classification of CF pumps. Types of impellers, casings and vane shapes used. Simple and multistage pumps and their applications. Series and parallel operation of CF pumps. Manometric head and its importance. Manometric efficiency and other efficiencies. Losses in CF pumps. Velocity diagrams. Cavitation. Unit quantities, specific speed. Performance and characteristic curves. Methods of balancing of end thrust in CF pump installations.

UNIT-V

Hydraulic Turbines: Classification of impulse and reaction turbines and their differences in working. Impulse turbines: Salient features and working details of Pelton wheel installation. Velocity diagrams. Calculation of number of buckets, bucket sizes and power developed. Overall efficiency, speed regulation methods.

Reaction turbines: Constructional details and working of Francis and Kaplan turbines. Draft tube in reaction turbines. Theory, types and efficiency of draft tubes. Velocity diagrams. Power developed and efficiencies, pressure head at inlet of the runner.

Principles of similarity applied to hydraulic turbines. Unit quantities, specific speed and its significance for turbine selection. Performance and characteristic curves for Pelton wheel, Francis and Kaplan turbines. Governing of turbines. Cavitation effects in reaction turbines and remedial measures. Surge tanks.

Suggested Reading:

1. Modi, P.N. & Seth, S.M., “Hydraulics & Fluid Mechanics Including Hydraulics Machines”,
2. Standard Book House, 2017.
3. K. Subramanya, “Theory and Applications of Fluid Mechanics”, Tata McGraw-Hill Publishing Company Ltd.,1993.
4. S.K.Som, Gautam Biswas, S Chakraborty. “Introduction to Fluid Mechanics and Fluid Machines”, McGraw Hill Education, 2017.
5. K.L. Kumar, “Engineering Fluid Mechanics”, Eurasia Publishing House Pvt Ltd., New Delhi,2009.
6. A.K.Mohanty. “Fluid Mechanics”, PHI Learning Pvt. Ltd, 1994.

Course Code	Course Title							Course Type
PC503ME	**HEAT TRANSFER**							**Core**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

- To understand the fundamental principles and laws of heat transfer and to explore the implications of these principles for system behaviour.
- To formulate the models necessary to study, analyse and design heat transfer systems through the application of these principles.
- To develop the problem-solving skills essential to good engineering practice of heat transfer in real-world applications.

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Illustrate the basic modes of heat transfer with its associated laws in simple geometries.
2. Solve the problems of steady state and transient heat conduction with simple and multi-layer geometries.
3. Analyze heat transfer coefficients for free and forced convection, considering boundary layers.
4. Develop relationships for radiation exchange between surfaces in an enclosure, blackbody radiation exchange.
5. Analyse heat exchanger performance by using the methods of Log Mean Temperature Difference (LMTD), effectiveness-NTU, and also focus on the knowledge of boiling and condensation.

UNIT-I

Heat transfer fundamentals: Basic heat transfer mechanisms (conduction, convection and radiation), Conduction: General conduction equation on plane wall, Cylinders and spheres.
One dimensional steady state conduction through plane walls, hollow cylinders and spheres with and without heat generation. Thermal resistance network, Boundary Conditions, Effect of variable thermal conductivity for one-dimensional steady-state conduction in a plane wall. The critical radius of insulation.

UNIT-II

Fins: Heat transfer analysis of a body with negligible internal temperature gradients, fins efficiency and effectiveness.
Lumped system analysis within the body with negligible internal temperature gradients. **Transient** heat transfer analysis of an infinite slab with specified temperature and connective boundary conditions. Use of Grover & Heisler charts for solving problems of infinite slabs, cylinders, spheres.

UNIT-III

Convection: Physical mechanism of convection, Buckingham pi-theorem and use of dimensional analysis in free and forced convection, Physical significance of different dimensionless numbers. Concept of velocity boundary layer, thermal boundary layer.

Reynolds analogy, Chilton-Colburn analogy for turbulent flow over flat surfaces. Calculation of heat transfer for flow over plates, cylinders and in pipes in free and forced convection using empirical formulae.

UNIT-IV

Radiation: Concept of a blackbody, Absorptivity, Reflectivity, and Transmissivity. Emissivity, the Planck Distribution law, Wien's Displacement Law, Stefan-Boltzmann, Kirchhoff's Law. The View factor, View factor relations, View Factors between Infinitely Long Surfaces: The Crossed-Strings

Method, Radiation exchange between Opaque, Diffuse, Gray Surfaces in an enclosure: Blackbody radiation exchange, the two-surface enclosure, radiation shields.

UNIT-V

Heat Exchangers: Heat exchanger types, overall heat transfer coefficient. Heat exchanger analysis: Use of the Log Mean Temperature Difference (Parallel-Flow, Counter-Flow), the Effectiveness–NTU Method. Heat Exchanger Design and Performance Calculations (LMTD, ε-NTU methods), Selection of heat exchangers.

Boiling: Pool boiling regimes, nucleate pool boiling, and critical heat flux for nucleate pool boiling, minimum heat flux.

