COURSE STRUCTURE(R19)
AND
DETAILED SYLLABUS
(III YEAR)

MECHANICAL ENGINEERING

For
B.Tech., Four Year Degree Course

(Applicable for the batches admitted from 2019-20)

LENDI INSTITUTE OF ENGINEERING AND TECHNOLOGY
An Autonomous Institution
Approved by AICTE & Permanently Affiliated to JNTUK, KakinadaAccredited by NAAC with "A" Grade and NBA (CSE, ECE, EEE & ME) Jonnada (Village), Denkada (Mandal), Vizianagaram Dist – 535 005 Phone No. 08922-241111, 241112
E-Mail: lendi_2008@yahoo.com
Website: www.lendi.org

III YEAR – I SEMESTER							
S. No.	**Course code**	**Course Title**	**Category**	**L**	**T**	**P**	**Credits**
1	R19MEC-PC3101	Dynamics of Machinery	PC	3	0	0	3
2	R19MEC-PC3102	Design of Power Transmission Elements	PC	3	0	0	3
3	R19MEC-PC3103	Metal Cutting & Machine Tools	PC	3	0	0	3
4	R19BSH-HM3101	Managerial Economics and Industrial Management	HM	3	0	0	3
5	R19MEC-PC3104	IC Engines &Turbo Machinery	PC	3	0	0	3
6	R19MEC-PE3101.1 R19MEC-PE3101.2 R19MEC-PE3101.3 R19MEC-PE3101.4	**Professional Elective -I** 1. Power Plant Engineering 2. Mechanical Behaviour of Materials 3. Advanced Machining Processes 4. Operations Management	PE	3	0	0	3
7	R19MEC-PC3105	Thermal Engineering Lab	PC	0	0	3	1.5
8	R19MEC-PC3106	Machine Tools Lab	PC	0	0	3	1.5
9	R19BSH-MC3103	Advanced Communication Skills Lab	MC	0	0	3	0
10	R19CSE-SD3102 R19BSH-SD3101	**Skill Development Elective** 1.Python Programming 2. MATLAB For Computational Methods	SD	0	0	3	0
11	R19MEC-SI3101	Summer Internship-1 (Evaluation)	SI	0	0	0	0
			Total	**18**	**0**	**12**	**21**
***Honors Course -2/Minor Course-2**							

III YEAR – II SEMESTER							
S. No.	**Course code**	**Course Title**	**Category**	**L**	**T**	**P**	**Credits**
1	R19MEC-PC3201	CAD/CAM	PC	3	0	0	3
2	R19MEC-PC3202	Heat Transfer	PC	3	0	0	3
3	R19MEC-PC3203	Finite Element Methods	PC	3	0	0	3
4	R19MEC-PE3201.1 R19MEC-PE3201.2 R19MEC-PE3201.3 R19MEC-PE3201.4	**Professional Elective –II** 1. Refrigeration & Air Conditioning 2. Design for Manufacturing & Assembly 3. Manufacturing Methods in Precision Engineering 4. Supply Chain Management	PE	3	0	0	3
5	R19EEE-OE3202 R19ECE-OE3202 R19CSE-OE3203 R19MEC-OE3201	**Open Elective –I** Energy Conservation and Management Image Processing Data Base Management System MOOCS #[Multi-Disciplinary]	O E	3	0	0	3
6	R19BSH-OE3204 R19CSE-OE3208 R19CSE-OE3201 R19MEC-OE3202	**Open Elective –II** 1. Statistical Quality Control 2.Neural Networks and Fuzzy Techniques 3. OOPs through JAVA 4.MOOCS*****[Multi-Disciplinary]	O E	3	0	0	3
7	R19MEC-PC3204	Heat Transfer Lab	PC	0	0	3	1.5
8	R19MEC-PC3205	Computer Aided Engineering Lab	PC	0	0	2	1
9	R19MEC-PC3206	Theory of Machines Lab	PC	0	0	3	1.5
10	R19MEC-MC3201	MOOCS -3	MC	0	0	0	0
11	R19BSH-MC3202	Entrepreneurship& Incubation	MC	3	0	0	0
			Total	**21**	**0**	**11**	**22**
***Honors Course -3/Minor Course-3**							
Summer Internship-2(After Third Year & Evaluated in IV-I Semester)							

 # Select subject from any other Engineering discipline other than mechanical discipline as per the guidelines from the BOS Chairman.

**The Eligible students who opted the courses for B.Tech with Honors/Minor only*

Note:L-Lecture, T-Tutorial, P-Practical, C-Credits

III Year –I Semester

Subject Code	Subject Name	L	T	P	C
R19MEC-PC3101	Dynamics of Machinery	3	0	0	3

Course Objective:

- Understand the concept of gyroscope and precession on stability of cars, ships and planes etc.
- Understand the laws of friction, brakes and dynamometers.
- Impart the method of calculating dynamic force analysis on slider crank mechanism as well as learn the design and analysis of flywheel, Various concepts on design and types of governors along with other topics such as sensitiveness and hunting.
- Know the methods of balancing of rotating masses and balancing of reciprocating masses as well.
- Analyze the basics of vibration as well as to find out the methods to calculate the natural frequencies of different systems.

Course outcomes:

After completion of this unit, students will be able to

1. Explain the stabilization of sea vehicles, aircrafts and automobile vehicles.(L2)
2. Solve the problems of frictional losses, torque transmission of mechanical systems.(L3)
3. Analyse the concept of slider crank mechanism, flywheel and governors (L4)
4. Demonstrate the methods of balancing of rotating masses and balancing of reciprocating masses as well. (L2)
5. Identify the methods to calculate the natural frequencies of undamped and damped systems. (L3)

UNIT –I

Precession: Gyroscopes, effect of precession motion on the stability of moving vehicles such as motor car, motorcycle, aero planes and ships.

Application: Stability of Aero plane, Marine Ship , Four wheeler and Two wheelers.

Learning Outcomes:

After completion of this unit student will able to

- Explain the stability of vehicles on road, sea and air (L2)
- Analyze the gyroscopic effects on aeroplanes, ships and automobiles (L4)

UNIT –II

FRICTION: Inclined plane, friction of screw and nuts, pivot and collar, uniform pressure, uniform wear, friction circle and friction axis: lubricated surfaces, boundary friction, film lubrication.

CLUTCHES: Friction clutches- single disc or plate clutch, multiple disc clutch, cone clutch, centrifugal clutch.

Application: Transmission Systems In Automobile, lifting systems

Learning Outcomes:

After completion of this unit student will able to

1. Understand the working principle of transmission system (L1)
2. Analyze the effect of friction on pivot and collar bearings (L4)

UNIT –III

Turning Moment Diagrams: Dynamic force analysis of slider crank mechanism, inertia torque, angular velocity and acceleration of connecting rod, crank effort and turning moment diagrams – fluctuation of energy – flywheels and their design.

Governors: Watt, porter and proell governors, spring loaded governors – Hartnell and Hartung with auxiliary springs. sensitiveness, isochronisms and hunting.

Application: Punching press, shearing machine, Paper cutting machine, stitching machine.

Learning Outcomes:

After completion of this unit student will able to

- Explain the fluctuation of energy and speed in IC Engines (L2)
- Analyze slider crank mechanism for turning moment on crankshaft (L4)
- Analyze the function of governors according to the load conditions (L4)

UNIT –IV

Balancing: Balancing of rotating masses single and multiple –single and different planes, use analytical and graphical methods. Primary, secondary, and higher balancing of reciprocating masses. analytical and graphical methods, unbalanced forces and couples – examination of "V" multi cylinder in line and radial engines for primary and secondary balancing, locomotive balancing, hammer blow, swaying couple, variation of tractive effort.

Application: In-line Engines, V-Engines, Locomotives.

Learning Outcomes:

After completion of this unit student will able to

- Explain static and dynamic balancing using force and couple diagrams (L2)
- Determine unbalanced forces and couples in rotary and reciprocating engines (L2)

UNIT –V

VIBRATIONS: Free Vibration of spring mass system, transverse loads, vibrations of beams with concentrated and distributed loads. Dunkerly's methods, Rayleigh's method, whirling of shafts, critical speeds, vibration isolation and transmissibility.

Application: Leaf Spring, Coil Springs.

Learning Outcomes:

After completion of this unit student will able to

- Analyze the natural frequencies of vibrating system (L4)
- Explain undamped and damped free vibrations(L2)

Text Books

1. Theory of Machines / S.S Rattan/ Mc. Graw Hill Publ.
2. Theory of machines / Khurmi / S.Chand.

References

1. Mechanism and machine theory by Ashok G. Ambedkar, PHI Publications.
2. Theory of Machines / Shigley / MGH – Rajput

Subject Code	Subject Name	L	T	P	C
R19MEC-PC3102	Design of Power Transmission Elements	3	0	0	3

Objectives:

- To understand the different bearings and their life prediction
- To learn to design curved beams having different cross sections like rectangular, circular, trapezoidal and T-section.
- To design the crane hooks and C-clamps
- To learn the design of main parts of I.C Engine.
- To design the power transmission elements.

Course Outcomes:

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

1. Select suitable bearing depending upon the application and calculate life of the bearing. (L3)
2. Examine the curved beams under the action of axial loads for different cross sections.(L4)
3. Analyze the different I.C Engine parts like cylinder, piston , connecting rod and crankshaft under (L4)
4. Design of various power screws. (L4)
5. Examine the gears for plastic deformation, dynamic and wear considerations. (L4)

Unit I

Bearings: Classification of bearings- applications, types of journal bearings – lubrication – bearing modulus – full and partial bearings – clearance ratio – power losses in bearings, bearing materials – journal bearing design – ball and roller bearings design – static and dynamic loading of ball, bearing life.

Application: Bearings used in automobiles, turbo fans, pumps etc.

Learning outcomes:

At the end of the unit, student will be able to

- Identify different types of bearings and its applications. (L3)
- Examine the power losses in bearings due to friction. (L4)
- Analyze the bearing parameters of journal and anti frictional bearing.(L4)
- Determine bearing life and reliability. (L5)

Unit II

Design of Curved Beams: Introduction, stresses in curved beams, expression for radius of neutral axis for rectangular, circular, trapezoidal and t-section, design of crane hooks, c – clamps.

Application: crane hooks, anchor chain links, I-bolts etc.

Learning outcomes:

At the end of the unit, student will be able to

- Determine stresses in curved beams for different cross sections. (L5)
- Distinguish various types of threads for different applications. (L4)

Unit III

Internal Combustion Engine Parts: Construction design and proportions of piston, forces acting on piston, cylinder, cylinder liners. Connecting Rod: Thrust in connecting rod – stress due to whipping action on connecting rod ends – cranks and crankshafts, strength and proportions of overhung and centre cranks – crank pins, crank shafts.

Application: All automobile engines.

Learning outcomes:

At the end of the unit, student will be able to

- Analyze the automobile components like piston, cylinder, cylinder liners, connecting rod and crankshaft under the action of various forces.(L4)
- Explain the stresses in connecting rod and crankshaft for different loading. (L2)

Unit IV

Design Of Power Screws: Design of screw, square ACME, buttress screws, design of nut, compound screw, differential screw, ball screw, design of screw jack - possible failures of screws and nuts

Application: Bolts and nuts, etc.

Learning outcomes:

At the end of the unit, student will be able to

- Examine the possible failures of different threads.(L2)
- Design of various power screws. (L4)

Unit V

Spur & Helical Gear Drives: Spur gears- helical gears – load concentration factor – dynamic load factor, surface compressive strength –bending strength – design analysis of spur gears – estimation of centre Distance, module and face width, check for plastic deformation, check for dynamic and wear considerations.

Application: Power Transmissions Systems (Gear box, differential).

