TKR COLLEGE OF ENGINEERING AND TECHNOLOGY
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MECHANICAL ENGINEERING
Course Structure R-20

B.Tech V Semester

S.No.	Class	Course Code	Name of the Subject	L	T	P	C
1	PC	C35PC1	Dynamics of Machinery	3	0	0	3
2	PC	C35PC2	Design of Machine Members-I	3	0	0	3
3	PC	C35PC3	Thermal Engineering-II	3	0	0	3
4	PC	C35PC4	Operations Research	3	0	0	3
5	PC	C35PC5	Instrumentation and Control Systems	3	0	0	3
6	PE	 C35PE6A C35PE6B C35PE6C	**Professional Elective-1** Automobile Engineering Non-Destructive Testing and Vacuum Technology Robotics	3	0	0	3
7	PC	C35PC7	Thermal Engineering Lab	0	0	2	1
8	PC	C35PC8	Kinematics and Dynamics Lab	0	0	2	1
9	MC	MC05	MOOCS/Online Course	0	0	0	0
Total							20

Mandatory Course: MOOCs/Online Course
The student should register for any one of the MOOCs course offered by NPTEL, COURSERA, UDEMY, student should submit the completion certificate to clear this course.

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MECHANICAL ENGINEERING-R20

B.Tech V Semester **L/T/P/C**
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DYNAMICS OF MACHINERY (C35PC1)

Pre-requisite: Engineering Physics, Engineering Mechanics, and Kinematics of Machines.

Course Objectives: This course will enable students to:
1. Understand techniques for studying motion of Machines and their components under the influence of forces due to inertia and externally applied load system.
2. Understand the precession motion gyroscopic principles and its effects on rotating members.
3. Assess the Dynamics of mechanical elements used in IC engines and automobiles
4. Deal with balancing of rotating and reciprocating parts of various machines and to study the influence of primary and secondary forces involved in the system.
5. Understand the concepts of free and forced vibrations in machines and its dynamic analysis.

Course Outcomes: On completion of the course, the students will be able to:
1. Design linkages and mechanisms for a given motion associated with forces.
2. Analyze the effect of precession motion and gyroscopic couples on moving bodies viz automobiles, aero planes and ships.
3. Analyze the effect of dynamics on various mechanical elements associated with IC engines and automobiles.
4. Apply the significance of balancing moving parts and its dynamic analysis to achieve the steady state of equilibrium.
5. Apply the vibration concepts and its effects on dynamic machine members.

UNIT– I:
Precession: Gyroscopes – effect of precession – motion on the stability of moving vehicles such as motorcycle – motorcar –aero planes and ships.
Dynamic Force Analysis: Dynamic Force Analysis–D'Alembert's principle, Dynamic Analysis of 4-link mechanism and Slider Crank Mechanism.

UNIT– II:
Turning Moment Diagram And Flywheels: Engine Force Analysis – Piston Effort, Crank Effort, etc., Inertia Force in Reciprocating Engine – Graphical Method - Turning moment diagram –fluctuation of energy – flywheels and their design -crank effort and torque diagrams.

UNIT– III:

Friction: pivots and collars – uniform pressure, uniform wear. Clutches – Types –Single plate, multi-plate and cone clutches.

Brakes and Dynamometers: Types of brakes – Simple block brake, band and block brake-internal expanding shoe brake-effect of braking of a vehicle, Dynamometers – absorption and transmission types. General description and methods of operation.

UNIT–IV:

Governors: Types of governors - Watt, Porter and Proell governors. Spring loaded governors – Hartnell and Hartung with auxiliary springs, Sensitiveness, isochronisms and hunting– stability– effort and power of the governors.

Balancing: Balancing of rotating masses - Primary, Secondary, and balancing of reciprocating masses. Analytical and graphical methods, unbalanced forces and couples.

UNIT–V:

Vibrations: Free Vibration of mass attached to vertical spring–Transverse loads –vibrations of beams with concentrated loads. Dunkerly's method–Raleigh's method. Whirling of shafts – critical speed – torsional vibrations – one, two and three rotor systems.

Note: Students should prepare model/analysis of machine parts of piston, crank, gyroscope etc. by forming groups.

Text Books:

1. Theory of Machines –V.P.Singh– DhanpatRai
2. Theory of Machines– Thomas Bevan.
3. Theory of Machines –R.K.Bansal–Laxmi publications

Reference Books:

1. Theory of Machines and Mechanisms/Joseph E. Shigley/ Oxford
2. Theory of Machines / Rao,J.S/ New Age
3. Theory of Machines /S.S.Rattan/ McGraw Hill.
4. Theory of Machines /Sadhu Singh/ Pearson
5. Kinematics and Dynamics-of Machinery -RLNorton –TMH
6. Theory of mechanisms and machines, Ghosh A and Malik A,K

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DESIGN OF MACHINE MEMBERS-I (C35PC2)

Pre-requisite: Engineering Mechanics and Mechanics of Solids, Manufacturing Process.

Course Objectives: This course will enable students to:

1. Gain the basic knowledge of formulation and analysis of different machine components.
2. Understand how to formulate and analyze stresses and strains in machine elements under the fatigue loading condition.
3. Learn and design power transmission shafts and couplings carrying various elements with geometrical features.
4. Design various fasteners, riveted and welded joints.
5. Design and evaluate the keys, knuckle and cotter joints for different applications.

Course Outcomes: On completion of the course, the students will be able to:

1. Design and select machine elements for various applications.
2. Analyze Strength/Failure theories and Safety factors for machine members under steady and fatigue loads.
3. Acquire procedure to analyze and design of permanent joints such as Riveted and welded joints etc. for different applications.
4. Identify and apply the various types of fasteners and joints with practical engineering applications.
5. Acquire procedure to analyze and design of keys, knuckle and cotter joints for different applications.

UNIT- I:

Introduction: General considerations in the design of Engineering Materials and their properties – selection –Manufacturing consideration in design. Tolerances and fits –BIS codes of steels.

Design for Static Strength: Simple stresses – Combined stresses – Torsional and Bending stresses – Impact stresses – Stress strain relation – Various theories of failure – Factor of safety – Design for strength and rigidity – preferred numbers, the concept of stiffness in tension, bending, torsion and combined situations.

UNIT- II:

Design for Fatigue Strength: Stress concentration–Theoretical stress Concentration factor– Fatigue stress concentration factor- Notch Sensitivity – Design for fluctuating stresses –

Endurance limit – Estimation of Endurance strength – Gerber's curve– Modified Goodman's line– Soderberg's line.

UNIT-III:
Riveted, Welded and Bolted Joints: Riveted joints- methods of failure of riveted joints strength equations-efficiency of riveted joints-eccentrically loaded riveted joints, Welded joints-Design of fillet welds-axial loads-circular fillet welds under bending, torsion. Welded joints under eccentric loading, Bolted joints – Design of bolts with pre-stresses – Design of joints under eccentric loading – locking devices – bolts of uniform strength.
UNIT- IV:
Keys, Cotters and Knuckle Joints: Design of keys-stresses in keys-cotter joints-spigot and socket, sleeve and cotter, jib and cotter joints-Knuckle joints.

UNIT – V:
Shafts: Design of solid and hollow shafts for strength and rigidity – Design of shafts for combined bending and axial loads – Shaft sizes – BIS code, Use of internal and external circlips, Gaskets and seals (stationary and rotary)
Shaft Couplings: Rigid couplings – Muff, Split muff and Flange couplings, Flexible couplings – Flange coupling (Modified).

Text Books:

1. Design of Machine Elements / V. Bhandari / Mc Graw Hill
2. Machine Design / Jindal /Pearson

Reference Books:

1. Design of Machine Elements / V. M. Faires /Macmillan
2. Design of Machine Elements-I / Annaiah, M.H / New Age
3. Machine Design by R S Kurmi and J K Guptha

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THERMAL ENGINEERING-II (C35PC3)

Pre-requisite: Engineering Physics, Thermodynamics, Thermal Engineering-I.

Course Objectives: This course will enable students to:
1. Gain the basic knowledge of Rankine cycle, performance enhancement techniques, combustion process and Boilers.
2. Understand the functions, types and applications of Draught and Nozzles.
3. Understand working principles of different types of steam turbines and their analysis.
4. Gain the knowledge on performance of reaction turbine and steam condensers.
5. Gain the knowledge of gas turbine and jet propulsion application

Course Outcomes: On completion of the course, the students will be able to:
1. Apply the knowledge of Rankine cycle in solving field problems while operating a power plant.
2. Analyze and incorporate suitable Draught system and Nozzle.
3. Compare the different types of steam turbines in the industry.
4. Evaluate the operating principles and performance of Reaction turbine and Steam condensers.
5. Analyze working of gas turbine and jet propulsion system.

UNIT – I:
Steam Power Plant: Rankine cycle - Schematic layout, Thermodynamic Analysis, Concept of Mean Temperature of Heat addition, Methods to improve cycle performance – Regeneration & reheating.
Boilers: Classification – Working principles of water tube and fire tube boilers with sketches– Mountings and Accessories – Working principles- Boiler horse power, Equivalent Evaporation, Efficiency and Heat balance – Draught- Classification – Height of chimney for givendraughtanddischarge-Conditionformaximumdischarge-Efficiencyofchimney.