Condensation: Physical Mechanisms, Laminar Film Condensation on a Vertical Plate, Turbulent Film Condensation, dropwise condensation.

Suggested Reading:

1. John H Lienhard IV, John H Lienhard V,A"Heat Transfer" Textbook, Fifth Edition, Phlogiston Press, 2019.
2. Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt "Fundamentals of Heat and Mass Transfer", 8th Edition, John willey& Sons, 2018.
3. J.P. Holman, "Heat Transfer", Tenth Edition, McGraw Hill Companies Inc., 2010.
4. Yunus A Cengel, "Heat Transfer A Practical Approach", Second Edition, McGraw-Hill, 2002.
5. James R. Welty, Charles Wicks, Robert Wilson, Gregory Rorrer, "Fundamentals of Momentum, Heat and Mass Transfer", 4th Edition, John Wiley and Sons Ltd, 2001.

Course Code	Course Title							Course Type
PC504ME	**MACHINE DESIGN**							**Core**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

- Importance of materials & criteria of failure of general mechanical components like springs, gears, brakes, bearings used in industry
- Importance of the stresses developed under different loading conditions
- Learn to apply design procedures for mechanical components like springs, gears, bearings
- Learn to evaluate the design procedure based on failure theories
- Learn to design components for new applications

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Identify and classify various materials & the corresponding failure theories to be applied in the design of simple mechanical components like springs, gears, bearings, IC engines.
2. Illustrate various mechanical components under different loading conditions & constraints.
3. Analyse various mechanical components under simple and combined loads.
4. Determine (material, dimensions, shape, number) mechanical components subjected to various types of loads, constraints & failure criterions.
5. Design mechanical components for specific applications in industry.

UNIT-I

Mechanical springs: Introduction. Different types of springs. Materials used for springs. Helical Springs: Whal factor, calculation of stress, Deflection and energy stored in spring. Design for static and fluctuating loads. Leaf Springs: Stress and Deflection. Nipping of Leaf springs. Design for static and fluctuating loads.

UNIT-II

Gears: Introduction of gear drives, different types of gears, Materials used for gears. Standards for gears and specifications. Spur Gear Design: Basic analysis of gear Tooth-Bending Stress-Lewis equation, refined analysis of gear tooth -bending strength-procedure, gear tooth surface fatigue analysis-procedure, spur gear design procedures, Design of Helical, Bevel and Worm gears, concepts of Design for manufacturability.

UNIT-III

Bearings: Introduction. Materials used for Bearings. Classification of bearings and mounting of bearings.

Design of sliding contact bearings: Properties and types of Lubricants, Design of Hydrostatic and Hydrodynamic sliding contact bearings.

Design of Rolling Contact Bearings: Different types of rolling element bearings and their constructional details, static load carrying capacity. Dynamic load carrying capacity. Load-life relationship, selection of bearing life. Design for cyclic loads and speeds. Selection of Ball and Roller bearings.

UNIT-IV

I.C. Engine parts: Introduction. Materials used. Design of piston, connecting rod and crank for I.C. Engines. Fly wheels: Introduction. Design of solid disk type and rimmed fly wheels. Design of

Brakes, Block brake with short shoe & long shoe, Pivoted block brake with long shoe, band brakes, disc brakes, internal expanding shoe, thermal considerations.

UNIT-V

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

Suggested Reading:

1. Bhandari V.B. "Machine Design", Tata Mc Graw Hill Publications, 1994.
2. Robert C. Juvinall, Kurt M. Marshek, "Fundamentals of Machine Component Design", Wiley publications, 5th edition, 2012.
3. J.E. Shigley , C.R. Misckhe, "Mechanical Engineering Design", Tata Mc Graw Hill Publication, 2003.
4. M.F. Spotts, "Design of Machine Elements", Prentice Hall, 1964.
5. Robert L. Norton, "Machine Design: An Integrated Approach",2/e Pearson Education, 2000.

Course Code	Course Title							Course Type
PC505ME	**METAL CUTTING AND MACHINE TOOLS**							**Core**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

- To learn the geometry and mechanics of metal cutting for turning, drilling milling and tool materials.
- To understand the heat distribution, tool wear and tool life
- To know the various machining processes such as lathe, drilling, milling, boring, broaching, grinding etc.
- To know various types of work and tool holding devices for conventional machining.
- To understand the basics of Unconventional Machining processes.

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Develop the relations for shear angle, shear strain, forces and temperatures associated with orthogonal cutting.
2. Select the cutting fluids, tool materials and coatings to control the tool wear and temperature.
3. Evaluate the tool life and economics of machining for maximum production and minimum cost.
4. Select the appropriate machine tool and tool & work holding devices for machining of components.
5. Illustrate the various finishing techniques and unconventional machining processes.