Learning outcomes:

At the end of the unit, student will be able to

- Analyse load concentration factor and dynamic load factor for gears. (L4)
- Explain the possible for dynamic and wear considerations under loads.(L2)
- Design analysis of spur and helical gears (L4)

Note: Design data book is permitted for examination

Text Books

1. Machine Design/V.Bandari/TMH Publishers
2. Machine Design/ NC Pandya & CS Shaw/ Charotar publishers
3. Design data book / Jalaluddin.

References

1. Machine Design: An integrated Approach / R.L. Norton / Pearson Education.
2. Design of machine elements/ Spots/Pearson Publications
3. Data Books : (i) P.S.G. College of Technology (ii) Mahadevan
4. Mech. Engg. Design / JE Shigley/Tata McGraw Hill education.

Subject Code	Subject Name	L	T	P	C
R19MEC-PC3103	Metal Cutting & Machine Tools	3	0	0	3

Course Objectives:

- Explain parameters in the metal cutting operation.
- Understand Types of lathes, Lathe operations, Work holders, Tool holders, Lathe attachments & Automatic Lathes
- Differentiate between Boring, reaming and tapping.
- Provide insight into Finishing processes and Abrasives, Bonds, Lapping, Honing and Broaching Operations
- Familiarize the principles of jigs and fixtures and types of clamping and work holding devices.

Course Outcomes:

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

1. Choose cutting processes and variables and Solve problems related To Cutting Forces, Tool Life and Tool Angles (L3)
2. Identify the different lathe operations (L3)
3. Demonstrate the various processes like boring, reaming, drilling etc. (L2)
4. Identify methods to generate different types of surfaces. (L3)
5. Identify the different types of Jigs and Fixtures.(L3)

UNIT I

Metal Cutting: Single and multi-point cutting tools, orthogonal and oblique cutting, chip formation, tool wear and tool life, Tool Angles, cutting tool materials, cutting fluids, chip formation and types of chips – built up edge and its effects, chip breakers, Merchant's force diagram and numerical on Merchant Force Diagram

Learning Outcomes:

At the end of the this unit, the student will be able to

- Describe cutting processes and variables. (L2)
- Differentiate between orthogonal and oblique cutting (L4)
- Classify various types of chips, cutting tool materials and cutting fluids. (L4)
- Solve cutting force, speed and feed finding techniques during machining. (L3)
- Impart knowledge on Cutting tools, Tool Angles, Chips, Chip breakers, Problems of Cutting Forces & Tool Life.(L1)

Applications:

Machining of Metals, Plastics and Glasses , Lathe machines, Shaping machines

UNIT II

Lathe and Lathe Operations: Principles of working, specifications, types of lathes, operations performed, work holders and tool holders. Taper turning operations, Machining time calculations. Turret and capstan lathes - Principle of working, collet chucks, Automatic lathes, single spindle and multi Spindle Automatic lathes.

Drilling and Drilling Machines: Principles of working, specifications, types, and operations performed - nomenclature of twist drill

Learning Outcomes:

At the end of this unit, the student will be able to

- List the specifications for various types of lathes and boring machines. (L1)
- Determine cutting speeds for different machining operations. (L5)
- Identify the different lathe attachments (L3)

Applications:

Woodturning, metalworking, turning, facing, grooving, parting, threading, drilling, boring, knurling, and tapping metal spinning, thermal spraying,

UNIT III

Boring and Boring Machines- Principles of working, specifications, types, and operations performed - tool holding devices - nomenclature of boring tools

Reaming and Reamers: Principles of working, specifications, types, and operations performed - tool holding devices

Taping and Taps: Principles of working, specifications, types, and operations performed - tool holding devices - nomenclature of taps.

Learning Outcomes:

At the end of this unit, the student will be able to

- Identify parts of boring, reaming machines. (L3)
- Compare tool geometry of Twist Drill, reamers and taps (L3)

Applications:

accurate holes in a workpiece, internal Threads

UNIT IV

Milling operations and Milling machines - Principles of working, specifications, classifications of milling machines, milling operations, types and geometry of milling cutters, methods of indexing, and accessories to milling machines.

Shaping, Slotting and planing machines - Principles of working - principal parts, specification, classification, operations performed.

Learning Outcomes:

At the end of this unit, the student will be able to

- Recognize the parts of the milling, shaping, slotting and planing machine. (L3)
- Compare tool geometry for milling, shaping, slotting and planning operations. (L3)
- Calculate machining times. (L5)

Applications:

Gears, straight/flat surfaces, cutting keys and accurate flat surfaces.

UNIT V

Grinding and grinding machines: Grinding process, types of grinding machines, grinding process parameters, and honing, lapping, other finishing processes.

Jigs and Fixtures: Classification of Jigs & Fixtures, types of clamping and work holding devices, typical examples of jigs and fixtures, 3-2-1 principle of location and clamping.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the basic principles of abrasive processes. (L2)
- Explain the designation of the grinding wheel and the significance of the various codes. (L2)
- Classify different types of grinding machines and their applications. (L2)
- Classify various types of jigs and fixtures. (L2)
- Identify various types of work and tool holding devices. (L3)
- Explain the design principles of jigs and fixtures. (L2)

Applications:

Making smooth surfaces on flat and Cylindrical objects.

Text books

1. P.N. Rao, Manufacturing Technology: Metal Cutting and n, (Volume 2), 3/e,Tata McGraw-Hill Education, 2013
2. R.K. Jain and S.C. Gupta, Production Technology, 17/e, Khanna Publishers, 2012.

Reference books

1. Kalpakjian S and Schmid SR, Manufacturing Engineering and Technology, 7/e, Pearson, 2018.
2. Milton C.Shaw , Metal Cutting Principles, 2/e, Oxford, 2012

3. Hindustan Machine Tools, Production Technology, TMH, 2001
4. V.K.Jain, Advanced Machining Process,12/e, Allied Publications, 2010
5. AB. Chattopadhyay, Machining and Machine Tools, 2/e, Wiley, 2017
6. Halmi A Yousuf & Hassan, , Machine Technology: Machine Tools and Operations, CRC Press Taylor and Francis Group, 2008.

Subject Code	Subject Name	L	T	P	C
R19BSH-HM3101	Managerial Economics and Industrial Management	3	0	0	3

Course Objectives:

- Inculcate the basic knowledge with the concepts of Economics & Demand and current business environment.(L2).
- Identify micro environment in which markets operate, how price determination is done under different kinds of competitions and know the different forms of Business organization. .(L2)
- Provide fundamental knowledge on Management, Administration, Organization methodologies (L2)
- Equip with knowledge of Inventory and Quality control (L3)
- Analyses the PERT/CPM techniques for better Project Management (L4)

Course Outcomes:

1. Equipped with the knowledge of fundamentals of economics, estimating the Demand for a product, Capable of analyzing Elasticity & Forecasting methods(L2)
2. Apply production concepts, assess the costs and Determine Break Even Point (BEP) of an enterprise for managerial decision making(L4)
3. Apply concepts & principles of management & designs of organization in practical world. (L3)
4. Apply principles of Work-study, Quality Control techniques and Inventory control in industry(L3)
5. Develop PERT/CPM Charts for projects of enterprise and estimate time & cost of project.(L4)

UNIT – I

Introduction to Managerial Economics: Definition, Nature and scope of Managerial Economics, Demand Analysis- Concept, Determinants , Law of Demand and its exceptions. Elasticity of Demand: Definition, Types, Measurement and Significance of Elasticity of Demand. Demand Forecasting, Methods of Demand Forecasting

Learning Outcomes:

At the end of this unit students will be able to:

- Awareness about basics of managerial economics(L1)
- Knowledge of the concepts of demand, elasticity of demand and methods of demand forecasting(L1)

Application:

Analyze the demand of a product by applying methods of the elasticity of demand.

UNIT – II

Cost Analysis: Cost Analysis: Cost concepts, cost behavior and cost types-Fixed Cost , Variable Cost Opportunity Cost, Out of Pocket Costs vs. Imputed Costs, Explicit cost Vs Implicit cost, Breakeven Analysis (BEA) - Determination of Breakeven Point (simple problems), Managerial Significance and limitations of BEA.

Learning Outcomes:

At the end of this unit students will be able to:

- Apply Break – Even Analysis and its importance in managerial decision making(L4)

Application:

Compute contribution, revenue, Cost comparison, Margin of safety for making accurate decisions related to profitability of particular Enterprise.

UNIT III

Industrial Management: Concepts of Industrial Management-Nature-Functions- Evolution

of Management Thought –Principles of Traditional and scientific management Motivational theories- Maslow and Douglas Mc Gregor theories- Decision making Process.

Learning Outcomes:

At the end of this unit students will be able to:

- Acquire the techniques, skills and modern engineering tools necessary for engineering practice.(L3)
- Apply concepts& principles of management & structures of organization in a practical world(L3)
- Evaluate management aspects and its implementation in aim of achieving organizational goals(L5)

Applications:

Divide the class into two teams' old employees and new joiners and motivate the work environment with respect to excellent management and the supportive.

UNIT IV

Operations Management: Principles and types of operations management-Classification of production systems-Plant layout and Process layout-Work Study- Statistical Quality Control: X-bar chart, R chart, C chart and P chart, (simple Problems) Inventory Management: Objectives-Functions, Inventory Controlling Techniques and Inventory controlling costs-EOQ(Simple problems)-ABC Analysis, VED Analysis.

Learning Outcomes:

At the end of this unit students will be able to:

- Compare Job and Mass Production related to manufacturing process(L2)
- Utilization of quality control techniques in Production process .(L3)
- Estimate qualitative and quantitative techniques of inventory management.(L2)

Applications:

Study the Inventory control employed in Big Bazaar and frames the basic inventory models which represent the inventory management.

UNIT V

Project Management: Project planning and control- Development of network-Difference between Program Evaluation Review Technique and Critical Path Method- Identifying critical path - project crashing (simple problems).

Learning Outcomes:

At the end of this unit students will be able to:

- Analyze methods of reducing the time and cost of the project.(L2)
- Visualize Project handling and control the techniques for optimum utilization of resources(L2)
- Develop PERT/CPM networks for projects of an enterprise and estimate time & cost of project(L4)

Application:

Estimation of the cost and time of the High way Corridor of the Visakhapatnam Metro Tram Project.

Text Books

1. Industrial Engineering and management by O.P Khanna, Khanna Publishers.
2. Managerial Economics and Financial Analysis by A.R.Aryasri, TMH, 2012.
3. Industrial Engineering and Production Management, MartandTelsang, S.Chand& Company Ltd. New Delhi.
4. Management Science by Aryasri; Publisher: Tata McGraw Hill, 2009
5. Management by James Arthur, Finch Stoner, R. Edward Freeman, and Daniel R. Gilbert 6th Ed; Publisher: Pearson Education/Prentice Hall.

Reference Books

1. 1 Raghunatha Reddy &Narasimhachary, Managerial Economics & Financial Analysis, Scitech, 2009.
2. Varshney&Maheshwari, Managerial Economics, Sultan Chand& Sons, 2014.
3. S.A. Siddiqui and A.S. Siddiqui, Managerial Economics and Financial Analysis, New Age International Publishers, Hyderabad, 2013
4. Dwivedi, Managerial Economics, Vikas 2012.
5. Industrial Management by Bhattacharya DK, Vikas publishers
6. Industrial Engineering by Banga& Sharma.