UNIT – II:
Steam Nozzles: Stagnation Properties- Function of nozzle – Applications and Types- Flow through nozzles- Thermodynamic analysis – Assumptions -Velocity of nozzle at exit-Ideal and actual expansion in nozzle- Velocity coefficient- Condition for maximum discharge-Critical pressure ratio- Criteria to decide nozzle shape- Super saturated flow, its effects, Degree of super saturation and Degree of under cooling – Wilson line

UNIT-III:

Steam Turbines: Classification – Impulse turbine; Mechanical details – Velocity diagram – Effect of friction – Power developed, Axial thrust, Blade or diagram efficiency – Condition for maximum efficiency. De-Laval Turbine - its features- Methods to reduce rotor speed-Velocity compounding and Pressure compounding- Velocity and Pressure variation along the flow – Combined velocity diagram for a velocity compounded impulse turbine.

Reaction Turbine: Mechanical details – Principle of operation, Thermodynamic analysis of a stage, Degree of reaction –Velocity diagram – Parson's reaction turbine – Condition for maximum efficiency.

UNIT – IV:

Steam Condensers: Requirements of steam condensing plant – Classification of condensers – Working principle of different types – Vacuum efficiency and Condenser efficiency – Air leakage, sources and its affects, Air pump- Cooling water requirement.

Gas Turbines: Simple gas turbine plant – Ideal cycle, essential components – Parameters of performance – Actual cycle – Regeneration, Intercooling and Reheating –Closed and Semi closed cycles – Merits and Demerits- Combustion chambers and turbines of Gas Turbine Plant-Brief Concepts.

UNIT – V:

Jet Propulsion: Principle of Operation –Classification of jet propulsive engines – Working Principles with schematic diagrams and representation on T-S diagram - Thrust, Thrust Power and Propulsion Efficiency – Turbo jet engines – Needs and Demands met by Turbojet – Schematic Diagram, Thermodynamic Cycle, Performance Evaluation Thrust Augmentation Methods.

Rockets: Working principle, classifications and applications.

Text Books:

1. Thermal Engineering / Mahesh M Rathore/ Mc Graw Hill
2. Gas Turbines – V.Ganesan /Mc GrawHill

Reference Books:

1. Gas Turbine Theory / Saravanamuttoo, Cohen, Rogers / Pearson
2. Fundamentals of Engineering Thermodynamics / Rathakrishnan/ PHI

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OPERATIONS RESEARCH (C35PC4)

Pre-requisite: Engineering Mathematics.

Course Objectives: This course will enable students to:
1. Get the basic knowledge of Linear Programming and its applications to engineering problems and able to formulate a problem in LP model, and solve it using graphical method and Simplex method.
2. Be taught about the variants of the LP problem such as Transportation, Assignment, and Sequencing problems
3. Learn to find the optimal replacement time of equipment and application of Group Replacement strategy
4. Get to know about solution methods to find the optimal strategy to maximize the outcome and learn the importance of maintaining optimal inventory in any industry
5. Be exposed to the intricacies of waiting line models faced in real world situations and Solve problems using the Bellman's Principle of Optimality and understand the concept of Simulation and its application to inventory and queuing problems.

Course Outcomes: On completion of the course, the students will be able to:
1. Apply the linear programming and dynamic programming techniques to solve the engineering problems.
2. Analyze working procedure modeling and implementation of solutions at the workplace.
3. Summarize various models of operations research like LPP, TPP, sequencing, replacement, game theory, project management,
4. Evaluate skills of individuals of the organization for better human resource management and performance appraisals.
5. Analyze the competitive situations in business organizations to find the optimal strategies to be adopted according to the given situation.

UNIT – I
Development – Definition– Characteristics and Phases – Types of models – operation Research models – applications.
Allocation: Linear Programming Problem Formulation – Graphical solution – Simplex method – Artificial variables techniques -Two–phase method, Big-M method.

UNIT – II

Transportation Problem: Formulation – Optimal solution, unbalanced transportation problem – Degeneracy. Assignment Problem – Formulation – Optimal solution - Variants of Assignment Problem- Traveling Salesman problem.

UNIT – III

Sequencing: Introduction – Flow –Shop sequencing – n jobs through two machines – n jobs through three machines – Job shop sequencing – two jobs through 'm' machines.

Replacement: Introduction – Replacement of items that deteriorate with time – when money value is not counted and counted – Replacement of items that fail completely, group replacement.

UNIT – IV

Theory of Games: Introduction – Minimax (maximin) – Criterion and optimal strategy – Solution of games with saddle points – Rectangular games without saddle points – 2 X 2 games – dominance principle – m X 2 & 2 X n games -graphical method.

Inventory: Introduction – Single item – Deterministic models – Purchase inventory models with one price break and multiple price breaks – shortages are not allowed – Stochastic models – demand may be discrete variable or continuous variable – Instantaneous production. Instantaneous demand and continuous demand and no set up cost.

UNIT – V

Waiting Lines: Introduction – Single Channel – Poisson arrivals – exponential service times – with infinite population and finite population models– Multichannel – Poisson arrivals – exponential service times with infinite population single channel Poisson arrivals.

Dynamic Programming: Introduction – Bellman's Principle of optimality – Applications of dynamic programming- capital budgeting problem – shortest path problem – linear programming problem.

Text Books:

1. Operations Research Theory & Practice / NVS Raju/ B.S. Publications
2. Operations Research / S.D.Sharma-Kedarnath
3. Introduction to O.R/Hiller &Libermann (TMH).

Reference Books:

1. OperationsResearch .M.Natarajan, P.Balasubramani, A. Tamilarasi/Pearson Education.
2. Operations Research: Methods & Problems / Maurice Saseini, ArhurYaspan& Lawrence Friedman
3. Operations Research / R.Panner selvam,PHI Publications.
4. Operations Research / Wagner/ PHI Publications.
5. Operation Research /J.K.Sharma/MacMilan.
6. O.R/Wayne L.Winston/Thomson Brooks/cole
7. Introduction to O.R /Taha/PHI

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MECHANICAL ENGINEERING-R20

B.Tech V Semester **L/T/P/C**
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INSTRUMENTATION AND CONTROL SYSTEMS (C35PC5)

Pre-requisite: Engineering physics, Engineering metrology, Basic Electrical & Electronics Engineering

Course Objectives: This course will enable students to:
1. Analyze the basic characteristic of a typical instrument
2. Apply and perform the measurement of different parameters, such as temperature, pressure and flow.
3. Understand the measurements of level, flow measurement, measurement of speed, measurement of acceleration and vibration.
4. Apply the concepts of stress strain measurements and humidity measurements.
5. Analyze the different elements of control system.

Course Outcomes: On completion of the course, the students will be able to:
1. Classify various elements and their purpose in typical instruments and to identify various errors that would occur in instruments.
2. Analyze the instruments to measure displacement and temperature.
3. Deduct a relation between acceleration and vibration to develop a suitable instrument.
4. Compare and contrast between various types of stress and strain measuring instruments.
5. Evaluate stability, frequency response, and other characteristics relevant to control system of instruments.

UNIT—I:
Definition — Basic principles of measurement, Measurement systems, generalized configuration and functional descriptions of measuring instruments, examples. Dynamic performance characteristics, sources of error, Classification and elimination of error.

UNIT—II:
Measurement of Displacement: Theory and construction of various transducers to measure displacement, Piezo electric, Inductive, capacitance, resistance, ionization and Photo electric transducers, Calibration procedures.
Measurement of Temperature: Classification Ranges Various Principles of measurement Expansion, Electrical Resistance Thermistor Thermocouple Pyrometers Temperature Indicators. Measurement of Pressure: Units classification different principles used. Manometers, Piston, Bourdon pressure gauges, Bellows Diaphragm gauges. Low pressure measurement Thermal conductivity gauges ionization pressure gauges, McLeod pressure gauge.

UNIT—III:

Measurement of Level: Direct method, Indirect methods, capacitative, ultrasonic, magnetic, cryogenic fuel level indicators Bubbler level indicators.

Flow Measurement: Rotameter, magnetic, Ultrasonic, Turbine flow meter, Hot, wire anemometer, Laser Doppler Anemometer (LDA).

Measurement of Speed: Mechanical Tachometers Electrical tachometers Stroboscope, Non-contact type of tachometer.

Measurement of Acceleration and Vibration: Different simple instruments, Principles of Seismic instruments, Vibro meter and accelerator meter using this principle.

UNIT— IV:

Stress Strain Measurements: Various types of stress and strain measurements electrical strain gauge factor method of usage of resistance strain gauge for bending compressive and tensile strains usage for measuring torque, Strain gauge Rosettes.

Measurement of Humidity: Moisture content of gases, sling psychrometer, Absorption psychrometer, Dew point meter. Measurement of Force, Torque and Power: Elastic force meters, load cells, Torsion meters, Dynamometers.

UNIT—V:

Elements of Control Systems: Introduction, Importance Classification Open and closed systems Servomechanisms Examples with block diagrams Temperature, speed and position control systems.

Text Books:

1. Instrumentation & Control Systems by Dr.N.V.S.Raju/ Hi-Tech Publishers; 1st edition
2. Measurement Systems: Applications & Design I D.S Kumar/Anuradha Agencies.
3. Instrumentation, measurement & analysis IB.C.Nakra & K.K.Choudhary/ TMH.