UNIT-I

Basic chip formation process. Tool geometry: Nomenclature of single point cutting tool by ASA, ORS and NRS. Geometry of drills, Milling cutters and broaches. Recommended Tool angles. Chip formation: Types of chips, BUE, Chip breakers. Machining: Orthogonal and oblique cutting, Mechanics of Orthogonal Cutting: Merchant's analysis, Friction. Shear angle: Shear angle Solutions of Merchant and Lee & Shafer. Cutting tool materials: High carbon steel, HSS, Carbides, Ceramics, Coated carbides, Cermets, HPC, cBN & Diamond.

UNIT-II

Measurement of Cutting Forces: Lathe tool dynamometers, Drilling, Milling and Grinding Dynamometers. 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 & **Machinability:** Types of wear, mechanism of tool wear, Tool life & Machinability. Effects of process parameters on Tool life, Taylor's tool life equation. Economics of machining: Tool life for maximum production, minimum cost.

UNIT-III

Constructional features and specifications of machine tools: Various operations on Lathe, Types of Lathes and special attachments on a Centre Lathe. Drilling, Milling operations. Indexing methods. Shaper, planer and slotter and their differences. Quick return mechanisms, Automatic feed devices. Jig Boring machines- Differences between horizontal and vertical jig boring machines. Principles of Broaching.

UNIT- IV

Abrasive Processes: Grinding machines. Types of grinding, Abrasives and bonds used for

grinding wheels. Specification and selection of wheels. Lapping, Honing, Polishing, Buffing, Super finishing and burnishing.
Screws and gear manufacturing: Screw making by 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. Tool holding and work holding devices. Quick clamping devices. Types of Jigs and fixtures.
Unconventional machining: Principles of working and applications of USM, AJM, WJM, EDM, ECM, LBM, EBM and PAM.

Suggested Reading:

1. David A. Stephenson, Johs S. Agapiou, "Metal Cutting Theory and Practice", CRC Press, 3rd Edition, 2016.
2. B.L. Juneja, Shekhon G.S. and Seth Nitin, "Fundamentals of Metal Cutting & Machine tools", New Age Publishers, 2003.
3. Amitabha Ghosh and Ashok Kumar Mallik, "Manufacturing Science", Affiliated East-West Press Pvt. Ltd., 2ndEdition, 2010.
4. Winston A. Knight and Geoffrey Boothroyd, "Fundamentals of Metal Machining & Machine tools", CRC Press, 3rd Edition, 2005.
5. McGeough JA, "Advanced Methods of Machining", Chapman & Hall, 1988.

Course Code	Course Title						Course Type
PC551ME	**FLUID MECHANICS AND HYDRAULIC MACHINES LABORATORY**						**Core**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	-	**-**	**-**	**2**	**3**	**25**	**50**	**1**

Course Objectives:

- The course should enable the students:
- To understand general governing equations for various fluid flows
- To enrich the concept of fluid mechanics and hydraulic machines.
- To demonstrate the classical experiments in fluid mechanics and hydraulic machinery.
- To understand the functioning of various flow measuring devices, pumps and turbines
- To evaluate the performance characteristics of turbines and pumps

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Illustrate the working of Hydraulic machines.
2. Apply the Bernoulli‟s principle in flow measurement used in hydraulic machines.
3. Analyze working principles of hydraulic pumps and turbines.
4. Evaluate the theoretical concepts and apply them in the functioning of hydraulic machines
5. Estimate the performance of pumps and turbines.

List of Experiments:

1. Determination of Cd and Cv of an orifice meter
2. Calibration of a mouth piece
3. Calibration of a Venturi meter
4. Verification of Bernoulli‟s principle
5. Performance test on Pelton wheel turbine
6. Characteristic curves test on Pelton wheel turbine
7. Performance test on Turgo wheel
8. Characteristic curves test on Turgo wheel
9. Performance test on Francis turbine
10. Characteristic curves test on Francis turbine
11. Performance test on reciprocating pump
12. Study of positive displacement and Rotodynamic pumps with the help of models.
13. Study of the working of Kaplan turbine

Course Code	Course Title						Course Type
PC552ME	**DYNAMICS OF MACHINES LABORATORY**						**Core**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	-	**-**	**-**	**2**	**3**	**25**	**50**	**1**

Course Objectives:

- Carry out the kinematic and dynamic analysis of planar and spatial mechanisms
- Find out natural frequencies, forced frequencies and other important parameters for different vibrating systems using Universal vibration apparatus.
- Perform modal analysis of vibrating systems
- Study the working of gyroscope and governors
- Effects of rotary unbalancing and methods of reduction

Course Outcomes:

1. Importance of vibrations in mechanical systems & analyse Single and multi-degree freedom vibrating systems.
2. Inspect methods to reduce effects of static and dynamic unbalance due to rotating systems. machines.
3. Investigate the effect of various governors on speed control of mechanisms.
4. Evaluate the reaction torque due to gyroscopic effects in systems.
5. Carry out the kinematic and dynamic analysis of planar and spatial mechanisms.