Subject Code	Subject Name	L	T	P	C
R19MEC-PC3104	IC Engines & Turbo Machinery	3	0	0	3

Course Objectives:

- To analyze the reasons for deviation of fuel-air cycles from air standard cycles in IC
- Engines.
- To study the stages of combustion in spark ignition engines and diesel engines.
- To Summarize the effects of volatility on the operation of I.C. Engines.
- To learn the process of carburetion, injection, ignition, cooling, lubrication and governingsystems.
- To impart knowledge about various engine performance characteristics and its testing.
- To acquire the knowledge related to turbo- machines

Course outcomes:

1. ***explain*** normal and abnormal combustion phenomena in SI and CI engines(L2)
2. ***outline*** the reasons for deviation of fuel-air cycles from air standard cycles.(L2)
3. ***develop*** the specifications of simple carburetor. (L3)
4. ***explain*** the working of injection, ignition, cooling, lubrication and governing systems. (L2)
5. ***analyze*** various engine performance characteristics with load and speed test on
6. I.C. Engines. (L4)
7. ***understand*** the operation of turbomachines (L2)

UNIT I

Introduction to I.C Engines: Engine classification, Two and four stroke engines, SI and CI engines, Scavenging in two Stroke engines, Valve timing diagram. Effect of valve timing and engine speed on volumetric efficiency. Fuel-air cycles and actual cycle: Reasons for deviation of actual cycle from air standard cycles,

SI Engines: Carburetion: Properties of air-petrol mixtures, mixture requirement, simple carburetor, limitation of simple carburetor, Nozzle lip, venturi depression, calculation of fuel jet and venturi throat diameter for given air fuel ratio.

Gasoline injection system: Disadvantages of carburetor, Type of injection system, components of injection system, Electronic gasoline fuel injection system, multi-point fuel injection system, working, advantages and disadvantages.

Application: SI Engines

Learning Outcomes:

At the end of this unit, the student will be able to

- ***understand*** the various types of IC engines (L2)
- ***identify*** the specifications of carburetor. (L3)
- ***explain*** the injection systems in SI engine (L2)

UNIT II

CI Engine: Combustion in CI engines, Ignition delay, Knock and it's control, Fuel injection in CI engines, Requirements, Types of injection systems, Fuel pumps, Fuel injectors, Exhaust emissions from SI engine and CI engine and it'scontrol.

Fuels: Fuels for SI and CI engine, Important qualities of SI and CI engine fuels, Rating of SI engine and CI engine fuels, Additives, Volatility of liquid fuels, ASTM distillation curve, effect of volatility on engine performance - cold starting, hot starting, vapour lock, acceleration, carburetor icing, and crank case dilution.

Application: CI engines, selection of fuel quality

Learning Outcomes:

At the end of this unit, the student will be able to

- ***explain*** the combustion problems occurring in CI engines. (L2)

- ***Summarize*** the effect of volatility on the operation of I.C. Engines. (L2)
- ***understand*** the fuels quality requirement for IC engines (L2)

UNIT III

Ignition System: Battery and magneto ignition system and their comparative study, spark plug heat range, electronic ignition system, firing order, Ignition timing, centrifugal and vacuum ignition advance.

Cooling System: Cooling requirement, air cooling, liquid cooling, type of liquid cooling system, advantage and disadvantage of air cooling and water cooling system, Antifreeze mixture.

Lubrication System: Function of lubricating system, Classification of lubricating system, mist lubrication system, dry sump lubrication, wet sump lubrication-splash, and modified and full pressure system

Governing: Necessity of governing, methods of governing-hit and miss governing,

Learning Outcomes:

At the end of this unit, the student will be able to

- ***compare*** different lubrication systems for IC engines (L2)
- ***explain*** different cooling systems, ignition systems for IC engines (L2)

UNIT IV

Testing and Performance: Performance parameters, measurements of brake power, indicated power, measurement friction power- Willan's line method, Morse test, motoring test, measurement fuel consumption, and measurements of air consumption, exhaust gas calorimeter. Calculation of various performance parameter, heat balance sheet and heat balance diagram. Performance curves of S.I. and C.I. Engine at full throttle variable speed operation and at constant speed variable load operation.

Application: Stationary engines, Engines for automobiles.

Learning Outcomes:

At the end of this unit, the student will be able to

- ***explain*** the measurement of power output of I.C. Engines. (L2)
- ***Solve*** the exercises to find performance parameters(L3)
- ***analyze*** various engine performance characteristics with load and speed test on I.C. Engines. (L4)

UNIT V

Turbo Compressors: Introduction, classifications of Centrifugal compressors – components, working, velocity diagrams, calculations of power and efficiencies. Slip factor, surging and choking, power and efficiencies.

Axial Flow Compressor: Construction and working, velocity diagram, calculation of power and efficiencies. Degree of reaction, work done factor, stalling, comparison of centrifugal and axial flow compressor.

Application: Aerospace industry**,** Power plants

Learning Outcomes:

At the end of this unit, the student will be able to

- Explain the principle of operation of turbo machines (L2)
- Solve exercises on power and efficiencies of turbo machines (L3)

TEXT BOOKS

1. I.C Engine, by V. Ganeshan, Tata McGraw Hill Publishers
2. A Course in International Combustion Engines, by Mathur& Sharma, DhanpatRai& Sons.
3. Yahya, S.H, Turbines, Compressor and Fans , Tata Mc Graw Hill, 1996

REFERENCES

1. Fundamentals of Internal Combustion Engine by Gill, Smith,Ziurs, Oxford & IBH Publishing CO.
2. Internal combustion engine fundamentals by John B. Heywood, Tata McGraw Hill Pub, 1988.
3. Earl Logan, Jr, Hand book of Turbomachinery, Marcel Dekker Inc, 1992.
4. Shepherd, D.G, Principles of Turbomachinery , Macmillan, 1969.

Subject Code	Subject Name	L	T	P	C
R19MEC-PE3101.1	Power Plant Engineering (**Professional Elective –I**)	3	0	0	3

Course Objective:

- Familiarize the sources of energy, power plant economics and environmental aspects.
- Outline the working components of different power plant.
- Explain renewable energy sources; characteristics, working principle, classify types, layouts, and plant operations.
- Explain the hydroelectric power plant operations
- Impart types of nuclear power plants, and outline working principle and advantages and hazards.

Course Outcomes:

At the end of this course, the student will be able to

1. Outline sources of energy, power plant economics, and environmental aspects. (L2)
2. Explain power plant economics and environmental considerations. (L2)
3. Illustrate the working mechanism of diesel and gas turbine power plants. (L2)
4. Summarize types of renewable energy sources and their working principle. (L2)
5. Demonstrate the working principle of nuclear power plants. (L4)

UNIT I

Introduction to the Sources of Energy - Resources and Development of Power in India.
Power Plant Economics and Environmental Considerations: Capital Cost, Investment of Fixed Charges, Operating Costs, General Arrangement of Power Distribution, Load Curves, Load Duration Curve. Definitions of Connected Load, Maximum Demand, Demand Factor, Average Load, Load Factor, Diversity Factor - Tariff - Related Exercises. Effluents from Power Plants and Impact on Environment - Pollutants and Pollution Standards - Methods of Pollution Control. Inspection and Safety Regulations.

Applications: Estimating cost analysis in any power plants

Learning Outcomes

At the end of this unit, the student will be able to

- Outline sources of energy, compare and selection of types of power plants.(L2)
- Explain cost factors, load and power distribution factors. (L2)
- Select tariff based on load and demand factors. (L3)
- Summarize the impact of power plant on the environment, pollution mitigation and regulations. (L2)

UNIT II

Steam Power Plant : Layout, Modern High Pressure and Supercritical Boilers - Power Plant Cycles - Modern Trends in Cycle Improvement - Waste Heat Recovery, Fluidized Bed Boilers., Fuel and Handling Equipments, Types of Coals, Coal Handling, Choice of Handling Equipment, Coal Storage, Ash Handling Systems.
Steam Power Plant : Combustion Process : Properties of Coal - Overfeed and Under Feed Fuel Beds, Travelling Grate Stokers, Spreader Stokers, Retort Stokers, Pulverized Fuel Burning System And Its Components, Combustion Needs and Draught System, Cyclone Furnace, Design and Construction, Dust Collectors, Cooling Towers And Heat Rejection. Analysis of Pollution from Thermal Power Plants - Pollution Controls.CO2 Recorders

Applications: Thermal power plants

Learning Outcomes:

At the end of this unit, the student will be able to

- Demonstrate latest high pressure boilers, power plant cycles and their improvements. (L2)

- Explain various types of coals, coal handling operations and associated systems. (L2)
- Outline and compare types of feeders, stokers, combustion systems. (L2)
- Illustrate draught, dust collector, furnace, cooling tower and heat rejection systems. (L2)
- Evaluate pollution levels from power plants, pollution control methods, and application of pollution recorders. (L4)

UNIT III

Diesel Power Plant: Diesel Power Plant: Introduction - IC Engines, Types, Construction-Plant Layout with Auxiliaries - Fuel Storage

Gas Turbine Plant: Introduction - Classification - Construction - Layout with Auxiliaries - Principles of Working Closed and Open Cycle Gas Turbines. Advantages And Disadvantages Combined Cycle Power Plants.

Applications: Diesel and Gas Power plants

Learning Outcomes:

At the end of this unit, the student will be able to

- Explain working principles, and compare types of diesel power plant. (L2)
- Outline the diesel power plant layout with its supporting equipment. (L2)
- Illustrate the working principle of open cycle and closed cycle gas turbine. (L2)
- Demonstrate combined cycle power plants with benefits and shortcomings. (L2)

UNIT IV

Hydro Electric Power Plant: Water Power - Hydrological Cycle / Flow Measurement - Drainage Area Characteristics - Hydrographs - Storage and Pondage - Classification of Dams and Spill Ways.

Hydro Projects And Plant: Classification - Typical Layouts - Plant Auxiliaries - Plant Operation Pumped Storage Plants.

Applications: Hydroelectric power stations

Learning Outcomes

At the end of this unit, the student will be able to

- Explain hydrological cycle, infer flow measurements from hydrographs. (L2)
- Summarize working principle of hydroelectric power plant. (L2)
- Illustrate typical layout of hydroelectric power plant, and its auxiliary equipment. (L2)

UNIT V

Power from Non-Conventional Sources: Utilization of Solar Collectors- Principle of its Working, Wind Energy - Types of Turbines - HAWT & VAWT-Tidal Energy. MHD power Generation.

Nuclear Power Station: Nuclear Fuel - Nuclear Fission, Chain Reaction, Breeding and Fertile Materials - Nuclear Reactor -Reactor Operation.

Types of Reactors: Pressurized Water Reactor, Boiling Water Reactor, Homogeneous Reactor, Gas Cooled Reactor, Radiation Hazards and Shielding - Radioactive Waste Disposal.

Applications: Solar power plant & Nuclear power plants

Learning Outcomes

At the end of this unit, the student will be able to

- Demonstrate working principle of power generation from non-conventional energy sources. (L2)
- Explain working principle of Nuclear power plants, nuclear fuels, and reactor operations. (L2)
- Outline the various types of nuclear reactors, their applications and limitations. (L2)

- Summarize the hazards of nuclear reactors and significance of nuclear waste disposal. (L2)

TEXT BOOKS

1. P.K. Nag, Power Plant Engineering, 3/e, TMH, 2013.
2. Arora and S. Domkundwar, A course in Power Plant Engineering, Dhanpat Rai & Co (P) Ltd, 2014

REFERENCE BOOKS

1. Rajput, A Text Book of Power Plant Engineering, 4/e, Laxmi Publications, 2012.
2. Ramalingam, Power plant Engineering, Scietech Publishers, 2013
3. P.C. Sharma, Power Plant Engineering, S.K. Kataria Publications, 2012.

Subject Code	Subject Name	L	T	P	C
R19MEC-PE3101.2	Mechanical Behaviour of Materials (**Professional Elective –I**)	3	0	0	3

Course objectives:

The objectives of the course are to

- Explain the structure of material over the effects of mechanical properties.
- Familiarize the defects inside the structure and their effects on the mechanical properties.
- Impart knowledge about strengthening mechanisms of materials.
- Teach mechanisms of failures of materials (fracture, fatigue and creep) and their relationship with the different types of stress.
- Familiarize Predict the metallurgical factors affecting creep.