Reference Books:

1. Principles of Industrial Instrumentation and Control Systems Chennakesava R Alavala/ Cengage Learning.
2. Instrumentation and Control systems! S.Bhaskar/Anuradha Agencies.
3. Experimental Methods for Engineers / Holman/McGraw Hill.
4. Mechanical and Industrial Measurements R.K. Jain/ Khanna Publishers.
5. Mechanical Measurements / Sirohi and Radhakrishna / New Age.
6. Instrumentation & Mech. Measurements /A.K. Tayal /Galgotia Publications.

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AUTOMOBILE ENGINEERING (C35PE6A)
(Professional Elective-1)

Pre-requisite: Thermal Engineering – I.

Course Objectives: This course will enable students to:
1. Learn basics of automobiles, drives, engine lubrication systems, emissions and pollution aspects.
2. Understand the types and requirements of Cooling system, Functions and types of Ignition system
3. Understand the functioning of current-voltage regulator, bendix drive mechanism, lighting systems and Transmission system components.
4. Understand the construction and operational features of Steering system, Suspension system and Braking system.
5. Know different kinds of pollution standards.

Course Outcomes: On completion of the course, the students will be able to:
1. Apply the basic automobile concepts to Engine lubrication system, Crank case ventilation and Emission controls for Automobiles.
2. Analyze the working of various components of the automobile Electrical System and Transmission System
3. Analyze the working of Steering System, Suspension System and Braking system.
4. Apply the concept of automobile emissions and its effects on environment and apply the concepts of different systems like axle, differential, brakes, Steering system etc.
5. Develop suitable fuels to reduce the emissions.

UNIT – I:
Introduction: Layout of automobile, introduction chassis and body components. Types of Automobile engines. Power unit, Introduction to engine lubrication, engine servicing.
Fuel System: S.I. Engine: Fuel supply systems, Mechanical and electrical fuel pump, filters, carburetor, types, air filters, petrol injection. Introduction to MPFI and GDI Systems.
C.I. Engines: Requirements of diesel injection systems, types of injection systems, DI Systems IDI systems. Fuel pump, nozzle, spray formation, injection timing, testing of fuel pumps. Introduction CRDI and TDI Systems.

UNIT - II:
Cooling System: Cooling Requirements, Air Cooling, Liquid Cooling, Thermo, water and Forced Circulation System, Radiators, Types, Cooling Fan, water pump, thermostat, evaporative cooling, pressure sealed cooling, antifreeze solutions.

Ignition System: Function of an ignition system, battery ignition system, constructional features of storage, battery, auto transformer, contact breaker points, condenser and spark plug, Magneto coil ignition system, electronic ignition system using contact breaker, electronic ignition using contact triggers, spark advance and retard mechanism.
Electrical System: Charging circuit, generator, current, voltage regulator, starting system, bendix drive mechanism solenoid switch, lighting systems, Horn, wiper, fuel gauge, oil pressure gauge, engine temperature indicator etc.

UNIT - III:
Transmission System: Clutches, principle, types, cone clutch, single plate clutch, multi plate clutch, magnetic and centrifugal clutches, fluid fly wheel, gear boxes, types, sliding mesh, constant mesh, synchro mesh gear boxes, epicyclic gear box, over drive torque converter. Propeller shaft, Hotch, Kiss drive, Torque tube drive, universal joint, differential rear axles ,types ,wheels and tyres.
Suspension System: Objects of suspension systems, rigid axle suspension system, torsion bar, shock absorber, Independent suspension system.

UNIT - IV:
Braking System: Mechanical brake system, Hydraulic brake system, Master cylinder, wheel cylinder tandem master cylinder Requirement of brake fluid, Pneumatic and vacuum brakes.
Steering System: Steering geometry, camber, castor, king pin rake, combined angle toe in, center point steering. Types of steering mechanism, Ackerman steering mechanism, davis steering mechanism, steering gears – types, steering linkages.

UNIT - V:
Emissions from Automobiles, Pollution standards National and international, Pollution Control, Techniques, Multipoint fuel injection for SI Engines. Common rail diesel injection Energy alternatives, Solar, Photo-voltaic, hydrogen, Biomass, alcohols, LPG,CNG, liquid Fuels and gaseous fuels, Hydrogen as a fuel for IC Engines. Their merits and demerits. Standard Vehicle maintenance practice.
Introduction to Electrical Vehicles (EV), Components, Advantages of EV, types of EV, Hydride Electrical Vehicles (HEV), Plug-in Hydride Electrical Vehicles (PHEV), Battery Electrical Vehicles (BEV), Introduction to Driverless Cars, Components of Driverless Cars, types of sensor used in EV, Advantages and limitations.

Text Books:

1. Automobile Engineering / William H Crouse
2. A Text Book Automobile Engineering–Manzoor, Nawazish Mehdi &Yosuf Ali, Frontline Publications.

Reference Books:

1. A Text Book of Automobile Engineering by R K Rajput. Laxmi Publications.
2. Automotive Mechanics / Heitner
3. Automotive Engineering / Newton Steeds & Garrett
4. A Text Book of Automobile Engineering By Khalil U Siddiqui New Age International

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NON-DESTRUCTIVE TESTING AND VACUUM TECHNOLOGY (C35PE6B)
(Professional Elective-1)

Pre-requisite: Nil

Course Objectives: This course will enable students to:
1. Study various Non Destructive Testing and types of defects.
2. Know the basics of non-destructive techniques using ultrasonic interferometer.
3. Provide a basic level of understanding on Vacuum technology.
4. Understand the importance Pressure gauges.
5. Introduce the fundamental concepts vacuum pumps.

Course Outcomes: On completion of the course, the students will be able to:
1. Describe the Types of defects and analyze them.
2. Analyze the principles of NDT methods.
3. Analyze Vacuum technology and concepts of flow meters.
4. Develop pressure gauges.
5. Understand the concepts of different vacuum pumps.

Unit-I:
Introduction to Non-destructive testing: Introduction, Objectives of Non-destructive testing, Types of defects – Cracking, Spalling, Staining, Construction and Design defects, Honey combing, Dusting, Blistering, Rain damage.

Unit-II
Methods of Non-destructive Testing: Liquid penetration method, Dye penetration method, Ultrasonic Inspection method, Pulse Echo method, Radiographic testing Magnetic particle testing, Eddy current testing.

Unit-III
Introduction to Vacuum Technology: Definition of vacuum, Degrees of vacuum and their ranges; Review of Kinetic theory of gases; Definitions of particle flux, mono layer formation time, pressure; Elementary gas transport phenomena; Knudsen's and Reynolds' numbers; Throughput, mass flow and conductance.
Flow meters: Molar flow, Mass flow.

Unit-IV

Pressure gauges: Classification, Direct and indirect gauges, Indirect gauges – Pirani gauge, Thermocouple gauge, Ionization gauge, hot cathode gauge, Penning gauge. Advantages, limitations and applications of pressure gauges.

Unit-V

Vacuum Pumps: Introduction, Vacuum and its necessity, Gas flow in vacuum systems, Pumping speed and through put. Creation of Vacuum: Rotary vane pump, Roots blower pump, Diffusion pump, Ionization pump, Diaphragm pump, Adsorption pump, Turbo molecular pump.
Measurement of Vacuum: Pirani/Thermocouple gauge, Penning/Ionization Gauge (hot cathode and cold cathode), Capacitance gauge, Bourdon gauge, McLeod gauge.
Quality of vacuum: Residual gas analyzer, Leak detection. Material selection and vacuum chamber.
Application of Vacuum: Thin film deposition, Cryogenics, Industry

Text Books:

1. Engineering Physics‖, B K Pandey and S Chaturvedi, Cengage Learning India, Revised Edition, 2014.
2. A User‘s guide to Vacuum technology, John. F. O‘Hanlon, Wiley, 3rd Edition, 2003.

Reference Books:

1. Physics for Engineers‖, R Srinivasan, New Age international, 1st reprint, 2007.
2. Engineering Physics‖, R K Gaur and S L Gupta, Dhanpatrai, Reprint, 2006.
3. Hand Book of Thin film deposition‖, Krishna Seshan, Noyes, 2nd Edition, 2002

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ROBOTICS (C35PE6C)
(Professional Elective-1)

Pre-requisite: Engineering Mathematics, Instrumentation, CAD/CAM.

Course Objectives: This course will enable students to:
1. Be familiar with the features of automation in robotics. Learn about the various components of Industrial Robotics.
2. Be taught about the Kinematic Motion Analysis, Homogeneous transformation, Forward and inverse kinematics, and solution of relevant problems.
3. Be able to solve problems involving Differential Kinematics of planar and spherical manipulators, and Jacobians. Be made familiar Dynamic analysis of Robot motion and solution of problems on planar two link manipulators.
4. Study the features of Trajectory planning for avoidance of obstacles, and solution of problems on different types of motion.
5. Be made to learn about the Robot actuators and Feedback components. Learn the Application of Robots in manufacturing activities, such as Material handling, Assembly and Inspection

Course Outcomes: On completion of the course, the students will be able to:
1. Understand the design and working of the various components of Robot such as End effectors, grippers, control systems etc.
2. Perform calculations of Robot motion involving forward kinematics, inverse kinematics, Homogeneous transformations etc.
3. Apply Differential Kinematics, Jacobian, Lagrange-Euler formulations, etc., to solve problems of planar and spherical manipulators.
4. Analyze the various types of motion (skew motion, straight line motion, etc.,) for solving problems in Trajectory planning.
5. Apply the knowledge of various types of Robot actuators and Feedback components, and applications of industrial robots in the activities of manufacturing.