List of Experiments:

1. To determine experimentally, the Mass Moment of Inertia of a Flywheel and Axle and compare with theoretical value.
2. To verify the formula of a Simple Pendulum and to show that the time period is independent of the mass of the bob.
3. To determine the radius of gyration “K” of given compound pendulum.
4. To find the damping coefficient(c), damping ratio (ξ) and logarithmic decrement (δ) of damped longitudinal vibrations of spring mass system.
5. To study the Torsional vibration (undamped) of single Rotor Shaft system.
6. To study the free Torsional vibrations of two rotor system and to determine the frequency of vibration theoretically and experimentally.
7. To study the response of a beam under forced oscillations and compare the experimental response with theoretical for resonance frequency.
8. To determine critical speed or whirling speed of a rotating shaft and to verify the value theoretically.
9. To verify the law of gyroscopic couple, = with the help of motorized Gyroscope calibrate the gyroscope.
10. To determine Centrifugal Forces of the Governor and Plot the Characteristic Curves of the governor.
11. To balance the given unbalanced rotating masses by drawing force polygon and couple polygon.

12. To find the natural and damped frequency of an Aluminium cantilever beam in transverse vibrations.
13. Determination of natural frequency of transverse vibration in a given aluminium rod with concentrated weights at two places using Dunkerley method
14. To determine the radius of gyration L and thereby determining the mass moment of inertia of a connecting rod.
15. Modal analysis of a composite beam.
16. Simulation experiments on Kinematic and dynamic analysis of mechanisms and systems using.

MSC Adams software

- Analysis of Freely falling body, Body moving up the slope, Simple pendulum, Linear spring, and Non-linear spring

Simulation of kinematic and dynamic analysis of:

- Four bar Mechanisms, Slider crank Mechanisms, Spur Gear Analysis, Multi-link robots, Cam Mechanisms and Rope and Chain drive systems
- Note: At least 10 experiments (08 hardware+02 software) from the set of above experiments needs to be conducted by each student.

Suggested Reading:

1. MSC Adams 2013.2 User Guide
2. Universal Vibration Apparatus User Manual (KC Engineers)
3. Static & Dynamic balancing of rotating masses, user manual (KC Engineers)
4. Gyroscope apparatus User Manual (KC Engineers)
5. Centrifugal Governors User Manual (KC Engineers)

SCHEME OF INSTRUCTION EXAMINATION
B.E (Working Professional - Mechanical Engineering)

VI Semester A.Y. 2024-2025

S.No.	Course Code	Course Title	Scheme of Instruction			Contact hrs/wk	Scheme of Examination		Credits
			L	T	P		CIE	SEE	
1	**PC601ME**	**Control System Theory**	3	0	0	3	40	60	3
2	**PC602ME**	**Metrology and Instrumentation**	3	0	0	3	40	60	3
3	**PC603ME**	**Refrigeration and Air Conditioning**	3	0	0	3	40	60	3
4	**PC604ME**	**Principles of Management**	3	0	0	3	40	60	3
5	**PC605ME**	**Non-Conventional Machining and Forming Methods**	3	0	0	3	40	60	3
PRACTICALS									
7	**PC 651ME**	**Metal Cutting and Metrology Lab**	-	-	2	2	25	50	1
8	**PC 652ME**	**Computer Aided Engineering Lab**	-	-	2	2	25	50	1
9	**PC 653ME**	**Mini Project**	**-**	**-**	**6**	**6**	**25**	**50**	**3**
Total			**15**	**0**	**10**	**25**	**275**	**450**	**20**

Course Code	Course Title							Course Type
PC601ME	**CONTROL SYSTEMS THEORY**							**Core**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

- To introduce students to the fundamental of feedback control system theory and use of analytical design methods in designing, analyzing various physical systems and to apply the gained knowledge in developing solutions for real world systems.
- To develop the ability of formulating mathematical models and designing feedback control systems.
- To provide students with necessary tools to analyze linear feedback control systems.
- To introduce the students to the concepts of digital control and modern control.

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Distinguish between open loop and closed systems with examples.
2. Develop mathematical models of mechanical, electrical, electro-mechanical systems.
3. Evaluate the effects of transient and steady state responses and apply these models to real time systems.
4. Apply the time response and frequency response methods to determine the stability of the system.
5. Apply the concepts of discrete time control systems. Analyse and design multi input, multi output systems by state space analysis.

UNIT-I

Introduction: Classification of control systems. Examples of control systems with applications in Mechanical Engineering. Relationships of components and analogies. Performance characteristics of control system components. Hydraulic and pneumatic control systems. Methods of analysis using standard input functions. Laplace transformation, use of transfer functions.

Derivation of system equations: The simultaneous equation method. Block diagram method and Laplace transform approach. Error sensing devices: Potentiometer, synchros, and AC-DC servomotors, Encoders, Decoders.

UNIT-II

Modeling in the time domain. Time Response: Response characteristics of systems Types of input. Transient response of first and second order system for step input. Time domain specification. Types of system, static error coefficients, error series, Routh-Hurwitz criterion of stability.

Root Locus Techniques: Typical systems analyzed by Root Locus Techniques. Effect of location of roots on the system response.