Course Outcomes:

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

1. Apply materials based on their structure and failure modes (L3).
2. Review the grain size and solid solution strengthening(L1)
3. Categorize materials using different machines (L1).
4. Summarize the various strengthening mechanisms with suitable examples (L2)
5. Identify the creep in different materials and its influence in selection of materials (L3)

UNIT – I

Elastic and plastic behaviour: Elastic behaviour of materials – Hooke's law, plastic behaviour: dislocation theory – Burger's vectors and dislocation loops, dislocations in FCC, HCP and BCC lattice, stress fields and energies of dislocations, forces on and between dislocations, slip and twinning.

Application: In construction purposes, analysis of various structures like bridges, columns, pillars, beams etc

Learning outcomes:

At the end of this unit, the student will be able to

- Explain the elastic behaviour of engineering materials(L2).
- Recall hooke's law(L1)
- Explain the dislocation theory(L2)
- Identify the dislocations in fcc, hcp and bcc lattice (L3)
- Determine the forces on and between dislocations (L5).

UNIT – II

Strengthening mechanisms: Cold Working, Grain Size Strengthening, Solid Solution Strengthening, Martensitic Strengthening, Precipitation Strengthening, Dispersion, Strengthening, Fibre Strengthening, Examples. Yield Point Phenomenon, Strain aging and Dynamic strain aging.

Application: In construction of stronger bridges and structures it is necessary to have a strong frame that can support high tensile or compression load and resist plastic deformation.

Learning outcomes:

At the end of this unit, the student will be able to

- Describe various strengthening mechanisms(L2)
- Discuss grain size and solid solution strengthening(L1).
- Apply dispersion strengthening and fibre strengthening(L3)
- Differentiate strain aging and dynamic strain aging(L4).

UNIT – III

Fracture and fracture mechanics: Types of Fracture, Basic Mechanism of Ductile and Brittle Fracture, Griffith's Theory Of Brittle Fracture, Ductile to Brittle Transition

Temperature (DBTT). Fracture Mechanics-Introduction, Modes of Fracture, Stress Intensity Factor, Strain Energy Release Rate, Fracture Toughness.

Application: prediction of failure in applied loads, residual loads and Size , shape, location orientation of crack

Learning outcomes:

At the end of this unit, the student will be able to

- Explain the basic mechanism of ductile and brittle fracture(L2).
- Apply griffith's theory(L3).
- Predict factors effecting on DBTT (L4).
- Classify various modes of fracture (L1).

UNIT - IV

Fatigue behaviour and testing: Stress Cycles, S-N Curves, Effect of Mean Stress, Factors Affecting Fatigue, Structural Changes Accompanying Fatigue, Cumulative Damage.

Application: Analysis of Fatigue behaviour of fiber's in fiber composites as the load bearers are fiber's, Analysis of plastic behaviour in metals etc.

Learning outcomes:

At the end of this unit, the student will be able to

- Draw the S-N curves for different materials (L3)
- Explanation of Cumulative of Damage (L2)

UNIT - V

Creep behaviour and testing's: Creep Curve, Stages In Creep Curve And Explanation, Structural Changes During Creep, Creep Mechanisms, Metallurgical Factors Affecting Creep, High Temperature Alloys, Stress Rupture Testing, Creep Testing Machines.

Applications: Stress relaxation in bolts and cable wires, Size must be precise in turbine rotors of jet engines.

Learning outcomes:

At the end of this unit, the student will be able to

- Identify various stages in creep curve(L3).
- Calculate various structural changes during creep(L3).
- Predict the metallurgical factors affecting creep (L4).
- Demonstrate various creep testing machines (L2).

Text books:

1. Dieter, G.E., "Mechanical Metallurgy", McGraw-Hill, SI Edition, 1995.
2. Davis. H. E., Troxell G.E., Hauck.G. E. W., "The Testing Of Engineering Materials", McGraw-Hill, 1982.

References:

1. Wulff, The Structure and Properties of Materials, Vol. III "Mechanical Behavior of Materials", John Wiley and Sons, 1983.
2. Honey Combe R. W. K., "Plastic Deformation of Materials", Edward Arnold Publishers, 1984.
3. Suryanarayana, A. V. K., "Testing of Metallic Materials", Prentice Hall India, 1979.

Subject Code	Subject Name	L	T	P	C
R19MEC-PE3101.3	Advanced Machining Processes (**Professional Elective –I**)	3	0	0	3

Course Objectives

- Understand idea about nontraditional machining processes
- Illustrate about ultrasonic machining in mechanical processes
- Explain concepts for electrical discharge machining
- distinguish various chemical machining and electro chemical machining process
- Identify the process occurs in high energy machining processes

Course Outcomes

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

1. Identify the modern manufacturing process with respect to productivity economic(L3)
2. Explain the trends in development of manufacturing process selection of suitable process for metal cutting and non-traditional manufacturing(L2)
3. Illustrate electrical discharge machining processes and applications(L2)
4. Distinguish between chemical and electrical machining processes and limitations(L4)
5. Compare different welding processes(L2)

UNIT I

Introduction: Need of Non-Traditional Machining Processes – Classification Based on Energy, Mechanism, source of energy, transfer media and process – Process selection Based on Physical Parameters, shapes to be machined, process capability and economics – Overview of all processes.

Application: pharmaceutical industries and fabrication of CNT

Learning outcomes:

After completion of this unit, student will be able to

- classify various Machining Processes(L2)
- Identify the source of energy in non traditional machining process(L3)
- Explain Physical Parameters in non traditional machining process(L2)
- Demonstrate overview of all processes(L2)

UNIT II

Mechanical Processes: Ultrasonic Machining: Principle- Transducer types – Concentrators – Abrasive Slurry – Process Parameters – Tool Feed Mechanism – Advantages and Limitations – Applications. Abrasive Jet Machining: Process- Principle – Process Variables – Material Removal Rate – Advantages and Limitations – Applications. Water Jet Machining: Principle – Process Variables – Advantages and Limitations – Practical Applications – Abrasive water jet machining process.

Application:

- Machining very precise and intricate shaped articles.
- Drilling the round holes of any shape.
- Grinding the brittle materials.
- Profiling the holes.

Learning outcomes:

After completion of this unit, student will be able to

- Identify basic idea about Ultrasonic Machining(L3)
- choose the concept of Ultrasonic Machining(L3)
- Explain working principle for Abrasive Jet Machining(L2)
- Show the Advantages and Limitations – Applications of ultrasonic machining (L2)
- Illustrate the working principle of Abrasive water Jet Machining(L2)

UNIT III

Electrical Discharge Machining: Electrical Discharge Machining: Mechanism of metal removal – Dielectric Fluid – Flushing methods – Electrode Materials – Spark Erosion Generators – Electrode Feed System – Material Removal Rate – Process Parameters – Tool Electrode Design – Tool wear Characteristics of Spark Eroded Surfaces- Advantages and Limitations – Practical Applications. Electrical Discharge Wire Cut and Grinding: Principle – Wire Feed System – Advantages and Limitations – Practical applications

Application: Die making and Mold making

Learning outcomes:

After completion of this unit ,student will be able to

- Identify basic idea about Electrical Discharge Machining(L3)
- explain Flushing methods of electrical discharge machining (L2)
- define Characteristics of Spark Eroded Surfaces(L1)
- choose Advantages and Limitations – Applications of electrical discharge machine(L3)
- Explain working principle Electrical Discharge Wire Cut and Grinding(L2)

UNIT IV

Chemical And Electro Chemical Machining: Chemical Machining: fundamentals, Principle –classification and selection of Etchant - chemical milling, Engraving, Blanking – Advantages and limitations – Applications. Electro Chemical Machining: Electro-chemistry of the process-Electrolytes – Electrolyte and their Properties – Material Removal Rate – Tool Material – Tool Feed System – Design For Electrolyte Flow – Process Variables – Advantages and Limitations – Applications – Electro Chemical Grinding: Honing, cutting off, Deburring and turning.

Application: Machining of complex profiles like turbine wheels, turbine and jet blades.

Learning outcomes:

After completion of this unit, student will be able to

- identify process parameters about Chemical Machining process(L3)
- Explain classification of chemical machining and its Applications(L2)
- show Electrolyte and their Properties of electro chemical machining(L1)
- choose Advantages and Limitations – Applications of electro chemical machining process(L3)
- compare various Honing, cutting off, Deburring and turning process(L2)

UNIT V

High Energy Machining Process:

Electron Beam Machining: Principle –Generation and control of electron beam-Advantages and Limitations – Applications. Plasma Arc Machining: Principle –Gas mixture– Types of Torches – Process Parameters – Advantages and Limitations – Applications. I

Other Additive Manufacturing Systems: Three Dimensional Printing (3DP): Principle, Process, Advantages, Limitations and Applications. Ballistic Particle Manufacturing (BPM): Principle, Process, Advantages, Limitations, Applications. Shape Deposition Manufacturing (SDM): Principle, Process, Advantages, Limitations, Applications

Application:

- custom cosmetic aircraft interior components,
- rocket engines components, combustor liners
- 3D printing delivers complex

Learning outcomes:

After completion of this unit, student will be able to

- choose process parameters about Electron Beam Machining(L3)
- Explain Applications of laser beam machining(L2)
- compare the various process parameters of Laser Beam Machining-Principle(L2)

- demonstrate Ballistic Particle Manufacturing process (BPM) (L1)
- Identify Shape Deposition Manufacturing process (SDM) (L3)

TEXT BOOKS

1. P.C Pandey And H.S. Shan, "Modern Machining Process", Tata Mc Graw – Hill Publishing Company Limited, New Delhi, 2007
2. .V.K. Jain, "Advanced Machining Process", Allied Publishers Pvt Limited 2007

REFERENCES

1. Amithaba Bhattacharyya, "New Technology", The Institution Of Engineers, India
2. HMT Bangalore, "Production Technology", Tata Mc Graw–Hill Publishing Company Limited, New Delhi.
3. Hassan El – Hofy "Advanced machining Processes" MC Graw-Hill.

Subject Code	Subject Name	L	T	P	C
R19MEC-PE3101.4	Operations Management (**Professional Elective –I**)	3	0	0	3

Course Objectives:

- Comprehend the knowledge of operations management and best practices in the manufacturing units.
- Apply operations management concepts from the general managementperspective.
- Elucidate the recent trends in Operations management
- Learn tools, analytical frameworks and general principles for managingoperations.

Course Outcomes:

1. ***develop*** the facility layouts for manufacturing systems (L3)
2. ***analyze*** inventory control costs related to deterministic models. [L4]
3. ***make use of*** the Operations planning and control as an integrated system(L3)
4. ***Compare*** the strategies for optimal scheduling.(L5)
5. ***Summarize*** the concepts of operational ergonomics(L2)

UNIT-I

Definition of operations management, Nature and Scope of Operations Management-– Operations strategy – frame work, Concept of operation planning and control for various operational systems in manufacturing sector. Characteristics of production systems, Make to order, Make to stock systems, facility layout – types, design of layouts-travel chart, assembly line balancing- exercise with heuristic method. Concept of layout design with CRAFT.

Learning Outcomes:

At the end of this unit students will be able to:

- ***outline*** the scope of operations management(L2)
- ***plan*** the facility layout for optimization of time and cost.(L3)

Application:

- Planning work stations for assembly lines.
- Layout preparation for job shops.

UNIT-II

Materials Management - Materials Management – Objectives, functions, stores management, Inventory control : costs associated with inventory control, EOQ, finite rate of replenishment model. Selective Inventory control methods , reorder level in practical inventorysystem with variable demand and lead time, Spare parts inventory management.

Learning Outcomes:

At the end of this unit students will be able to:

- ***explain*** the functions of materials management(L2)
- ***analyze*** inventory control costs related to deterministic models. [L4]

Application:

- Stores inventory management in manufacturing plants.
- 2.Design the practical inventory control systems for cost optimization

UNIT-III

Operations planning and control as an integrated system - Aggregate planning strategies, optimal aggregate plan-Linear programming approach to Aggregate planning -problems, master production schedule – product structure tree, Material requirement planning, MRP-II – Concepts of just-in-time, Pull and push system of work flow in JIT- ERP.