UNIT – I
Introduction: Automation and Robotics, CAD/CAM and Robotics – An over view of Robotics – present and future applications.
Components of the Industrial Robotics: common types of arms. Components, Architecture, number of degrees of freedom – Requirements and challenges of end effectors, Design of end effectors, Precision of Movement: Resolution, Accuracy and Repeatability, Speed of Response and Load Carrying Capacity.

UNIT – II

Motion Analysis: Basic Rotation Matrices, Equivalent Axis and Angle, Euler Angles, Composite Rotation Matrices. Homogeneous transformations as applicable to rotation and translation – problems. Manipulator Kinematics-H notation-H method of Assignment of frames-H Transformation Matrix, joint coordinates and world coordinates, Forward and inverse kinematics – problems on Industrial Robotic Manipulation.

UNIT – III

Differential transformation of manipulators, Jacobians – problems, Dynamics: Lagrange – Euler and Newton – Euler formations – Problems.

Trajectory planning and avoidance of obstacles, path planning, Skew motion, joint interpolated motion – straight line motion.

UNIT IV

Robot actuators and Feedback components:

Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors, comparison of Actuators, Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors, Tactile and Range sensors, Force and Torque sensors.

UNIT V

Robot Application in Manufacturing:

Material Transfer - Material handling, loading and unloading- Processing - spot and continuous arc welding and spray painting - Assembly and Inspection. Robotic Programming Methods – Languages: Lead through Programming, Textual Robotic Languages such as APT, MCL.

Text Books:

1. Industrial Robotics / Groover M P /Mc GrawHill
2. Introduction to Industrial Robotics / Ramachandran Nagarajan /Pearson

Reference Books:

1. Robot Dynamics and Controls / Spong and Vidyasagar / JohnWiley
2. Robot Analysis and control / Asada ,Slotine / Wiley Inter-Science
3. Robotics – Fu et al / TMH Publications

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MECHANICAL ENGINEERING-R20

B.Tech V Semester **L/T/P/C**
0 /0 /2 /1

THERMAL ENGINEERING LAB (C35PC7)

Pre-requisite: Thermodynamics, Thermal Engineering – I

Course Objectives: This course makes the students to understand

1. Working of different kinds of internal combustion Engines
2. Working of an Air Compressor unit
3. Different elements of an IC Engine
4. Working of a Stream Boiler
5. Working of Inlet and Exhaust Valves of an IC Engine

Course outcomes: At the end of the course, the student should be able to
1. Analyze the performance characteristics of an internal combustion engines.
2. Analyze the air compressor characteristics.
3. Examine various parts of an IC engine.
4. Illustrate the working of a Boiler.
5. Evaluate of engine friction by conducting morse test on 4-strokemulti cylinder petrol engine.

List of Experiments:

1. IC Engines Valve/Port Timing Diagrams
2. IC Engines PerformanceTestfor4StrokeSIengines
3. IC EnginesPerformanceTestfor2StrokeSIengines
4. IC Engines Morse, Retardation, Motoring Tests
5. IC Engine Heat Balance–CI/SI Engines.
6. IC Engines Economical speed Test on a SI engine.
7. IC Engines effect of A/F Ratio in a SI engine.
8. Performance Test on Variable Compression Ratio Engine.
9. IC engine Performance Test on a 4S CI Engine at constant speed.
10. Volumetric efficiency of Air –Compressor Unit
11. Dis-assembly/Assembly of Engines
12. Study of Boilers.

Note:
1. Performany10 out of the 12experiments.
2. Assignment -Allocate group wise problems to students related to boilers and engines.

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MECHANICAL ENGINEERING-R20

B.Tech V Semester **L/T/P/C**
0 /0/ 2/ 1

KINEMATICS AND DYNAMICS LAB (C35PC8)

Pre-requisite: Engineering Physics, Engineering Mechanics, Mechanics of Materials and Kinematics of Machines.

Course Objectives:
The objective of the lab is to understand the kinematics and dynamics of mechanical elements such as linkages, gears, cams and learn to design such elements to accomplish desired motions or tasks.

Course Outcomes: Upon successful completion of this lab, students should be able to:
1. Analyze forces and torques of components in linkages
2. Apply the concept of static and dynamic balance
3. Analyze forward and inverse kinematics of open-loop mechanisms
4. Apply vector mechanics as a tool for solving kinematic problems.
5. Create a schematic drawing of a real-world mechanism.

List of Experiments:

1. To determine the state of balance of machines for primary and secondary forces
2. To determine the frequency of torsional vibration of a given rod
3. Determine the effect of varying mass on the centre of sleeve in porter and proel governor
4. Find the motion of the follower if the given profile of the cam
5. The balance masses statically and dynamically for single rotating mass systems
6. Determine the critical speed of a given shaft for different n-conditions
7. For a simple pendulum determine time period and its natural frequency
8. For a compound pendulum determine time period and its natural frequency
9. Determine the effect of gyroscope for different motions
10. Determine time period, amplitude and frequency of undamped free longitudinal vibration of single degree spring mass systems.
11. Determine the pressure distribution of lubricating oil at various load and speed of a Journal bearing.
12. Determine time period, amplitude and frequency of damped free longitudinal vibration of single degree spring mass systems

Note: Perform any10 out of the 12 experiments.

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MECHANICAL ENGINEERING
Course Structure R-20

B.Tech VI Semester **L/T/P/C**
3 /0/ 0/ 3

B.Tech VI SEMESTER

S.No.	Class	Course Code	Name of the Subject	L	T	P	C
1	PC	C36PC1	Design of Machine Members-II	3	0	0	3
2	PC	C36PC2	Heat Transfer	3	0	0	3
3	PC	C36PC3	Machine Tools and Metrology	3	0	0	3
4	PE	C36PE4A C36PE4B C36PE4C	**Professional Elective-2** Plant Maintenance & Reliability Engineering Mechatronics Refrigeration and Air-Conditioning	3	0	0	3
5	PE	C36PE5A C36PE5B C36PE5C	**Professional Elective-3** Total Quality Management Non Traditional Machining Processes Fracture Mechanics	3	0	0	3
6	OE	C36OE6	**Open Elective-1**	3	0	0	3
7	PC	C36PC7	Machine Tools and Metrology Lab	0	0	2	1
8	HS	CHSE3	Advanced English Communications Skill Lab	0	0	2	2
9	PC	C36PC8	Heat Transfer Lab	0	0	2	1
10	MC	MC06	Personality /Skill Development / Technical events /Internship	0	0	0	0
Total							**22**

Mandatory Course: The satisfactory report should be submitted either for 1 or 2 or 3 given below.

1. Personality /Skill Development: Student should participate in personality development /Communication skills programme, student should submit the completion certificate for clearing this course.

2. Technical Events: The student should participate in any technical event organized by the College/Organization/Industry and submit the participation certificate for clearing this course.

3. Internship: The Student should submit the completion certificate from the respective organization. Where he/she performs their internship.

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MECHANICAL ENGINEERING-R20

B.Tech VI Semester **L/T/P/C**
3 /0/ 0/ 3

DESIGN OF MACHINE MEMBERS – II (C36PC1)

Note: Design data hand book is permitted

Pre-requisite: Engineering Physics, Engineering Mechanics, Mechanics of Solids, Design of Machine Members-I

Course Objectives: This course will enable students to:
1. Understand the design procedures for complete machine members under dynamic conditions by utilizing the concepts of strength of materials mathematical equations and design data handbooks.
2. Understand the design criteria for sliding contact and rolling contact bearings.
3. Understand the design criteria for various parts of IC engines like piston and connecting rod.
4. Understand the design criteria for mechanical power transmission elements viz pulleys, belts, chains, ropes and springs.
5. Understand the design criteria for Precision power transmission components viz spur gears, helical gears, bevel gears, worm gears and power screws.

Course Outcomes: On completion of the course, the students will be able to:
1. Design various mechanical elements to arrive at dimensional geometry for a given loading systems and for its effective functional criteria.
2. Analyze various types of journal bearings, ball bearings and roller bearings under dynamic conditions.
3. Design various parts of IC engines under the influence of dynamic and inertia forces.
4. Apply Power Transmission Systems associated with use of belts, chains, ropes and springs.
5. Examine critical components of Power Transmission Systems under severe conditions for dynamic forces, wear theories and heavy loading systems.

UNIT– I:
Sliding Contact Bearings: Types of Journal bearings – Lubrication – Bearing Modulus – Full and partial bearings – Clearance ratio – Heat dissipation of bearings, bearing materials –journal bearing design.
Rolling Contact Bearings: Ball and roller bearings – Static load – dynamic load – equivalent radial load– design and selection of ball & roller bearings.

UNIT– II:

Engine Parts: Connecting Rod: Thrust in connecting rod – stress due to whipping action on connecting rod ends –Pistons, Forces acting on piston – Construction, Design and proportions of piston.

UNIT– III:

Mechanical Springs: Stresses and deflections of helical springs – Extension and Compression springs – Design of springs for fatigue loading – natural frequency of helical springs – Energy storage capacity – helical torsion springs – Design of co-axial springs, Design of leaf springs.

UNIT–IV:

Belts, Pulleys and Chain drives: Transmission of power by Belt and Rope ways, Transmission efficiencies, Belts–Flat and V types–Ropes –pulleys for belt and rope drives, Types of chain drives-Materials-Applications-Advantages-Power transmission and Design of chain drive.