UNIT-III

Modeling in the frequency domain. Frequency response analysis: The frequency response of a second order system, effect of numerator factors, zero factors in a transfer function. Bode plots, Gain-Phase plot, Nyquist criterion for stability, Gain Margin and Phase Margin, compensation techniques.

UNIT-IV

Discrete Control Analysis: The Z-transformation, digital control, advantages and disadvantages, Digital control system architecture. The discrete transfer function. Z-domain stability. Stability tests. Jury's stability criteria.

UNIT-V

State space representation: Concept of state. State variable, state models of linear time invariant systems, derivation of state model from transfer functions and differential equations.
State transition matrix, solution of state equations by time domain method.

Suggested Reading:

1. Katsuhiko Ogata, “Modern Control Engineering”, Prentice hall, 5th edition, 2010.
2. Norman S Nise, Control system engineering‟, Wiley publications, 6th edition, 2010.
3. Francis Raven H. "Automatic Control Engineering", Tata McGraw Hill, 5th Edition, 1995.
4. Peter Dransfield, "Engineering Systems and Automatic Control", Prentice Hall of India, 1974.
5. Gene F. Franklin, J. David Powell, Abbas Emamin Naini, "Feedback control of Dynamic Systems", Pearson Education Pvt. Ltd., 4th Edition, 2004.

Additional Readings

1 Benjamin kuo, “Automatic control systems”, 9th Edition, Wiley, India, 2010.

Course Code	Course Title						Course Type
PC602ME	**METROLOGY AND INSTRUMENTATION**						**Core**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	**T**	**D**	**P**		**CIE** / **SEE**	
	3	**-**	**-**	**-**	**3**	**40** / **60**	**3**

Course Objectives:

- To familiarize with limits and Fits, ISO system and the instruments used to measure these limits.
- To have knowledge of various precision linear and angular measuring instruments
- To learn the importance of form and how to measure form errors
- To understand the working principles of various instrument used for the measurement of strain, pressure, temperature and vibrations.

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Illustrate manufacturing process variables.
2. Explain the measurement of the physical phenomenon.
3. Understand and Apply measurement principles in Industrial requirements.
4. Evaluate the methods of measurements affecting Mechanical Engineering Process.
5. Design, innovate and modify measuring technology.

UNIT-I

Limits and Fits, I.S.O. system. Types of interchangeability. Slip gauges and end bars. Height gauges, Abbe's rule, Types of micrometers. Tomlinson gauges, sine bar, autocollimator, calibration of precision polygons and circular scales. Dial indicator, Sigma mechanical comparator. Free flow and back pressure type Pneumatic comparators. Contact & non-contact tooling, Applications of single and multi-jet gauge heads; computation and match gauging.

UNIT-II

Optical projector-measurement by comparison, movement and translation, chart gauge types and micro gauge bridge lines. Tool maker's microscope, Floating carriage diameter measuring machine and Coordinate Measuring Machine. Measurement of straightness & flatness using autocollimator. Roundness measurement with intrinsic datum (V-block, Bench centers) and extrinsic datum (TALYROND).

UNIT-III

Taylor's principles for plain limit gauges. Usage and limitations of Ring and Snap gauges. Indicating type limit gauges. Position and receiver gauges, principles of thread gauging. Gauge materials and steps in gauge manufacture. General geometrical tests for machine tools. Surface roughness characteristics and its measurement. Elements of instrumentation system. Static characteristics, Systematic and random errors. Dynamic response of first and second order instruments.

UNIT-IV

Strain Measurement: Wire and foil type resistance strain gauges, Evaluation of principal strains with Rosette gauges. Desirable characteristics of gauge material, backing material and adhesive. Ballast and bridge circuits. Lead resistance compensation. Adjacent arm and self-temperature

compensating methods. Strain gauge calibration. Strain gauge circuits for measuring axial load, bending load and torque.
Measurement of displacement with LVDT and Lasers interferometry.

UNIT-V

Force Measurement: Proving ring, Strain gauge load cells, Piezo-electric load cell, Ballastic weighing, Pneumatic and hydraulic force meters. Pressure Measurement: Thermocouple vacuum gauge, High and Low pressure measuring devices. Pirani gauge, Bourdon gauge and Bulk modulus gauge, calibration methods.

Vibration measurement, accelerometers, vibration exciters, calibration of vibrometers. Temperature measurement: Laws of thermo electricity, types of materials and junctions used in thermocouples, lead and extension wires, ambient temperature compensation, protection tubes, series and parallel circuits. RTD. Total radiation and Optical Pyrometers.

Suggested Reading:

1. R.K. Jain, “Engineering Metrology”, Khanna Publications, 1996.
2. I.C. Gupta, “A text book of Engineering Metrology”, Dhanpat Rai & Sons, 1984.
3. Bechwith, Marangoni, Lienhard, “Mechanical Measurement”, LPE; Pearson Education Asia 2000.
4. D.S. Kumar, “Mechanical Measurements”, Metropolitan Book Co., New Delhi, 2001.
5. Rega Rajendra, “Principles of Engineering Metrology”, Jaico Publishing House, Mumbai, 2008.