Learning Outcomes:

At the end of this unit students will be able to:

- ***analyze*** the Aggregate planning strategies for cost optimization (L4)

- ***relate*** the concepts of MRP-I, MRP-II, JIT (L2)

Application:

1. Optimal aggregate plan in beverage plants.
2. JIT implementation in automobile plants.

UNIT-IV

Operations Scheduling in production systems: Forward scheduling, backward scheduling. Scheduling in batch production, determination of batch size, sequencing and scheduling for batch production

Job shop scheduling – Introduction – flow –shop sequencing – n jobs through twomachines – n jobs through three machines – job shop sequencing – two jobs through 'm' machines. Scheduling on single work centre, flow time, lateness calculations, Gantt chart for scheduling.

Learning Outcomes:

At the end of this unit students will be able to:

- ***solve*** the problems of scheduling for batch production (L3)
- ***compare*** the concepts of MRP-I, MRP-II, JIT (L2)

Application: 1. Scheduling in batch production units –beverage plants, soap making units.

2. Scheduling in job order plants- foundry units, machine shops

UNIT-V

Operational Ergonomics: Introduction –Product life cycle- product design and development, Elements of costs, Estimating manufacturing costs, Break even analysis-applications-Economical factors for make or buy decisions-exercises- reliability engineering –reliability concept-bath tub curve, MTBF, System reliability: series arrangement of components, parallel arrangement of components, Total productive maintenance.

Learning Outcomes:

At the end of this unit students will be able to:

- ***analyze*** the manufacturing costs for process selection and make or buydecisions (L4)
- ***solve*** the problems on System reliability (L3)

Application:

- Automobile units applying concepts of make or buy decisions for ordering parts.
- 2.Reliability analysis of spare parts.

Text Books:

1. Production and operation Management–By P. Ramamurty –New Age International Publication,New Delhi
2. Production and operation Management –By R. Mayer –TMH,New Delhi
3. PannerSelvem: "Production and Operation Management", Prentice Hall of India, New Delhi,2012.

REFERENCE BOOKS:

1. Industrial Engineering & Production Management –Martand Telsang, S.Chand & Co
2. Production and operations Management by –Adam and Ebert –PHI ,New Delhi

Subject Code	Subject Name	L	T	P	C
R19MEC-PC3105	Thermal Engineering Lab	0	0	3	1.5

Course objective:

To provide hands-on experience in operating various types of internal combustion engines and understand their functioning and performance.

Course Outcomes:

After completion of this lab the student will be able to

1. Outline the valve and port timing diagram of SI engine & CI engine (L1)
2. Determine the performance parameters for 4-stroke C.I engine&4-stroke S.I engine. (L2)
3. Evaluate and Prepare heat balance sheet for twin cylinder C.I engine. (L3)
4. Apply the concept of Morse test on SI engine.(multi cylinder). (L3)
5. Analyse the efficiency of reciprocating air compressor. (L4)

LIST OF EXPERIMENTS:

1. Draw the Valve timing diagram of 4-Stroke CI engine.
2. Draw the port timing diagram of 2-stroke SI engine.
3. Find different performance parameters of twin cylinder 4-Stroke CI engine with hydraulic dynamometer loading by conducting load test on it.
4. Find FP by conducting Retardation test on the four stroke CI engine .
5. Prepare the heat balance sheet on twin cylinder 4-Stroke CI engine with hydraulic dynamometer loading.
6. Find FP by conducting motoring test on 4-Stroke SI engine.
7. Find different performance parameters of variable compression ratio engine by conducting load test on it.
8. Find different performance parameters of two stage reciprocating air compressor by conducting load test on it.
9. Find economical speed by conducting Economical speed test on 4-stroke multi cylinder SI engine.
10. Find FP by conducting Morse test on 4-stroke multi cylinder SI engine

Subject Code	Subject Name	L	T	P	C
R19MEC-PC3106	Machine Tools Lab	0	0	3	1.5

Course objectives:

- Explain the devices used for turning, slotting, shaping etc...
- Illustrate the operating parameters of milling machines
- Explain the working of different types of lathe operations

Course outcomes:

After completion of this course the student may be able to

1. Explain the lathe working principle and can perform various operations to prepare different shapes of products (L2)**.**
2. Experiment with drilling machines and can perform various operations to prepare different shapes of products (L3)**.**
3. Make use of shaper, slotting and planing machine and can perform various operations to prepare different shapes of products (L3)**.**
4. Explain the surface grinding machine and can perform various operations to prepare different shapes of products (L2)**.**
5. Experiment with a milling machine, with understanding working principle and can perform various operations to prepare different shapes of products (L3)**.**

List Of Experiments

1. Facing, Turning And Centre Drill Operations on Lathe Machine
2. The Step Turning And Knurling Operations on Lathe Machine
3. Make Slots In The Given Hollow Cylinder With Slotting Machine
4. Make A Spur gear on Milling Machine By Using Given Wooden Piece
5. Thread Cutting And Taper Turning Operations on Lathe Machine
6. Make A Rectangular "V" Block on Shaping Machine
7. Grind The Single Point Cutting Tool on Tool End Cutter Machine
8. Drilling And Tapping Operations on Radial Drilling Machine Using Aluminium Specimen
9. Grind The Surface Of Ms Flat Plate on Surface Grinding Machine
10. Perform Straight Slots on Planning Machine Using Wooden Specimen

Subject Code	Subject Name	L	T	P	C
R19BSH-MC3103	Advanced Communication Skills Lab	0	0	3	0

Course Objectives

- Encourage use of a wide range of grammatical structures and vocabulary in speech and writing
- Demonstrate good writing skills for effective paraphrasing, argumentative essays, and formal correspondence
- Provide training and opportunities to develop fluency in English through participation informal group discussions and presentations using audio-visual aids
- Knowing the best practices at the workplace to perform well in the interview.
- Encouraging smart self-learning, communication skills that focus on employability.

Course Outcomes

1. understand the grammatical forms of English and the use of these forms in specific communicative and career context
2. use a wide range of reading comprehension strategies appropriate to texts, to retrieve information
3. strengthen their ability to write paragraphs, essays, emails and summaries ➢improve their speaking ability in English both in terms of fluency and comprehensibility by participating in Group discussion and oral assignments
4. prepare their own resume and answer interview related questions unhesitatingly with acceptable soft skills

Unit 1

Preparing for Written Assessment

Grammar: Articles: Know how to use different types of Articles**,** use articles appropriately in context Identify errors in the use of articles, **Prepositions**: Learn to use prepositions in context, Identifying errors in the use of prepositions, Look at the different functions of Prepositions, **Tenses**: understand the different form of tense used in sentences, know the various purposes of using different Tense forms, Use appropriate tense forms of verbs in context, Identify the errors in the use of tense forms, **Concord**: Know how to identify Subject-Verb-Agreement in sentences, Use SVA appropriately in Context, identify the errors in the use of SVA, **Voices**:Know when to use Active or Passive Voice, Convert Active sentences to Passive ones,Relative Clause: Know what relative pronouns are, know when to use relative clauses,know the functions of Relative Clauses.

Soft Skills: Leadership:Introduction to Leadership, Leadership Power, Leadership Styles, Leadership in Administration. **Interpersonal Relations**:Introduction to Interpersonal Relations, Analysis of different ego states, Analysis of Transactions, Analysis of Strokes, Analysis of Life position

Learning Outcomes

At the end of the module, the learners will be able to

- Comprehend the factors that influence use of grammar and vocabulary in speech and writing(L3)
- Produce a range of valid grammatical sentences in the real world situations and professional environment.(L3)
- develop employability skills through Leadership skills and interpersonal skills (L3)

Unit 2

Reading Comprehension

Purposes & Strategies of Reading:know the general purpose of Reading,assess your skills of reading ,develop reading Strategies **Skimming for details**:Skim through a variety of

passages, understand how skimming will orient you to the text, **Identifying main Ideas**:Identify the main ideas in the give text,Look for supporting statements in a passage, understand how the writer supports main ideas with details **Scanning for information:**Scan passages for factual information, understand how scanning can help find certain answers quickly,know how to look for factual answers,**drawing inferences:**Understand how to draw inferences,infer meanings while reading passages, **vocabulary**:Learn strategies to understand difficult words used in the passage,Apply strategies of reading to understand a variety of passages,**practise tests**

Soft Skills:Communication: Introduction to Communication, Flow of Communication, Listening, Barriers of Communication, How to overcome barriers of communication. **Stress Management**:Introduction to Stress, Causes of Stress, Impact Stress, Managing Stress

Learning Outcomes

At the end of the module, the learners will be able to

- assess the reading skill by developing reading strategies (L3)
- Understand the skimming & scanning techniques orients to identify the theme,purpose and statements.(L2)
- develop employability skills through communication skills and stress management(L3)

Unit 3

Writing paragraphs & Essays

Features of Good Writing:understand what makes a piece of writing good,Analyse & discuss some samples of good & bad writing, **Gathering Ideas**: Discuss various techniques for gathering ideas before you start writing, practice some of the techniques that can be used in the Prewriting stage ,**Purposes of Writing:**understand the importance of purpose of writing,explore various purpose of writing,choose content & language based on the purpose **Writing for Specific audience:**Study ways of tailoring content to suit a target audience,analyse text to deduce the target audience,discuss how language is used to suit the target audience **organizing ideas:**understand the importance of organising ideas in a text,Learn the different ways of organising ideas,practice organising ideas while writing **Writing an introduction:**Know the importance of a good introduction, understand the different ways in which writers catch the attention of readers, **Developing supporting ideas:**Learn how to develop your ideas in a paragraph, discuss a variety of supporting ideas ,**Writing a conclusion:**Learn the different parts of a conclusion, Practice writing an effective conclusion **Using linkers:**Learn the different types of Linkers or cohesive devices, Discuss why it is important to use connectors in writing,**Choosing the right words:**Discuss why writers make a careful choice of language,Learn how to select language to make the intended impact, **Writing film & book reviews:** Learn the different categories of books & films,Know the elements which go into analysing books & films,Write your own film & book reviews **Common errors in writing, editing & proofreading**.:Practice correcting errors in basic sentence structure,Learn to proof-read & edit your draft before writing the final version

Soft Skills:Group Dynamics and Team Building: Importance of groups in organization,Interactions in group, Group Decision Taking, Team Building, Interaction with the Team, How to build a good team?

Learning Outcomes

At the end of the module, the learners will be able to

- produce logically coherent argumentative essays (L3)
- understand the use of passive voice in academic writing (L2)
- use appropriate vocabulary to express ideas and opinions (L2)
- develop employability skills through group dynamics and team building (L3)

Unit 4

Preparing for oral Assignment

Group Discussion: Group Discussions as a tool for selection, skills for GD,Leadership & Problem-Solving Skills, Types of GD, Group Dynamics, Roles & Functions: Beginning, Presenting, Elaborating, Roles & Functions: Clarifying, Synthesising & Challenging, Roles & Functions: Agreeing, Disagreeing & Summarizing., Etiquette: Body Language & Time Management, GD Activities

Soft Skills: Conflict Management:Introduction to Conflict, Causes of Conflict, Managing Conflict **Time Management:** Time as a Resource, Identify Important Time Wasters, Individual Time Management Styles, Techniques for better Time Management.