UNIT–V:

Gears: Spur gears and Helical gears – Brief introduction involving important concepts–Design of gears using AGMA procedure involving Lewis and Buckingham equations, Check for wear.

Text Books:

1. Machine design / R.S.Kurmi and J.K Gupta / S.Chand Publications
2. Design of Machine Elements/Spotts /Pearson
3. Machine tool design/ V.Bhandari/McGrawHill

Reference Books:

1. Design of Machine Elements-II/Annaiah/New Age
2. Design of Machine Elements/Sharma and Purohit/PHI

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MECHANICAL ENGINEERING-R20

B.Tech VI Semester **L/T/P/C**
3 /0/ 0/ 3

HEAT TRANSFER (C36PC2)

Pre-requisite: Differential Equations, Thermodynamics, Fluid Mechanics.

Course Objectives: This course will enable students to:
1. Identify the important Heat Transfer modes in any physical system and conduction equation in different coordinates.
2. Know the difference of one-dimensional steady state conduction heat transfer and one-dimensional transient conduction heat transfer.
3. Impart the concept of convective heat transfer with dimensional analysis and concept of forced convection
4. Gain knowledge on free convection heat transfer, condensation and heat exchangers.
5. Understand the concept of radiation heat transfer and importance of shape factor.

Course Outcomes: On completion of the course, the students will be able to:
1. Understand basic modes of heat transfer and compute problems in steady state and unsteady state heat conduction.
2. Explain steady and transient heat conduction in one dimension.
3. Interpret and analyze free and forced convection heat transfer, flow regimes of boiling and condensation
4. Analyze the importance of free convection heat transfer with phase change and LMTD and NTU methods to design heat exchangers.
5. Determine the principles of radiation heat transfer and shape factor.

UNIT – I:
Introduction: Modes and mechanisms of heat transfer – Basic laws of heat transfer – General discussion about applications of heat transfer.
Conduction Heat Transfer: Fourier rate equation – General heat conduction equation in Cartesian, Cylindrical and Spherical coordinates – simplification and forms of the field equation – steady, unsteady, and periodic heat transfer – Initial and boundary conditions
One Dimensional Steady State Conduction Heat Transfer: Homogeneous slabs, hollow cylinders, and spheres- Composite systems– overall heat transfer coefficient – Electrical analogy – Critical radius of insulation

UNIT – II:
One Dimensional Steady State Conduction Heat Transfer: Variable Thermal conductivity - systems with heat sources or Heat generation-Extended surface (fins) Heat Transfer – Long Fin, Fin with insulated tip and Short Fin, Application to error measurement of Temperature

One Dimensional Transient Conduction Heat Transfer: Systems with negligible internal resistance – Significance of Biot and Fourier Numbers –Infinite bodies- Chart solutions of transient conduction systems

UNIT – III:

Convective Heat Transfer: Classification of systems based on causation of flow, condition of flow, configuration of flow and medium of flow – Dimensional analysis as a tool for experimental investigation– Buckingham Theorem and method, application for developing semi–empirical non-dimensional correlation for convection heat transfer–Significance of non-dimensional numbers

Forced convection: External Flows: Concepts about hydrodynamic and thermal boundary layer and use of empirical correlations for convective heat transfer -Flat plates and Cylinders.

UNIT – IV:

Internal Flows: Concepts about Hydrodynamic and Thermal Entry Lengths – Division of internal flow based on this –Use of empirical relations for Horizontal Pipe Flow and annulus flow.

Free Convection: Development of Hydrodynamic and thermal boundary layer along a vertical plate - Use of empirical relations for Vertical plates and pipes.

Heat Exchangers: Classification of heat exchangers – overall heat transfer Coefficient and fouling factor– Concepts of LMTD and NTU methods - Problems using LMTD and NTU methods.

UNIT – V:

Heat Transfer with Phase Change: Boiling: – Pool boiling – Regimes – Calculations on Nucleate boiling, Critical Heat flux and Film boiling. Condensation: Film wise and drop wise condensation – Nusselt's Theory of Condensation on a vertical plate - Film condensation on vertical and horizontal cylinders using empirical correlations.

Radiation Heat Transfer: Emission characteristics and laws of black-body radiation – Irradiation – total and monochromatic quantities – laws of Planck, Wien, Kirchoff, Lambert, Stefan and Boltzmann– heat exchange between two black bodies – concepts of shape factor – Emissivity – heat exchange between grey bodies – radiation shields – electrical analogy for radiation networks.

Text Books:

1. Heat and Mass Transfer – Dixit /Mc Graw Hill
2. Heat and Mass Transfer / Altamush Siddiqui/Cengage
3. A Bejan, Heat Transfer John Wiley, 1993

Reference Books:

1. Essential Heat Transfer - Christopher A Long /Pearson
2. Heat Transfer – Ghoshdastida /Oxford
3. Yunus A Cengel, Heat Transfer: A Practical Approach, McGraw Hill, 2002

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MECHANICAL ENGINEERING-R20

B.Tech VI Semester **L/T/P/C**
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MACHINE TOOLS AND METROLOGY (C36PC3)

Pre-requisite: Engineering Physics, Kinematics of Machinery, Manufacturing Process.

Course Objectives: This course will enable students to:
1. Learn the fundamental principles of metal removal processes performed on machine tools and get to know about the elements of cutting process.
2. To understand the tool interface characteristics for evaluating effect of temperature – heat on tool wear and surface condition of the material.
3. Gain knowledge on the constructional and working features of machine tools such as Lathe, Drilling, Boring and shaping.
4. Understand the concept of Limits, fits and tolerances and learn to use the Limit Gauges, Sine bar etc.
5. Learn the methods of Measurement of flat surfaces, and Surface Roughness Measurement.

Course Outcomes: On completion of the course, the students will be able to:
1. Apply the techniques to minimize the errors in measurement.
2. Analyze the methods and devices for measurement of length, angle, gear & thread parameters, surface roughness and geometric features of parts.
3. Analyze the working of lathe, shaper, planer, drilling, milling and grinding machines.
4. Examine speed and feed mechanisms of machine tools.
5. Estimate machining times for machining operations on machine tools

UNIT - I:
Elementary treatment of metal cutting theory - Element of cutting process - Geometry of single point tool and angles chip formation and types of chips, Mechanics of orthogonal cutting - Merchant's Force diagram. Engine lathe: work and tool holding devices, Lathe attachments. Turret and capstan lathe. Classification: Single spindle and multi-spindle automatic lathes - tool layouts.

UNIT - II:
Kinematic scheme of shaping, slotting and planning machines, Drilling and Boring Machines - Principles of working, specifications, types, operations performed - tool holding devices - twist drill - Boring machines - Fine boring machines - Jig boring machine. Deep hole drilling machine. Kinematics scheme of the drilling and boring machines

UNIT - III:

Milling Machine: Principles of working - specifications - classifications of milling machines. Principal features of horizontal, vertical and universal milling machines - machining operations Geometry of milling cutters - methods of indexing.

Finishing Processes: Grinding - fundamentals - theory of grinding - classification of grinding machines - cylindrical and surface grinding machine - Tool and cutter grinding machine, Different types of abrasives - bonds

UNIT - IV:

Systems of Limits and Fits: Introduction, normal size, tolerance limits, deviations, allowance, fits and their types - unilateral and bilateral tolerance system, hole and shaft basis systems.

Linear Measurement: Length standard: line and end standard, slip gauges - calibration of slip gauges, Dial indicator, micrometers.

Measurement of Angles and Tapers: Different methods - Bevel protractor - angle slip gauges - spirit levels - single bar - Sine plate used to determine the tappers.

Limit Gauges: Taylor's principles GO and NO GO gauge, plug, ring, snap, taper, profile and position gauges.

UNIT - V:

Optical Measuring Instruments: Tool maker's microscope and its uses - collimators, optical projector - optical flats and their use; straight edges, surface plates, optical flat and auto collimator.

Surface Roughness Measurement: Difference between surface roughness and surface waviness Mechanical Comparators, Electrical and Electronic Comparators.

Screw Thread Measurement: Element of measurement - errors in screw threads - measurement of effective diameter, angle of thread and thread pitch, profile thread gauges. Alignment tests on lathe, milling, drilling machine tools, Gear measuring instruments and gear tooth profile measurement.

Text Books:

1. Engineering Metrology / R. K. Jain / Khanna Publishers
2. Engineering Metrology / I C Gupta / DhanpathRai
3. Production Technology / HMT / Tata Mc GrawHill.
4. Production Technology / R. K. Jain and S. C. Gupta / Khanna Pulishers

Reference Books:

1. Dimensional Metrology / Connie Dotson / Thomson 4thEdition.
2. BIS Standards on Limits & Fits, Surface Finish, Machine Tool Alignmentetc.
3. Fundamentals of Dimensional Metrology / Connie Dotson / Thomson / 4thEdition.
4. Principles of Engineering Metrology / Rega Rajendra / Jaico Publications.
5. Workshop Technology - Vol. - II / B. S.Raghuvamsi.
6. Elements of Work Shop Technology - Vol. II / HajraChoudary / MediaPromoters.