Course Code	Course Title							Course Type
PC603ME	**REFRIGERATION AND AIR CONDITIONING**							**Core**
Prerequisite	Contact hours per week				Duration of SEE	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**	(Hours)	**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

- To understand the basic concepts of refrigeration and air conditioning systems.
- To study the different methods of refrigeration system and their performance.
- To understand conventional and non-conventional refrigeration system.
- To study the psychrometric terms and psychrometric processes.
- To study the lower temperature applications: cryogenics by using cascade systems.

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Distinguish different types of refrigerants and their properties used in the refrigeration cycle.
2. Analyze the performance of vapour compression and vapour absorption system.
3. Distinguish between conventional and non-conventional refrigeration system.
4. Apply the principles of Psychrometrics to estimate the air conditioning loads for the industrial applications.
5. Illustrate various methods to obtain cryogenic temperatures.

UNIT-I

Definition of Refrigeration & Air Conditioning. Necessity of refrigeration. Applications of refrigeration and air conditioning. Units of refrigeration. Refrigerants classification and desirable properties of refrigerants. Air refrigeration: Carnot refrigeration cycle and its limitation. Air refrigeration cycle operating on Brayton cycle and analysis. Aircraft refrigeration: Necessity. Advantages of using air cycles for aircraft refrigeration. Refrigeration systems for low and high speed aircrafts.

UNIT-II

Vapour compression system: Simple vapour compression cycle: COP, representation of cycle on T- S, P-H and H-S diagrams. Actual vapour compression cycle. Effect of superheating and sub cooling– problems.

Vapour absorption refrigeration systems: Ammonia –water, Lithium Bromide – water systems. Improvements using analyzer and rectifier. Desirable properties of combinations. Electrolux refrigerator – It‟s working.

UNIT-III

Steam jet refrigeration systems: Analysis using T-S and H-S diagrams. Quantity of motive steam required. Use of barometric and evaporative condensers. Limitations and advantages of steam jet systems.

Thermoelectric refrigeration systems: Seebeck effect, Peltier effect and Thompson effect. Analysis of the thermoelectric refrigeration systems using Peltier effect. Expression for COP. Criterion for selecting thermoelectric effects. Vortex tube refrigeration – principle and working.

UNIT-IV

Psychrometric properties of air: Psychrometric chart and psychrometric processes and combination of processes. By pass factor. SHR and Room conditioning using SHR with and

without recirculation. Design and classification of Air conditioning systems, RSHF, GSHF, ERSF. Human comfort and tolerances. ASHRAE comfort charts. Effective temperature.

UNIT-V

Cryogenics: Limitations of single stage vapour compression systems applied to low temperature applications. Multistage compression and cascade systems for production of low temperature. Joule Thompson effect and coefficient. Inversion curve. Liquification of air using Linde and cloude systems. Liquification of hydrogen and helium. Application of cryogenics in metallurgy, cryobiology and cryosurgery.

Suggested Reading:

1. Roy J. Dossat, "Principles of Refrigeration", 5th edition, Pearson Education, 2001.
2. Jordon & Priester, "Principles of Refrigeration and Air Conditioning", Prentice Hall, India, 1988.
3. Arora C.P., "Refrigeration and Air Conditioning", Tata McGraw Hill, New Delhi, 1988.
4. Silberstein, Obrzut, Tomczyk, Whitman, Johnson, Refrigeration and Air Conditioning Technology, 9th Edition, Cengage, January 2021.
5. G F Hundy, A. R. Trott, T C Welch, Refrigeration and Air-Conditioning, Elsevier Science, 2008.

Course Code	Course Title							Course Type
PC604ME	**PRINCIPLES OF MANAGEMENT**							**Core**
Prerequisite	Contact hours per week				Duration of SEE	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**	(Hours)	**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

- To understand the principles of management and their application to the functioning of an organization
- Upon completion of this course, the students will get a clear understanding of management
- Functions in an organization
- Various activates of organisation with respective different objectives
- Understand organizational structures

Course Outcomes: Upon successful completion of this course, the student will be able to:

1. Able to organizational communications
2. Understand organizational objectives
3. Organizational human communications

UNIT-I

Definition of management, science or art, manager vs entrepreneur; Types of managers managerial roles and skills; Evolution of management- scientific, human relations, system and contingency approaches

UNIT-II

Types of Business Organizations, sole proprietorship, partnership, company, public and private enterprises; Organization culture and environment; Current trends and issues in management.
Nature and purpose of Planning, types of Planning, objectives, setting objectives, policies, Strategic Management, Planning Tools and Techniques, Decision making steps & processes.

UNIT-III

Nature and purpose of Organizing, formal and informal organization, organization structure, types, line and staff authority, departmentalization, delegation of authority, centralization and decentralization, job design, human resource management, HR planning, Recruitment selection, Training & Development, Performance Management, Career planning and Management.