Learning Outcomes

At the end of the module, the learners will be able to

- participate in group discussions using appropriate conventions and language strategies and develop advanced listening skills for in-depth understanding of academic text(L3)
- collaborate with a partner to make discussions (L2)
- develop employability skills through conflict management and time management(L3)

Unit 5

Interview Skills

Purpose of interviews: Know what recruiters looking for during Interviews,Become familiar with the process of career search, understand your skills,interests,achievements and attitude better **Preparing a Resume:**Understand what a job application is,know the details to be included in a CV,Know how to lay out details of a CV & prepare CV on your own **Writing a Cover Letter:**Study the information which is included in a cover letter.Learn how to organise information in a cover letter ,**Before and at the interview:**Learn how to prepare for an interview,learn how to behave during the interview, discuss what the interviewer might assess you on **Answering FAQs about yourself & your families:**Learn how to answer questions about yourself & family, Learn how to identify & talk about your strengths and Weaknesses **Answering FAQs about Likes & Dislikes:**Learn to choose interests which will be relevant to your Interview.learn to speak about your likes & Dislikes **Answering FAQs about Justifying your candidature:**Know what you need to say to answer a question about yourself, Be able to answer questions about your suitability for a job **Answering FAQs about Priorities,Attitudes & Biases:**Understand what your priorities will be in a job & learn to talk about them,learn to correct understanding of your attitude, biases & prejudice, if any, towards others,know positive qualities that are valued at work **Answering FAQs about Professional goals:** Become aware of the things you need to keep in mind while choosing a job,Set goals for your professional growth & plan how to achieve them **Public Speaking: Planning, Practice & Delivery:**Plan one minute speeches on simple topics, understand how to capture the audience's attention, be able to create strong closing statements.

Soft Skills:Motivation: Introduction to Motivation, Relevance and types of Motivation, Motivating subordinates, Analysis of Motivation

Learning Outcomes

At the end of the module, the learners will be able to

- prepare a CV with a cover letter to seek internship/ job (L2)
- understand the structure of Interviews and familiar with frequently asked questions while interview and how to respond to it (L3)
- develop employability skills through motivation and analysis of motivation (L3)

Subject Code	Subject Name	L	T	P	C
R19CSE-SD3102	**Python Programming (Skill Development Elective Course)**	0	0	3	0

Course Objectives:

- To understand structure and data types of python script.
- To implement iterations and functions in python.
- To implement modules and data structures using mutable & immutable objects.
- To understand object oriented concepts on real world scenarios.
- To understand packages for statistics and gaming.

Course Outcomes:

1. Understand python shell environment and its program constructs.
2. Implement iterators and functions for data processing.
3. Implement modules and install packages.
4. Implement sequences and data structures for data organization.
5. Implement Object oriented concepts and handle different errors through exceptions.

Unit 1:

Introduction: History of Python, Features of Python, Applications, Python Using the REPL (Shell), Running Python Scripts, Variables, Assignment forms, Keywords, Input-Output, Indentation.

Operators and Type Conversion: Data Types: Numeric, Booleans, Sequence, Strings, Operators, Type conversions, Expressions.

Learning Outcomes:

After completing this chapter, student will be able to

- Understand the environment of python. (L2)
- Create and run simple scripts in python. (L2)
- Understand data types and their conversions. (L2)
- Understand operators for doing operations on different expressions. (L2)

Unit 2:

Decision &Control Statements: if, if-elif-else, for, while, break, continue, pass.

Functions: Defining Functions, Calling Functions, Arguments types, Fruitful Functions (Function Returning Values), Scope of the Variables in a Function - Global and Local Variables, Anonymous Functions, Lambdas with map, reduce and filter.

Learning Outcomes:

After completing this chapter, student will be able to

- Understand the iterations using looping structures. (L2)
- Make decisions through conditional statements. (L2)
- Understand functions to define call and pass as arguments. (L2)
- Write anonymous functions for resolving complex problems. (L2)

Unit 3:

Modules: Creating modules, import statement, from Import statement, name space, builtin modules- os, random, math, json, request, date, RegEx, itertools.

Packages: Introduction to PIP**,** Installing packages using PIP.

Exploring Data Science Libraries: NumPy, Pandas, Matplotlib

Learning Outcomes:

After completing this chapter, student will be able to

- Create and implement modules using import. (L3)
- Understand different built-in modules. (L2)
- Understand PIP to install new packages in python. (L2)
- Apply mathematical libraries for analysing data sets. (L2)

Unit 4:

Strings & Data Structures: String**,** String Formatting**,** List, String and List Slicing, Tuple, Sets, Frozen Sets, Dictionaries, Comprehensions, Built-in methods of all sequences.

Files in Python: Types of files,File Operations, Understanding read functions, read(), readline() and readlines(), Understanding write functions, write() and writelines(), reading and writing different file formats(.txt,.json,.csv etc)Programming using file operations

After completing this chapter, student will be able to

- Implement Data structures on different real time data. (L2)
- Understand text processing using String Object. (L2)

Unit 5:

Object Oriented Programming OOP in Python: Classes, 'self variable', Methods, Constructor, Inheritance, Polymorphism, and Data Abstraction.

Errors and Exceptions: Syntax Errors, Exceptions, Exception Handlers, Raising Exceptions, User-defined Exceptions

Learning Outcomes:

After completing this chapter, student will be able to

1. Implement Object oriented concepts with real world scenarios. (L2)
2. Understand Methods and decorators for annotating objects. (L2)
3. Understand error handling and handle exceptions. (L2)

APPLICATIONS:

- Web Application Development and Scraping
- Designing Games
- Machine Learning and AI based applications
- Data Science and Visualization
- Embedded and CAD Applications

TEXT BOOKS:

1. Core Python Programming by R Nageswara Rao ,dreamtech press publications
2. Python Programming: Using Problem Solving Approach by Reema Theraja, Oxford publications

REFERENCE BOOKS:

1. Python Programming: A Modern Approach, Vamsi Kurama, Pearson.
2. Learning Python, Mark Lutz, Orielly.
3. Python Programming by Ashok N Kamathane, McGrawhill
4. Fundamentals of Python by Kenneth H Lambert, Cengage

Subject Code	Subject Name	L	T	P	C
R19BSH-SD3101	**MATLAB for Computational Methods** (Skill Development Elective Course)	0	0	3	0

Course Objectives:

- To familiarize the MATLAB Programming for numerical techniques.
- To impart knowledge in basic concepts and few programming techniques using MATLAB in relation to the engineering applications.
- Carry out computational projects within numerical methods using MATLAB.

Course Outcomes:

At the end of the course students will be able to

1. Construct and apply small programs in MATLAB to mathematical problems. (L3)
2. Develop a program to find a real root of an equation using various numerical methods.(L3)
3. Develop programs to find the interpolation values using Lagrange's and Newton's interpolation formulae for a given set of points.(L3)
4. Develop programs to find solutions of ordinary differential equations using various numerical methods. (L3)
5. Develop programs to solve system of linear equations. (L3)

Module 1. MATLAB Basics: Basics for MATLAB,Input and Output operations, arithmetic operations, recovering from problems, errors in input, aborting calculations, algebraic or symbolic computation, substituting in symbolic expressions, symbolic expressions, variable Precision and exact arithmetic, vectors and matrices, suppressing output, functions, built-in functions, user-defined functions, managing variables. Programs on MATLAB basics.

List of Programs:

1. Mathematical computing using Built-in functions.
2. Symbolic Mathematics using Built-in functions

Module 2. MATLAB Programming: Writing scripts and functions, loops, arrays, conditional statements. Programs using functions, loops, arrays and conditional statements. Two-Dimensional Plots.

List of Programs:

1. Script files and functions on Mathematical problems.
2. Programming using loops and conditional statements.
3. MATLAB Code for Two-Dimensional Plots.

Module 3. MATLAB Programming for Numerical Methods: Root finding, interpolation, numerical differentiation, numerical integration, numerical solutions of ordinary differential equations and MATLAB Solvers for differential equations and Numerical Methods.

List of Programs:

1. MATLAB Code for Bisection Method, Regula Falsi Method, Newton-Raphson Method and Iterative methods.
2. MATLAB Code for Newton forward, backward interpolation formula and Lagrange's interpolation formula
3. MATLAB Code for the first order and second order derivatives of the given data.
4. MATLAB Code for trapezoidal rule and Simpson's 1/3rd and 3/8 rules.
5. MATLAB Code for Euler methods modified Euler's methods and Runge-Kutta method of fourth order.
6. MATLAB Code for Gauss-Seidel iteration method.
7. MATLAB Code for solving engineering problems
8. MATLAB Solvers for differential equations and numerical methods.

Suggested Books:

1. B.S. Grewal, Numerical Methods in Engineering & Science, Khanna Publishers, 2014.
2. Steven Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists-McGraw-Hill Higher Education (2006).
3. Sastry, S.S, Introductory Methods of Numerical Analysis, 5th edition, Prentice Hall, 2017.
4. MiszaKalechman, Practical MATLAB Basics For Engineers, CRCPress (2008).
5. John H. Mathews, Kurtis D. Fink, Numerical methods using MATLAB, Prentice Hall (1998).
6. RudraPratap, Getting Started with MATLAB A Quick Introduction for Scientists and Engineers,Oxford University Press (2010).
7. Brian R. Hunt, Ronald L. Lipsman, Jonathan M. Rosenberg, A Guide to MATLAB for Beginners and Experienced Users, Cambridge University Press(2006).
8. S.R. Otto and J.P. Denier, An Introduction to Programming and Numerical Methods in MATLAB Springer-Verlag London Limited(2005).
9. YogeshJaluria, Computer Methods For Engineering With MatlabApplications,Taylor &Francis(2011).
10. William Bober, Introduction to Numerical and Analytical Methods with MATLAB for Engineers and Scientists, CRC Press(2014).
11. Rao V. Dukkipati, MATLAB: An Introduction with Applications, New Age International (P) Limited, Publishers(2010)

III Year –II Semester

Subject Code	Subject Name	L	T	P	C
R19MEC-PC3201	CAD/CAM	3	0	0	3

Course Objectives:

- To familiarize the students with all the important elements of CAD/CAM, geometric representation and transformations.
- To introduce the students about various parametric representations of curves and surfaces in geometric modelling.
- To impart knowledge related to methods and techniques in geometric modelling of solids in CAD.
- To understand the students with numerical control (NC), computer numerical control (CNC) and direct numerical control (DNC) machines.
- To analyze the students about the principles and concepts of robotics and various elements of Computer Integrated Manufacturing(CIM).

Course Outcomes:

1. Apply the basics of geometric transformations in CAD/CAM. (L3)
2. Distinguish various geometric modelling methods for building CAD models. (L4)
3. Identify the concepts of parametric representation to curves and surfaces, create surfaces such as Coons, Bezier and B-spline. (L3)
4. Select NC, CNC and DNC machines. (L4)
5. Summarize the principles of robotics and Computer Integrated Manufacturing. (L2)

UNIT I

CAD/CAM: Introduction, hardware and software, I/O devices, benefits. Graphics standards-Neutral file formats – IGES, STEP.

2D and 3D geometric transformations: Translation, scaling, rotation, mirroring, homogeneous transformations, concatenation of transformations, viewing transformations.

Applications: Used for image registration and the removal of geometric distortion.

Learning Outcomes:

At the end of this unit, the student will be able to

- Recall Various Input And Output Devices (L1)
- Construct Geometric Transformations In 2D And 3D (L3)
- Apply Window To Viewport Transformation (L3)

UNIT II:

Geometric Modelling:

Parametric representation: Representation of curves, Hermite curves, Spline, Bezier and B-spline curves in two dimensions; Geometric modelling of surfaces: Surface patch, Coons and bicubic patches, Bezier and B-spline surfaces, sweep surfaces, surface of revolution, blending of surfaces.

Applications: Used in design engineering and manufacturing for geometric modeling application

(industrial design) and geometric modeling systems (CAD systems).

Learning Outcomes:

At the end of this unit, the student will be able to

- Apply The Concepts Of Parametric Representation To Curves And Surfaces. (L3)
- Develop Surfaces Such As Coons, Bezier And B-Spline (L3)

UNIT III:

Geometric Modelling of solids:

Geometric Modelling of Solids: Wireframe, surface modelling, solid entities, boolean operations, CSG approach and B-rep of solid modelling, geometric modelling of surfaces.