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MECHANICAL ENGINEERING-R20

B.Tech VI Semester **L/T/P/C**
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PLANT MAINTENANCE AND RELIABILITY ENGINEERING (C36PE4A)
(Professional Elective-2)

Pre-requisite: Nil

Pre-requisite: Engineering Physics, Engineering Mechanics, Mechanics of Solids, Design of Machine Members-I

Course Objectives: This course will enable students to:
1. Understand the approaches and techniques to assess and improve process and/or product quality and reliability.
2. Know good facility planning and plant layout.
3. Understand the condition monitoring and diagnostic maintenance.
4. Identification of the problem and data collection and procedure for reliability.
5. Understand the basic concepts and techniques of modern reliability engineering tools.

Course Outcomes: On completion of the course, the students will be able to:
1. Evaluate the basic techniques of quality improvement, fundamental knowledge of statistics and probability.
2. Use control charts to analyze for improving the process quality
3. Examine the principles of condition based maintenance.
4. Analyze reliability maintenance system and evaluation.
5. Adapt safety education and training.

Unit-I

Quality: Conceptual Framework: Introduction, Awareness on Maintenance and Plant Engineering and Maintenance, Objective of Maintenance and Plant Engineering, State of Plant, Function and Responsibilities of Plant Engineering, Physical Assets Management or Total Productive Maintenance or Tero-techonology.

Maintenance Planning: Introduction, Planning Function in Maintenance, Organizing Plant Engineering and Maintenance, Staffing in Plant Engineering, Directing in Plant Engineering, Co-ordination by Plant Engineering and Management, Plant Engineering and Management as Integrating Function.

Maintenance Strategies: Introduction, Maintenance Strategies, Failure Based Maintenance, Contractual Maintenance, Reliability-centered Maintenance, Time Based Management, Conduction-based Monitoring, Total Productive Maintenance, Factors Influence the Selection of Maintenance Policy/strategy, Maintenance Strategy, Hurdle in Formulation Maintenance

Strategy, Maintenance Procedure and their Selection, Characteristics of Maintenance Strategy, Top Down and Bottom-Up Approach.

Unit-II

Facility Planning and Plant Layout: Introduction, Objective of Good Facility Planning, Principles of Facility Layout, Facility Location Study, Facilities Governing Selection of Location, Steps in Facility Location Study, Quantitative and Semi-Quantitative Techniques for Facility Location Planning, Quantitative Models for Facility Location Planning, Plant Layout, Flow Patterns to Facilities Assembly Lines.

Failure Mode, Effect and Criticality Analysis: Introduction, FMEA/FMECA- Outline, Jargon, Elements, Basic Information, Analysis Procedure, Environmental Influences, FMECA Planning, Block Diagrams, Severity Classifications, Application of Statistical Process Control (SPC) in FMEA/FMECA, Failure Models by FMECA, Process FMEA, Design FMEA, Application and Merits of FMEA/FMECA.

Unit-III

Diagnostic Maintenance: Introduction, Philosophies of Maintenance, Significance of Condition-based Maintenance, Approaches to Condition- based Maintenance, Fault Diagnosis and Diagnostic Maintenance, Destructive Tests, Non-destructive Tests, LEO Approach.

Condition Monitoring: Introduction, Principles of Condition-based Maintenance, Four Steps to Dynamic Predictive Maintenance, Setting up a Condition Monitoring Activity, Implementation of Condition-based Maintenance, Design of Maintenance Information, Techniques of Condition Monitoring, Advantages of Condition Monitoring over Other Philosophies.

Trend Analysis: Introduction, Failure Patterns, Machine Life Cycle- Bathtub Curve, Types of Failure based on Volume of Failure, Types of Failure based on Mode of Failure, Repairable and Non-repairable Systems, Trend, Methods of Trend Analysis, Test for Presence of Correlation.

Unit-IV

Reliability Oriented Maintenance Models: Introduction, Identification of the problem and Data Collection, Procedure for Reliability - centered Maintenance Modeling and Analysis, Statistical Preliminaries in Reliability Evaluation, Probability Functions, Statistical Distribution in Reliability Studies, Trend Test, Graphical Evaluation of Non-homogeneous Passion Process (NHPP) parameters, Methods of Total Time on Test(TTT) Plotting, TTT Transforms, TTT Plots, Failure Distribution and Goodness of Fits, Identification Candidate Distribution, Goodness of Fit Test, Weibull Plots, Design of Reliability.

Reliability Oriented Maintenance System and Evaluation: Introduction, Reliability Improvement, Reliability Systems, Modular Design, Distinction between Quality and Reliability, Definitions and terms used in Reliability Calculation, Availability, Maintainability, Overall Equipment Effectiveness.

Unit-V

Total Productive Maintenance and KAIZEN: Introduction, TPM Environment, Relationship between TPM, Tero-technology, and physical Assets Management, TPM-Overview, Concept, Eight Pillars, Template, Barriers to Implement TPM, Comparison between TPM and TQM, Zero Breakdown, Kaizen- types of kaizen, expected contribution by kaizen, Total Maintenance Planning.

Industrial Safety: Safety Management, Safety Education and Training, Accidents, Efforts by Government, Provisions Under Factories Act, 1948, Electricity Rules, Provisions Under Workmen's Compensation Act.

Text Books:

1. N.V.S Raju, "Plant Maintenance and Reliability Engineering", Cengage Learning India Pvt Ltd, 2011.
2. Clifton R H, "Principles of Planned Maintenance", McGraw Hill, Newyork,2001

Reference Books:

1. Ebling CE, "An introduction to Reliability and Maintainability Engineering" Tata Mc Graw Hill, Delhi, 2004.
2. Srinath L S "Reliability Engineering", Affiliated East-West Press Limited, New Delhi, 2002.
3. Dhillon B S, "Engineering Maintainability", Prentice Hall of India, New Delhi, 2000.
4. Wireman Terry, "Preventive Maintenance", Reston Publishing Company, Reston Virginia, 1998.

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MECHANICAL ENGINEERING-R20

B.Tech VI Semester **L/T/P/C**
3 /0/ 0/ 3

MECHATRONICS (C36PE4B)
(Professional Elective-2)

Pre-requisite: Engineering Physics, Electronics Engineering.

Course Objectives: This course will enable students to:
1. Understand the basic mechatronic systems, elements, levels of mechatronic system, design processes and advantages of disadvantages of mechatronic systems.
2. Learn precision mechanical systems and electronic interface systems like TTL and CMOS interfacing.
3. Study mechanical actuating systems, electrical actuating systems, hydraulic and pneumatic actuating systems.
4. Learn the programmable logic controllers, data handling devices and applications of programmable logic controllers.
5. Gain the knowledge on programmable motion controllers and different types of feedback devices

Course Outcomes: On completion of the course, the students will be able to:
1. Understand the basic concept of mechatronics, advantages and disadvantages of mechatronics systems.
2. Explain precision mechanical systems, electronic interface subsystems like TTL, CMOS interfacing, sensor interfacing and actuator interfacing.
3. Analyze different actuator systems and their interconnection for a given applications.
4. Explain programmable logic controllers, internal relays and counters and applications of PLC.
5. Evaluate the performance of programmable motion controllers and various feedback devices.

Unit-I
Mechatronics systems, elements, levels of Mechatronics system, Mechatronics design process, system, measurement systems, and control Systems, microprocessor-based controllers, advantages and disadvantages of Mechatronics systems. Sensors and transducers, types, displacement, Position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, Liquid flow, liquid level, temperature and light sensors.

Unit-II
Precision Mechanical Systems: Modern CNC Machines – Design aspects in Machine structures, guide ways, feed drives, spindle and spindle bearings, measuring systems, control software and operator interface, gauging and tool monitoring.
Electronic Interface Subsystems: TTL, CMOS interfacing - Sensor interfacing – Actuator interfacing – solenoids, motors Isolation schemes- opto coupling, buffer IC's.

Unit-III

Hydraulic and pneumatic actuating systems, Fluid systems, Hydraulic and Pneumatic systems, components, control valves, electro-pneumatic, hydro pneumatic, Electro-hydraulic servo systems: Mechanical actuating systems and electrical actuating systems.

Unit-IV

Programmable Logic Controllers: Basic Structure - Programming : Ladder diagram -Timers, Internal Relays and Counters - Shift Registers - Master and Jump Controls - Data Handling - Analog input / output - PLC Selection - Application.

Unit-V

Programmable Motion Controllers : Introduction - System Transfer Function – Laplace transform and its application in analyzing differential equation of a control system - Feedback Devices : Position , Velocity Sensors - Optical Incremental encoders - Proximity Sensors : Inductive , Capacitive , Infrared - Continuous and discrete processes - Control System Performance & tuning - Digital Controllers - P , PI , PID Control - Control modes – Position , Velocity and Torque - Velocity Profiles – Trapezoidal- S. Curve.

Text Books:

1. William Bolton, Mechatronics: Electronic control systems in mechanical and electrical engineering, 6/e, Pearson Education.
2. HMT Ltd, ―Mechatronics‖, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1998.
3. Michaels Histand& David G, Alciatore, ―Introduction to Mechatronics and Measurement
4. Systems‖, Tata McGraw- Hill, International Edition, 2011.
5. MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran & GK Vijaya Raghavan/WILEY India Edition/2008
6. Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering/ W Bolton/ Pearson Education Press/3rd edition, 2005.