UNIT-IV

Directing, individual and group behaviour, motivation, motivation theories, motivational techniques, job satisfaction, job enrichment, leadership, types & theories of leadership, effective communication.
Controlling, system and process of controlling, budgetary and non-budgetary control techniques, use of computers and IT in management control, productivity problems and management, control and performance, direct and preventive control, reporting.

UNIT-V

Behavioural aspects of entrepreneurs: Personality – determinants, attributes and models, Leadership concepts and models. Values and attitudes. Motivation aspects, change behavior. Corporate social responsibility. Time Management: Various approaches of time management, their strengths and weaknesses. The urgency addiction and time management matrix.

Suggested Reading:

1. Robins S.P. and Couiter M., Management, Prentice Hall India, 10th ed., 2009.
2. Stoner JAF, Freeman RE and Gilbert DR, Management, 6th ed., Pearson Education, 2004.
3. Tripathy PC & Reddy PN, Principles of Management, Tata McGraw Hill, 1999.
4. Harold Koontz, Cyril O'Donnell, Principles of Management an analysis of managerial functions. 1968.
5. Neharika Vohra Stephen P. Robbins, Timothy A. Judge, Organizational Behavior, 18th Editions, Pearson Education, 2022.

Course Code	Course Title							Course Type
PC605ME (PE623ME Regular)	**NON-CONVENTIONAL MACHINING AND FORMING METHODS**							**Core**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

- To know the various unconventional methods of machining and forming techniques.
- To understand the principles, advantages and applications of unconventional machining and forming processes.
- To know the various process parameters and their effect on machining and forming.

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

1. 1 Illustrate the basic principles of non-conventional machining techniques.
2. 2Select non-conventional machining techniques for various materials.
3. 3Illustrate principles of non-conventional forming techniques.
4. 4Select modern forming processes to various metals.
5. 5Analyze the process parameters of non-conventional machining and forming techniques.

UNIT-I

Ultrasonic Machining (USM): Process description, abrasive slurry, Abrasive materials and their characteristics.

Functions of liquid medium in slurry. Types of Transducers, effect of process parameters, applications and limitations.

Abrasive Jet Machining (AJM): Principle of operation, process details, process variables and their effect on MRR and accuracy. Equation for MRR. Advantages, disadvantages and applications.

Water Jet Machining (WJM): Schematic diagram, equipment used, advantages and applications.

UNIT-II

Electro Discharge Machining (EDM): Process description with schematic diagram, process parameters, functions and characteristics of dielectric medium, dielectric fluids, over cut and side taper Flushing, Mechanism of metal removal, crater volume, types of power supply circuits, mathematical analysis of metal removal rate (MRR), characteristics of spark eroded surfaces, advantages, disadvantages and applications, wire electro-discharge machining principles and description.

Electro-Chemical Machining (ECM): Schematic of the process, process parameters, function and characteristics of electrolyte, chemistry of the process. Equation for specific MRR and electrode feed rate, advantages, limitations and applications.

Rotary Machining, Hot machining, high speed machining, description of each process, process parameters, advantages and applications.

UNIT-III

LASER Beam Machining (LBM): Principle of LASER Beam production, materials used, thermal analysis of the process, process parameters, equations for power density and machining rate, advantages, limitations and applications.

Plasma Arc Machining (PAM): Equipment used, process description and parameters, types of plasma arc: Transferred arc and non-transferred arc and process applications.

Electron Beam Machining (EBM): Schematic of the process, process parameters, principle of production of Electron beam, equipment used, Advantages, disadvantages and applications. ION Etching: Process description and applications.
Hybrid Machining Processes: Principle and applications of Electro chemical discharge machining, electro chemical abrasive finishing, electro discharge abrasive grinding.

UNIT-IV
Rubber Pad Forming: Principle of the process, process details, process variants - Guerin, wheelon, Marforming and Hydro forming processes and applications.
High Energy Rate Forming (HERF): Advantages of high energy rate forming, Explosive forming: Explosive materials, standoff operation and contact operation, advantages and applications.
Electro- Hydraulic Forming (EHF): Schematic of the process, description and its applications.
Electro-Magnetic Forming (EMF): Process details and parameters, materials used and applications. HERF hammers.

UNIT- V
Stretch Forming: Introduction, types of stretch forming: stretch draw forming, rotary stretch forming or stretch wrapping, compression forming, radial draw forming. Stretch forming equipment and accessories, accuracy and surface finish, process variables and limitations.
Tube spinning: Introduction, methods of tube spinning, Backward spinning, Forward spinning, machines and tools used. Machine variables, speeds and feeds, effect of tube spinning on work metal properties and applications.
Hydrostatic Forming: Process principle description and applications.
Water Hammer Forming (WHF): Schematic diagram of the process, principle of operation, process variable, work materials, process limitations and applications.