Applications: Used to help design engineers to view the part / object as if it was really manufactured. The CAD software can even change the perspective and viewing angles.

Learning Outcomes:

At the end of this unit, the student will be able to

- Apply The Concepts Of Parametric Representation To Curves And Surfaces. (L3)
- Develop Surfaces Such As Coons, Bezier And B-Spline (L3)
- Differentiate Wireframe, Surface And Solid Modelling. (L4)

UNIT IV

Computer Aided Manufacturing (CAM): Structure of numerical control (NC) machine tools, designation of axes, drives and actuation systems, feedback devices, computer numerical control (CNC) and direct numerical control (DNC), adaptive control system, functions of CNC and DNC systems.

Part Programming: Part programming instruction formats, information codes, preparatory functions, miscellaneous functions (G-codes, M-codes). Tool codes and tool length offset, interpolations canned cycles.

Applications: Helping design engineers to view the part / object as if it was really manufactured. The CAD software can even change the perspective and viewing angles

Learning Outcomes:

At the end of this unit, the student will be able to

- Define NC, CNC and other various NC systems. (L1)
- Explain about various Devices And Activation Systems. (L2)
- Apply the Fundamentals and use various codes of Part Programming In CNC. (L3)

UNIT V

Group Technology: Part family, coding and classification, production flow analysis, types and advantages. Computer aided processes planning – importance, types.

Computer integrated manufacturing (CIM): Elements of CIM, Virtual Reality (VR), Augmented Reality (AR), Artificial Intelligence (AI) and expert systems in CIM.

Applications: Group Technology is used in design standardization, manufacturing cell layouts, process planning, purchasing, and manufacturing technology systems design.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand various manufacturing techniques in which parts having similarities in geometry.(L1)
- Apply the functions that are manufactured in one location using a small number of machines or processes. (L3)
- Summarize The Fundamentals Of Robotics. (L2)
- Categorize The CIM Environment and Its Elements. (L4)

Text books:

1. P. N. Rao, CAD/CAM: Principles and applications, 3/e, Tata McGraw-Hill, Delhi, 2017
2. Ibrahim Zeid, R.Siva Subramanian, CAD/CAM: Theory and Practice, 2/e, Tata McGraw-Hill, Delhi, 2009

Reference books:

1. Mikell P. Groover, Emory W. Zimmers , CAD/CAM, 5/e, Pearson Prentice Hall of India, Delhi, 2008
2. P. Radhakrishnan, S. Subramanyan & V. Raju, CAD/CAM/CIM, 3/e, New Age International Publishers, 2008
3. Computer Aided Manufacturing, 3/e, Tien Chien Chang, Pearson, 2008

Subject Code	Subject Name	L	T	P	C
R19MEC-PC3202	Heat Transfer	3	0	0	3

Course Objectives

- To gain experience in the application of CFD analysis to real engineering designs.
- To impart the basic laws of conduction, convection and radiation heat transfer and their applications.
- To familiarize the convective heat transfer concepts.
- To make conversant with the heat transfer analysis related to thermal systems like heat exchangers, evaporator, and condenser.
- To explain basics of radiation heat transfer.

Course Outcomes

After completing the course, the student will be able to

1. Apply the concepts of different modes of heat transfer. (L3)
2. Utilize the knowledge of conduction heat transfer in the design of insulation of furnaces and pipes. (L3)
3. Analyze free and forced convection phenomena in external and internal flows. (L4)
4. Design of thermal shields using the concepts of black body and non-black body radiation. (L5)
5. Apply the basics of mass transfer for applications in diffusion of gases. (L3)

UNIT- I

Introduction: Basic modes of heat transfer- rate equations- generalized heat conduction equation - steady state heat conduction solution for plain and composite slabs - cylinders - critical thickness of insulation- heat conduction through fins of uniform cross section- fin effectiveness and efficiency.

Unsteady State Heat Transfer Conduction- Transient heat conduction- lumped system analysis and use of Heisler charts.

Applications: Heat transfer in cooking utensils, iron boxes, water geysers, heat transfer through metals

Learning Outcomes:

At the end of this unit the student will be able to

- identify the phenomenon related to different modes of heat transfer (L1)
- compare different types of conduction heat transfer (L2)
- apply concept of thermal resistance and its importance in practical problems (L3)

UNIT- II

Convection: Basic concepts of convection–heat transfer coefficients - types of convection – forced convection and free convection.

Forced convection in external flow–concepts of hydrodynamic and thermal boundary layer-use of empirical correlations for flow over plates and cylinders. Fluid friction – heat transfer analogy, approximate solution to laminar boundary layer equation for external flow. Internal flow – Use of empirical relations for convective heat transfer in horizontal pipe flow.

Free Convection -development of hydrodynamic and thermal boundary layer along a vertical plate – use of empirical relations for convective heat transfer on plates and cylinders in horizontal and vertical orientation

Application: chimneys fitted in factories, heat transfer in liquids and gases, heat transfer in cooling towers and cooling jackets for reactors

Learning Outcomes:

At the end of this unit the student will be able to

- Apply the convective heat transfer principles (L3)
- Use analogy between fluid friction and heat transfer to solve engineering problems. (L3)

UNIT -III

Boiling and Condensation: Different regimes of boiling- nucleate, transition and film boiling – condensation - film wise and drop wise condensation.

Application: Refrigerant boiling and condensing in Air conditioners and refrigerators, boiling of fluids in chemical industries, industrial kettles

Learning Outcomes:

At the end of this unit the student will be able to

- interpret the basic modes of condensation heat transfer (L2)
- identify different regimes of boiling in design of boilers (L3)

UNIT-IV

Heat Exchangers: Types of heat exchangers- parallel flow- counter flow- cross flow heat exchangers- overall heat transfer coefficient- LMTD and NTU methods- fouling in heat exchangers.

Applications:. Heat exchangers for process industries, sugar factories, chemical industries, refrigeration and air conditioning units

Learning Outcomes:

At the end of this unit the student will be able to

- explain the working of different types of heat exchangers (L2)
- calculate the heat transfer in heat exchangers (L2)
- design a heat exchanger for a given application (L3)

UNIT- V

Radiation: Radiation heat transfer – thermal radiation – laws of radiation - Black and Gray bodies – shape factor-radiation exchange between surfaces - Radiation shields - Greenhouse effect.

Applications: heat transfer through vacuum, electromagnetic radiation, heat transfer from camp fir, Heat radiated from I.C.Engine, solar radiation

Learning Outcomes:

At the end of this unit the student will be able to

- Apply the principles of radiation heat transfer (L3)
- Calculate the radiation heat transfer between two bodies (L2)
- Design a radiation shield for given conditions (L3)
- Examine the effect of greenhouse gases on atmosphere (L4)

Text Books:

1. P.K. Nag, Heat Transfer, 3/e, Tata McGraw-Hill, 2011.
2. Fundamentals of Engineering Heat and Mass Transfer- R.C. Sachdeva, New Age Publications
3. Heat and Mass Transfer- R.K Rajput, Publishers -S Chand & Co Ltd
4. *Heat & Mass Transfer- D.S.KUMAR,* S. K. Kataria & Sons Publishers
5. Heat and Mass Transfer Databook- C.P. Kothandaraman and S. Subramanyan, New Age Publications

Reference Books

1. Heat Transfer- J.P.Holman, 9/e, Tata McGraw-Hill,2008.
2. Fundamentals of Heat and Mass Transfer- F. P. Incropera and D.P. Dewitt, 6/e, John Wiley, 2007
3. Heat Transfer- A Practical Approach- Cengel. A.Yunus,, 4/e, Tata McGraw-Hill, 2007.
4. A Textbook of Heat Transfer- S.P. Sukhatme, Universities Press, 2005
5. A Heat and Mass Transfer- Lienhard and Lienhard,, Cambridge Press, 2011.

Subject Code	Subject Name	L	T	P	C
R19MEC-PC3203	Finite Element Methods	3	0	0	3

Course Objectives:

- Familiarize basic principles of finite element analysis procedure.
- To learn the theory and characteristics of finite elements that represent engineering
- structures.
- Explain theory and characteristics of finite element structural applications using trusses and beams.
- Apply the finite element solutions to solve 2D problems like triangular, axi – symmetrical solids and quadrilateral elements.
- Explain the finite element solutions to solve heat transfer problems and problems involving dynamics.

Course Outcomes:

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

1. To learn basic principles of finite element analysis procedure .(L1)
2. Apply the basics of FEM to relate stresses and strains for structural elements.(L3)
3. Identify the applications and characteristics of FEA elements for trusses & beams. (L3)
4. Apply the formulation techniques to solve 2D problems using triangle, axi – symmetric elements and quadrilateral elements.(L3)
5. Able to identify how the finite element method expands beyond the structural domain, for problems involving dynamics, heat transfer and fluid flow.(L3)

Unit I:

Introduction: Introduction to finite element methods for solving field problems, Stress and equilibrium, Boundary conditions, Strain-Displacement relations, Stress- strain relations for 2D and 3D Elastic problems. Potential energy and equilibrium, The Rayleigh-Ritz method, Formulation of Finite Element Equations.

Application: structural analysis

Learning Outcomes:

At the end of the unit, the student will be able to

- Understand the numerical methods involved in Finite Element theory.(L2)
- Understand the concepts behind variational methods and weighted residual methods in FEM. (L2)
- Understand direct and formal (basic energy and weighted residual) methods for deriving finite element equations. (L2)

Unit-II:

One dimensional problems : Discretization process, Types of elements, node numbering, mesh generation, Convergence criteria, interpolation functions, local and global coordinates. Shape function, Element Stiffness Matrix and Load Vector, Assembly of global stiffness matrix and load vector Finite element equations, Treatment of boundary conditions, Temperature effects.

Application: structural analysis

Learning Outcomes:

At the end of the unit, the student will be able to

- Understand the role and significance of shape functions in finite element formulations and use linear, quadratic, and cubic shape functions for interpolation(L2)
- Understand the process of meshing and application of boundary conditions.(L2)
- Understand global, local, and natural coordinates.(L2)
- Develop element characteristic equation procedure and generation of global stiffness equation will be applied.(L3)

- Able to apply Suitable boundary conditions to a global structural equation, and reduce it to a solvable form.(L3)
- Solve axially loaded bar Problems.(L3)

UNIT III:

Analysis of trusses & beams

Analysis of Trusses: Finite element modelling, coordinates and stiffness Matrix for plane truss element. assembly of global stiffness matrix and load vector, finite element equations, treatment of boundary conditions, stress, strain and support reaction calculations.

Analysis of Beams: Boundary conditions, Load vector, Hermite shape functions and simple problems.

Application: Building roof and railway bridges and shafts supported in bearing such as axles and line shafts etc.

Learning Outcomes:

At the end of the unit, the student will be able to

- Understand the use of the basic finite elements for structural applications using truss and beam. (L2)
- Solve truss and beam problems. (L3)

UNIT IV:

Two Dimensional Problems: Finite Element Modeling, Constant Strain Triangle (CST) Element Stiffness, Force terms, Stress calculation, Problem modeling and boundary conditions. Plane Stress and plane Strain Problems using CST Element. Problems on isoparametric formulation of 4-noded quadrilateral element.

Numerical Integration: Gaussian quadrature one point, two point and three point formulae, 2D integrals.

Application: Plates under bi-axial loading and the bending of plates , pressure vessels, flywheel, turbine discs etc.

Learning Outcomes:

At the end of the unit, the student will be able to

- Implement the formulation techniques to solve two-dimensional problems using triangle and quadrilateral elements .(L3)
- Solve plane stress conditions, axisymmetric and Quadrilateral Element problems.(L3)

UNIT V:

One Dimensional Heat transfer Problems & Dynamic analysis

One Dimensional Heat transfer Problems: Equilibrium equations, heat conduction in plane walls, heat transfer analysis of fins, finite element formulation, simple problems.