Reference Books:

1. Mechatronics Source Book by Newton C Braga, Thomson Publications, Chennai.
2. Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
3. Mechatronics System Design / Devdasshetty/Richard/Thomson.
4. Mechatronics/M.D.Singh/J.G.Joshi/PHI.
5. Mechatronics – Electronic Control Systems in Mechanical andElectricalEngg. 4th Edition, Pearson, 2012 W. Bolton
6. Mechatronics – Principles and Application Godfrey C. Onwubolu,Elsevier, 2006 Indian print

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MECHANICAL ENGINEERING-R20

B.Tech VI Semester **L/T/P/C**
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REFRIGERATION AND AIR CONDITIONING (C36PE4C)
(Professional Elective-2)

Pre-requisite: Engineering Physics, Thermodynamics
Course Objectives: This course will enable students to:
1. Learn the working of basic refrigeration cycles with applications and air refrigeration systems.
2. Analyze the working principle and performance of VCR system along with classification of refrigerants
3. Impart the working principles of VAR system, Steam jet refrigeration system and compute problems
4. Learn different parts of air conditioning system and to understand the requirements of human comfort.
5. Gain knowledge on different kinds of air conditioning systems.

Course Outcomes: On completion of the course, the students will be able to:
1. Develop understanding of the principles and practice of thermal comfort.
2. Develop generalized psychometrics of moist air and apply to HVAC processes.
3. Review thermodynamics and thermal systems engineering and develop understanding of vapor compression and possibly heat-driven refrigeration systems and evaporative cooling systems.
4. Calculate cooling load for air conditioning systems used for various
5. Analyze the refrigeration and air conditioning systems.

Unit-I
Introduction to Refrigeration, Necessity, Methods of refrigeration, Unit of refrigeration; Coefficient of performance (COP), Refrigerants- Classification, Nomenclature, Desirable properties, Comparative study, secondary refrigerants, Introduction to eco-friendly Refrigerants.
Air Refrigeration Systems: Reversed Carnot refrigeration cycle. Temperature Limitations, Bell Coleman air refrigeration cycle, Necessity of cooling the aeroplane, Aircraft refrigeration systems, simple cooling and Simple evaporative types, Regenerative type and Reduced Ambient type system, Comparison of different systems.

Unit-II
Vapour Compression (VC) Refrigeration Systems: (A) Simple Vapour Compression (VC)Refrigeration systems- Limitations of Reversed Carnot cycle with vapour as the refrigerant; Analysis of VC cycle considering degrees of sub cooling and superheating; VC cycle on P-V, T-Sand P-H diagrams; Effects of operating conditions on COP.

Unit-III

Vapour Absorption Refrigeration Systems: Vapour Absorption Refrigeration Systems – Basic Systems, Actual COP of the System, Relative merits and demerits, Properties of aqua ammonia; Electrolux Refrigeration. Steam Jet Refrigerating System- Introduction, Analysis, Relative merits and demerits.

Unit-IV

Psychrometry and Air Conditioning Processes: Properties of Air-water vapour mixture-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Wet bulb temp, Psychometric chart, Psychometric of air-conditioning processes, Basic processes in conditioning of air; Psychometric processes in air washer- Problems Air-Conditioning Load Calculations: Outside and inside design conditions;

Unit-V

Air Conditioning Systems with Controls and Accessories: Classifications, Layout of plants; Equipment selection; Air distribution system; Duct systems Design; Filters; Refrigerant piping; Design of summer air-conditioning and Winter air conditioning systems; Temperature sensors, Pressure sensors, Humidity sensors, Actuators, Safety controls; Accessories.

Text Books:

1. A course in Refrigeration & Air Conditioning – Arora & Domkundwar, Dhanpat Rai &sons.
2. Refrigeration & Air conditioning –C.P. Arora, TMH, New Delhi.

Reference Books:

1. Refrigeration & Air conditioning –R.C. Jordan and G.B. Priester, Prentice Hall of India Refrigeration & Air conditioning –W.F. Stocker and J.W. Jones, TMH, New Delhi.
2. Refrigeration & Air conditioning- Manohar Prasad Wiley Estern limited, New Delhi.
3. Refrigeration & Air conditioning by R.S.Khurmi.
4. Data book: Refrigeration and Psychrometric Properties (charts and tables) by C PC Kothandaraman

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MECHANICAL ENGINEERING-R20

B.Tech VI Semester **L/T/P/C**
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TOTAL QUALITY MANAGEMENT (C36PE5A)
(Professional Elective-3)

Pre-requisite: Nil

Course Objectives: This course will enable students to:
1. Understand the quality, accuracy and precision.
2. Know the factors affecting the selection of sampling inspection.
3. Understand the importance of SQC and six sigma methodology.
4. Understand the TQM strategy optimization principles.
5. Understand benchmarking approach and quality standards.

Course Outcomes: On completion of the course, the students will be able to:
1. Analyze the fundamental principles of Total Quality Management.
2. Choose appropriate statistical techniques for improving processes.
3. Analyze design of experiments techniques.
4. Develop research skills that will allow them to keep abreast of changes in the field of Total Quality Management.
5. Evaluate TQM strategies and environmental management system.

Unit-I

Quality: Conceptual Framework: Introduction, Basic Terminology Related to Quality, Accuracy and Precession, Dimensions of Quality, Methods and Generating Ideas for Quality Improvement, Inspection, Systems of Quality Control, Objectives of Quality Control, Quality in Service Organizations.

Quality Gurus and Their Contributions: Introduction, History and Development, Walter Andrew Shewhart, Joseph Moses Juran, Kaoru Ishikawa, Walter Edwards Deming, Armand Vallian Feigenbaum, Philip B. Crosby, Shigeo Shingo, Genichi Taguchi, Taiichi Ohno, Claus Moller, Malcolm Baldrige National Quality Award.

Unit-II

Acceptance Sampling: Introduction, Situations Warranting Sampling Inspection, Desirable Characteristics of Sample, Merits of Sampling Inspection Method, Methods for selection of a sample for Sampling Inspection, Factors Affecting the selection of Sampling Inspection, Sampling Plans, Methods of Acceptance Sampling, Operating Characteristic Curves.

Statistical Quality control and Statistical Process Control: Introduction, Objective and Uses of SQC Charts, Statistical Quality Control, Variables and Attributes, Statistical Process Control, Process Capability, Seven tools of SQC, Control Charts, Terminology and Their Distinctions.

Unit-III

Cost of Quality: Introduction, Cost of Quality, Classification of Quality Related Costs, Quality-Cost Analysis, Eliminate Total Quality Costs, Quality-Cost Trade-off, CoQ: An old concept, New thinking, ISO 9000 and cost of Quality, Controlling COPQ. Six-Sigma: The Quality-Improvement Program: Introduction, Evolution of Six-Sigma, Six-Sigma Vs Process Capability, Six-Sigma Methodology, Design of Six-Sigma (DFSS)-DMADV, Merits and Limitations of Six-Sigma, Six-Sigma Participants and Hierarchy, Six-Sigma Vs TQM, Six-Sigma Vs Zero Defects.

Unit-IV

Customer Satisfaction: TQM Strategy: Introduction, customer is Quality-Definition, Total Quality-view through customer Eye, Best Practices of TQM For customer satisfaction, customer satisfaction, customer satisfaction measurement, measurement models, customer perception of quality, quality of service, quality assurance, quality audit, audit procedure, quality survey, produce audit, Recognition of Quality Effects. Taguchi Approach to TQM: Introduction, Quality Loss Function, Quality Robustness, Design of Experiments, Orthogonal Arrays, Inner Arrays and Outer Arrays, Noise, Steps Involved in Implementation of Taguchi's Experimental Design, Assessment on Taguchi's Ideas.

Unit-V

Bench Marking: Introduction, concept, History, and Evolution of Benchmarking, Types of Benchmarking, Cots of Benchmarking, Roles of Top Management in Benchmarking Process, Benchmarking Approach: Methodology, Phases in Benchmarking, merits and Demerits of Benchmarking process. Quality standards, Certification, and Awards: Introduction, ISO 9000: Quality Management System, Management System Standards, ISO 14000: Environmental Management System, Other Important IS/ISO Standards/Systems, Standards, Quality awards.

Text Books:

1. Total Quality Management/N.V.S.Raju/Cengage Learning India Pvt.Ltd.
2. Total Quality Management / Joel E. Ross/Taylor and Franscis Limited
3. Total Quality Management/P. N. Mukherjee/PHI

Reference Books:

1. Total Quality Management:A Practical Approach/H. Lal
2. Quality Management/Kanishka Bedi/Oxford University Press/2011
3. Total Engineering Quality Management/Sunil Sharma/Macmillan
4. Beyond TQM / Robert L.Flood
5. Statistical Quality Control / E.L. Grant.

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NON TRADITIONAL MACHINING PROCESSES (C36PE5B)
(Professional Elective-3)

Pre-requisite: Manufacturing Process, Machine Tools.

Course Objectives: This course will enable students to:
1. Learn the traditional manufacturing methods and recent developments in ultrasonic machining process.
2. Know about the knowledge of chemical and electro-chemical process.
3. Learn fundamentals in thermal metal removal processes.
4. Understand the basic principle of electron beam machining and laser beam machining processes.
5. Know the importance of advanced machining methods.

Course Outcomes: On completion of the course, the students will be able to:
1. Analyze different nontraditional machining process and select the appropriate process for the given component.
2. Evaluate the performance of various nontraditional machines.
3. Distinguish different types of nontraditional machining process based on their characteristics.
4. Apply suitable nontraditional machining process to produce components of complex shapes.
5. Analyze metal removal rates and process parameters of different types of nontraditional machines.