Suggested Reading:
1. Pandey PC. and Shah H.S., "Modern Machining Process", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1980
2. Bhattacharya A., "New Technology", the Institution of Engineers, India, 1984.
3. Davies and Austin, "Developments in High Speed Metal Forming". The Machinery Publishing Co. Ltd., 1985
4. Mikell. P. Groover "Principles of Modern Manufacturing" Wiley India Pvt. Ltd., New Delhi, 2014.
5. Hassan Abdel-Gawad El-Hofy, Advanced Machining Processes, Nontraditional and Hybrid Machining Processes, McGraw Hill Publishing Co. Ltd.

Course Code	Course Title						Course Type
PC651ME	**METAL CUTTING AND METROLOGY LAB**						**Core**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	**T**	**D**	**P**		**CIE** / **SEE**	
		-	**-**	**2**	**3**	**25** / **50**	**1**

Course Objectives:

- To have knowledge of various precision measuring instruments.
- To familiarize machining and metal cutting operations.

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

1. Perform different operations on lathe, Shaper and Milling Machine Tools
2. Perform Finishing operations on flat and curved surfaces
3. Estimate shear angle, stresses involved, power required and tool life in metal cutting
4. Evaluate tolerances, taper angles, roundness, and roughness for a component
5. Calibrate the precision measuring instruments

List of Experiments:

(a) Metrology

1. Linear measurements with inside, outside and depth micrometers, Vernier calipers and Height gauges.
2. Measurement of roundness errors with Bench Centre method and V-block method.
3. Measurement of thread elements with Tool Maker‟s Microscope
4. Measurement of angles with Sinebar, Bevel protractor and Precision level.
5. Tolerance measurement with Electrical Comparator, Mechanical Comparator and GO -No GO Gauge.
6. Calibration of Outside micrometer and Dial gauge.
7. Profile measurement with profile projector
8. Surface roughness measurement using surface roughness tester

(b) Metal Cutting & Machine Tools

1. External & Internal thread cutting on Lathe: single start and multi start threads.
2. V Block machining on Shaper
3. Machining of Square and Hexagonal bolt heads on Milling Machine Tool.
4. Spur Gear cutting on milling machine tool.
5. Study of cylindrical grinding, reaming and burnishing operations
6. Estimation of shear angle by measuring thickness and length of chips.
7. Measurement of Cutting forces with Lathe tool dynamometer and determination of friction angle and stresses on shear plane and rake plane.
8. a) Test for tool life. b) Measurement of Chip-tool interface temperature by thermocouple.

Course Code	Course Title						Course Type
PC652ME	**COMPUTER AIDED ENGINEERING LAB**						**Core**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation	Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
		-	**-**	**2**	**3**	**25**	**50**	**1**

Course Objectives:

- To understand the various features of geometric modelling using standard softwares like Creo(Pro-E) /CATIA/Solid Works like 2d-Sketching, Part Modeling and Assembly.
- To understand the application of Finite Element Analysis using standard packages like ANSYS/ NASTRAN/ADINA in solving structural and thermal problems.

Course Outcomes: The students will be able to

1. Develop models of engineering components and assemblies using Computer Aided Modelling methods and procedures.
2. Simulate/solve structural and thermal problems using standard software
3. Analyze non-linear engineering problems.
4. Prepare technical document /report.

Computer Aided Modelling

1. Introduction to various features of geometric modeling packages like: Creo (Pro-E) /CATIA/Solid Works.
2. Practicing problems on 2D-Sketching.
3. Creation of various Part Models using extrude, revolve, blend and sweep
4. Creation of Assembly Modelling

Computer Aided Analysis

1. Simple Truss problem
2. Plane Stress and Plane Strain analysis
3. Beam Analysis
4. Modal Analysis
5. Buckling Analysis
6. Thermal analysis
7. Contact analysis

Course Code	Course Title							Course Type
PC653ME	**MINI PROJECT**							**Core**
Prerequisite	Contact hours per week				Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	**T**	**D**	**P**		**CIE**	**SEE**	
		-	**-**	**6**	**3**	**25**	**50**	**3**

Course Outcomes:

1. At the end of the course, students will demonstrate the ability to:
2. Conceive a problem statement either from rigorous literature survey or from the requirements raised from need analysis.
3. Design, implement and test the prototype/algorithm in order to solve the conceived problem.
4. Write comprehensive report on mini project work.

Guidelines:

1. The mini-project is a team activity having 3-4 students in a team. This is mechanical product design work/ manufacturing process with a focus on mechanical system design/manufacturing process.
2. The mini project may be a complete hardware or a combination of hardware and software. The software part in mini project should be less than 50% of the total work.
3. Mini Project should cater to a small system required in laboratory or real life.
4. It should encompass components, devices, with which functional familiarity is introduced.
5. After interactions with course coordinator and based on comprehensive literature survey/ need analysis, the student shall identify the title and define the aim and objectives of mini-project.
6. Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal within first week of the semester.
7. The student is expected to exert on design, development and testing of the proposed work as per the schedule.
8. Art work and Layout should be made using CAD based software.
9. Completed mini project and documentation in the form of mini project report is to be submitted at the end of semester.