Unit-I

Introduction and Ultrasonic Machining: Need for non-traditional machining methods – Classification of modern machining processes – considerations in process selection – Materials - Applications.

Ultrasonic machining: Elements of the process, mechanics of metal removal process parameters, economic considerations, applications and limitations, recent development.

Unit-II

Abrasive Jet, Water Jet and Abrasive Water Jet Machining and Electro Chemical Processes: Basic principles, equipments, process variables, and mechanics of metal removal, MRR, application and limitations.

Electro–Chemical Processes: Fundamentals of electro chemical machining, electro chemical grinding, electro chemical honing and deburring process, metal removal rate in ECM, Tool design, and Surface finish and accuracy economic aspects of ECM – Simple problems for estimation of metal removal rate. Fundamentals of chemical machining, advantages and applications.

Unit-III

Thermal Metal Removal Processes: General Principle and applications of Electric Discharge Machining, Electric Discharge Grinding and Electric Discharge Wire Cutting processes–Power circuits for EDM, Mechanics of metal removal in EDM, Process parameters, selection of tool electrode and dielectric fluids, methods surface finish and machining accuracy, characteristics of spark eroded surface and machine tool selection. Wire EDM, principle, applications.

Unit-IV

Electron Beam Machining and Laser Beam Machining, Generation and control of electron beam for machining, theory of electron beam machining, comparison of thermal and non-thermal processes–General Principle and application of laser beam machining– thermal features, cutting speed and accuracy of cut.

Unit-V

Advanced Machining Methods, Application of plasma for machining, metal removing mechanism, process parameters, accuracy and surface finish and other applications of plasma in manufacturing industries. Fundamentals of Chemical machining– principle- maskants– etchants – advantages and applications. Magnetic abrasive finishing, Abrasive flow finishing, Electro stream drilling, shaped tube electrolyte machining.

Note: Assign practical oriented problems to students by forming groups.

Text Books:

1. Advanced Machining Processes/ V K Jain /Allied publishers-2010.
2. Modern Machining Processes -P.C.Pandey, H. S.Shan / TMH Publishers-2012.

Reference Books:

1. Manufacturing Engineering and Technology/SeropeKalpakjain / Pearson Publications-2002. Production Technology / HMT / Tata McGraw-Hill Education-2006.
2. Unconventional Manufacturing Processes / M.K Singh / New Age International Publishers- 2007
3. Understand advanced machining methods and its applications.

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FRACTURE MECHANICS (C36PE5C)
(Professional Elective-3)

Pre-requisite: Metallurgy and Material Science and Mechanics of Solids.

Course Objectives: This course will enable students to:
1. Examine the concept of failure in members with pre-existing flaws
2. Understand the Griffith's analysis and linear elastic fracture mechanics.
3. Apply fracture mechanics theory and to calculate stress areas and energy release rate.
4. Gain the knowledge on crack tips and crack growth due to fatigue.
5. Understand creep performance under different conditions.

Course Outcomes: On completion of the course, the students will be able to:
1. Apply the knowledge of fracture mechanics to predict the ductile and brittle fracture.
2. Evaluate the crack resistance and energy release rate for crack criticality.
3. Analyze the alternate failure prediction parameters.
4. Investigate fatigue failure and micro mechanism of fatigue damage.
5. Analyze the comparison of creep performance under different conditions and creep fatigue interactions.

UNIT-I
Introduction: Prediction of mechanical failure. Macroscopic failure modes; brittle and ductile behavior. Fracture in brittle and ductile materials – characteristics of fracture surfaces; inter-granular and intra-granular failure, cleavage and micro-ductility, growth of fatigue cracks, the ductile/brittle fracture transition temperature for notched and un notched components. Fracture at elevated temperature.

UNIT-II
Griffiths analysis: Concept of energy release rate, G, and fracture energy, R. Modification for ductile materials, loading conditions. Concept of R curves. Linear Elastic Fracture Mechanics, (LEFM). Three loading modes and the state of stress ahead of the crack tip, stress concentration factor, stress intensity factor and the material parameter the critical stress intensity factor, crack tip plasticity, effect of thickness on fracture toughness.

UNIT-III

Elastic-Plastic Fracture Mechanics (EPFM): The definition of alternative failure prediction parameters, Crack Tip Opening Displacement, and the J integral. Measurement of parameters and examples of use.

UNIT-IV

Fatigue: definition of terms used to describe fatigue cycles, High Cycle Fatigue, Low Cycle Fatigue, mean stress R ratio, strain and load control. S-N curves. Good mans rule and Miners rule. Micro mechanisms of fatigue damage, fatigue limits and initiation and propagation control, leading to a consideration of factors enhancing fatigue resistance. Total life and damage tolerant approaches to life prediction.

UNIT-V

Creep deformation: the evolution of creep damage, primary, secondary and tertiary creep. Micro-mechanisms of creep in materials and the role of diffusion. Ashby creep deformation maps. Stress dependence of creep – power law dependence. Comparison of creep performance under different conditions – extrapolation and the use of Larson-Miller parameters. Creep-fatigue interactions. Examples.

Text Books:

1. T.L. Anderson, Fracture Mechanics Fundamentals and Applications, 2nd Ed. CRC press, (1995)
2. B. Lawn, Fracture of Brittle Solids, Cambridge Solid State Science Series 2nd ed1993.
3. J.F. Knott, Fundamentals of Fracture Mechanics, Butterworths (1973)
4. J.F. Knott, P Withey, Worked examples in Fracture Mechanics, Institute of Materials.
5. H.L.Ewald and R.J.H. Wanhill Fracture Mechanics, Edward Arnold, (1984).
6. S. Suresh, Fatigue of Materials, Cambridge, University Press (1998)

Reference Books:

1. L.B. Freund and S. Suresh, Thin Film Materials Cambridge University Press,(2003).

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MACHINE TOOLS AND METROLOGY LAB (C36PC7)

Course Objectives:

1. To import practical exposure to the machine tools.
2. To conduct experiments and understand the working of the same.
3. To familiarize students with surface roughness measurements on machine components and develop an understanding of the basics of Metrology, how the principles and applications of different areas of measurement.
4. Maintenance of the accuracies of measurement. This is achieved by periodical calibration of the metrological instruments used in the plant.
5. To determine the measuring instrument capabilities and ensure that these are adequate for their respective measurements

Course Outcomes:

1. Analyze the basic techniques of machining processes along with the thermal aspects of orthogonal cutting mechanics,
2. Examine lathe cutting tool materials such as high speed steel, carbide, cutting tools, shapes, and tool geometry
3. Determine the proper grade of wheel for grinding material and evaluate the major components of a single and production type fixture or jig.
4. Calibrate the measuring instruments, and conduct the experiments with minimum error in measurements. .
5. Apply the basic knowledge of various instruments in practical situations.

List of Experiments:

1. Introduction of general purpose machines -Lathe, Drilling machine, Milling machine, Shaper,
2. Planing machine, slotting machine, Cylindrical Grinder, surface grinder and tool and cutter grinder.
3. Step turning and taper turning on lathe machine
4. Thread cutting and knurling on–lathe machine.
5. Drilling and Tapping
6. Shaping and Planning
7. Cylindrical Surface Grinding
8. Grinding of Tool angles.
9. Tool makers microscope and its application
10. Angle and taper measurements by bevel protractor and sine bars.
11. Use of spirit level and optical flats in finding the flatness of surface plate.
12. Thread measurement by 2-wire and3 –wire methods.

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HEAT TRANSFER LAB (C36PC8)

Pre-requisite: Thermodynamics, Heat Transfer.

Course Objectives: This course will enable students to:
1. Impart experimental experience in Heat Transfer Lab those support Mechanical Engineering.
2. Calculate Heat Transfer lab experiments so that they can understand the basic principles and able to take assessment of individual environment.
3. Learn fundamentals in element of Heat Transfer and its applications so as to identify, formulate and solve the problems of Heat Transfer device designs.
4. Develop an idea about how to measure heat transfer coefficients/constant like emissivity, Stefan Boltzmann constants for devices like metal rod, lagged pipe, etc.
5. Understand importance energy conversation and make them to experience with practical applications in Heat Transfer Lab.

Course Outcomes: On completion of the course, the students will be able to:
1. Apply the heat transfer knowledge to do experiments related to conduction of heat transfer.
2. Evaluate heat transfer coefficient in free and forced convection heat transfer situation
3. Determine fin efficiency and emissivity in respective experiments
4. Observe the phenomena of drop and film wise condensation
5. Evaluate the performance of heat exchangers in parallel and counter flow types

List of Experiments:
1. Composite Slab Apparatus – Overall heat transfer co-efficient.
2. Heat transfer through lagged pipe.
3. Heat Transfer through a Concentric Sphere
4. Thermal Conductivity of given metal rod.
5. Heat transfer in pin-fin
6. Experiment on Transient Heat Conduction
7. Heat transfer in forced convection apparatus.
8. Heat transfer in natural convection
9. Parallel and counter flow heat exchanger.
10. Emissivity apparatus.
11. Stefan Boltzman Apparatus.
12. Critical Heat flux apparatus.
13. Study of heat pipe and its demonstration.
14. Film and Drop wise condensation apparatus.

Note: Students should engage first one hour in CAD/CAM lab and practice the models.