Dynamic analysis: Formulation of finite element model, element consistent and lumped mass matrices, evaluation of eigen values and eigenvectors, free vibration analysis.

Applications:

- Heat transfer involved in the operation of Power plant equipments such as boilers, condensers, air pre-heaters etc., refrigeration and air conditioning systems.
- Dynamic analysis is applied in all kind of structural components like bars, trusses, beams, frames and also machine components like piston rod, connecting rod, spindle etc.

Learning Outcomes:

At the end of the unit, the student will be able to

- Understand the application and use of the Finite Element Methods for heat transfer problems. (L2)
- Solve heat transfer problems. (L3)
- Understand problems involving dynamics using Finite Element Methods.(L2)

- Able to apply suitable boundary conditions to a global equation for dynamic problems and solve them Eigen values, Eigen Vectors and vibration analysis for stepped bar and beam elements.(L3)

Text books

1. Chandraputla, Ashok &Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall.
2. S.S.Rao, The Finite Element Methods in Engineering, Elsevier Butterworth -Heinemann 2nd Edition, 2011.

Reference books

1. J N Reddy, An introduction to the Finite Element Method, McGraw – Hill, New York, 1993.
2. R D Cook, D S Malkus and M E Plesha, Concepts and Applications of Finite Element Analysis, 3rd Edition, John Wiley, New York, 1989.
3. K J Bathe, Finite Element Procedures in Engineering Analysis, Prentice-Hall, Englewood Cliffs,1982.
4. T J R Hughes, the Finite Element Method, Prentice-Hall, Englewood Cliffs, NJ, 1986.
5. C Zienkiewicz and R L Taylor, the Finite Element Method, 3rd Edition. McGraw-Hill, 1989

Subject Code	Subject Name	L	T	P	C
R19MEC-PE3201.1	Refrigeration & Air Conditioning **(Professional Elective-2)**	3	0	0	3

Course Objective:

- Understand the basic cycles of various refrigerating systems
- Performance evaluation along with details of system components.
- Summarize various refrigerant properties
- Imparting knowledge of psychrometric properties
- Explain air conditioning systems

Course Outcomes:

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

1. Analyze various refrigerating cycles (L4)
2. Evaluate the performance of various cycles.(L5)
3. Evaluate cooling load calculations.(L5)
4. Examine various refrigerant properties and psychrometric processes. (L4)
5. Select the appropriate process and equipment for the required comfort and industrial air-conditioning. (L3)

UNIT – I

Introduction To Refrigeration: Necessity and applications – unit of refrigeration and C.O.P. – Mechanical refrigeration – types of ideal cycles of refrigeration. air refrigeration: bell Coleman cycle - open and dense air systems – refrigeration systems used in air crafts and problems**.**

Application: Aerospace industries

Learning Outcomes

At the end of this unit, the student will be able to

- Examine the applications of refrigeration. (L4)
- Analyze various refrigerating cycles (L4)
- Evaluate the performance of various cycles. (L5)

UNIT – II

Vapour Compression Refrigeration: Working principle and essential components of the plant – simple vapour compression refrigeration cycle – COP – representation of cycle on T-S and p-h charts – effect of sub cooling and super heating – cycle analysis – actual cycle influence of various parameters on system performance – use of p-h charts – numerical problems.

Application: Industries ,Aerospace etc.

Learning Outcomes:

At the end of this unit, the student will be able to

- Explain working principle of VCR. (L2)
- Explain representation of cycle on T-S and p-h charts. (L2)
- Evaluate the performance of VCR. (L5)
- Examine various parameters in sub-cooling and super heating. (L4)

UNIT III

Refrigerants – Desirable properties – classification - refrigerants used – nomenclature – ozone depletion – global warming

VCR System Components: Compressors – general classification – comparison – advantages and disadvantages. condensers – classification – working principles evaporators – classification – working principles expansion devices – types – working principles

Application: Industries, Domestic refrigerators etc.

Learning Outcomes

At the end of this unit, the student will be able to

- Examine Desirable properties of refrigerant. (L4)
- Discuss ozone depletion – global warming. (L6)
- List out various advantages and disadvantages of VCR.. (L2)
- Explain working principle of evaporators and expansion devices. (L2)

UNIT IV

Vapor Absorption System: Calculation of maximum COP – description and working of NH3 – water system and Li Br –water (Two shell & Four shell) System, principle of operation three fluid absorption system, salient features.

Steam Jet Refrigeration System: Working Principle and basic components. principle and operation of (i) thermoelectric refrigerator (ii) vortex tube.

Application: Industries, Domestic refrigerators etc.

Learning Outcomes

At the end of this unit, the student will be able to

- Classify various absorption refrigeration cycles. (L4)
- Explain working principle of VAR. (L2)
- Determine the COP of VAR.(L5)
- Explain working principle of steam jet and thermo electric refrigerator and vortex tube. (L2)

UNIT – V

Introduction To Air Conditioning: Psychometric properties & processes – characterization of sensible and latent heat loads — need for ventilation, consideration of infiltration – load concepts of RSHF, GSHF- problems, concept of ESHF and ADP temperature.

Air Conditioning Systems: Classification of equipment, cooling, heating humidification and dehumidification, filters, grills and registers, fans and blowers.

Application: Industries, Domestic Air-conditioning systems etc.

Learning Outcomes

At the end of this unit, the student will be able to

- Examine Psychometric properties & processes. (L4)
- Evaluate sensible and latent heat loads. (L5)
- Evaluate RSHF, GSHF, ESHF and ADP temperature (L5)
- Explain working principle of air conditioning systems. (L2)

Text Books:

1. A Course in Refrigeration and Air conditioning / SC Arora & Domkundwar / Dhanpatrai
2. Refrigeration and Air Conditioning / CP Arora / TMH.

References:

1. Refrigeration and Air Conditioning / Manohar Prasad / New Age.
2. Principles of Refrigeration /Dossat / Pearson Education.
3. Basic Refrigeration and Air-Conditioning / Ananthanarayanan / TMH Course

Subject Code	Subject Name	L	T	P	C
R19MEC-PE3201.2	Design for Manufacturing & Assembly **(Professional Elective-2)**	3	0	0	3

Course Objectives:

- To Explain the product development cycle and manufacturing issues to be considered in design.
- To Familiarize manufacturing consideration in cast, machining, cleaning and weld components.
- To summarize the design recommendations of machine components for the manufacturer
- To Impart knowledge of manufacturing assembly of machine components.
- To distinguish Differences and similarities between Design for Manufacturing and Design for Assembly.

Course Outcomes:

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

1. Outline the concepts of Design for Manufacturing & Assembly for machine components .(L2)
2. Identify the necessity for redesigning components out of manufacturing considerations.(L3)
3. Consider the manufacturing considerations while designing cast, forged weld and sheet metal components.(L2)
4. Apply the design recommendations of plastic parts with in manufacturing considerations.(L4)
5. Understand contemporary issues and their impact on design for manufacturing and assembly.(L2)

Unit I:

Introduction to DFMA: History of DFMA, Steps for applying DFMA during product design, Advantages of applying DFMA during product design, Reasons for not implementing DFMA, Introduction to Manufacturing Process: Classification of manufacturing process, Basic manufacturing processes. Introduction to materials and material selection: Classification of engineering materials, Material selection for product design

Application: The use of DFA allows a considerable reduction of the manufacturing costs, assembly time, and number of component parts, as well as increasing the productivity

Learning outcomes:

At the end of the unit, student will be able to

- Identify various steps in design process.(L3)
- Apply economical considerations at design stage.(L3)
- Develop creativity attitude in designing.(L3)
- Use Assembly charts for material selection(L1)

Unit II:

Design for casting: Design consideration of Investment casting, Typical characteristics and applications, Die-casting: Introduction to die-casting, Advantages of the die-casting process, Disadvantages of the die casting process, Applications, Suitable material consideration, General design consideration, Specific design recommendation.

Application: Used for production of cast iron, steel parts, very large sized parts, etc.

Learning outcomes:

At the end of the unit, student will be able to

- List various casting processes.(L1)
- Identify tolerances for various casting processes in manufacturing.(L3)

- Understand sand casting design process.(L2)

Unit III:

Design for machining: Design for machining: Introduction to machining, Recommended materials for Machinability, Design recommendations, Design for tuning operation: Process description, Typical characteristics and applications, Suitable materials, Design recommendations, Design for machining round holes: Introduction, Suitable materials, Design recommendations, Recommended tolerances, Parts produced by milling: Process description, Characteristics and applications of parts produced on milling machines.

Application: The design and production of gear wheels, keys, pulleys, etc.

Learning outcomes:

At the end of the unit, student will be able to

- Recall various machining processes in manufacturing.(L1)
- Select dimensional tolerances and surface roughness values of the machined components.(L3)
- Identify the necessity of redesigning of the components.(L3)

Unit IV:

Metal Extrusion: Introduction to Process, Suitable material for extrusion, Design recommendation for metal extrusion. Rolled formed section: Process, Design recommendations rolled section, Impact or cold extrusion: Process, Design recommendations for backward extrusion, Forward extrusion: Process, Design recommendations for forward extrusion.

Application: The production of bottles, Cylinders, shafts, etc.

Learning outcomes:

At the end of the unit, student will be able to

- Apply the design principles for various sheet metal operations.(L3)
- Define various cleaning process in metal extrusion process.(L1)
- Develop the design principles for Hot Dip Metallic Coating process.(L3)

Unit V:

Introduction to Assembly:

The assembly process, Characteristics and applications, Example of common assembly, Economic significance of assembly, General taxonomies of assembly operation and systems, Assembling a product.

Design for Assembly: Introduction, Design consideration, Design for Fasteners: Introduction, Design recommendation for fasteners.

Application: Design and Assembly of a manufacturing unit.

Learning outcomes:

At the end of the unit, student will be able to

- Apply design with assembly product.(L3)
- Deduct the time to assemble, if a product contains fewer parts. (L5)

Text Books:

1. J.Lesko, Industrial Design, Materials and Manufacture Guide, John Willyanons, Inc.
2. GeorgeE.DieterandLindaC.Schmidt(2009),EngineeringDesign,Fourthedition,McGraw-Hill companies, NewYork, USA
3. GeoffreyBoothroyd,PeterDewhurstandWinstonKnight,ProductDesignforManufactureandAssembly,SecondEdition,CRCpress,Taylor&Francis,Florida, USA

References:

1. A.K.ChitaleandR.C.Gupta,(1999)ProductdesignandManufacturing,PrenticeHall of India, NewDelhi.
2. O.Molloy,S.TilleyandE.A.Warman(1998)DesignforManufacturingandassembly, First Edition, Chapman & Hall, London, UK.

3. D.E.Whitney,(2004)MechanicalAssemblies:TheirDesign,Manufacture,andRolein Product Development, Oxford University Press, NewYork
4. JamesG.Bralla(1998)DesignforManufacturabilityHandbook,SecondEdition, McGraw-Hillcompanies, NewYork, USA.

Subject Code	Subject Name	L	T	P	C
R19MEC-PE3201.3	Manufacturing Methods in Precision Engineering **(Professional Elective-2)**	3	0	0	3

Course Objectives:

- To familiarize with surface treatments and their industrial applications.
- To explain powder metal production sintering techniques for metal powders.
- To demonstrate the processing of plastics and ceramics.
- To explain wafer preparation, optical lithography including current best practice and perceived limits and equipment required for micro-device packaging processes.
- To demonstrate the processing of different types of composite materials.

Course Outcomes:

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

1. Classify different surface treatment methods.(L2)
2. Analyze the processing of powder metals (L4)
3. Understand the applications of ceramics and plastics. (L2)
4. Develop CAD mechanisms in microelectronics like E-Manufacturing, nanotechnology and micromachining, high speed machining. (L3)
5. Apply the methods of liquefied, solidified and particulate methods for MMC, CMC, Polymer matrix composites. (L3)

Unit I

Surface treatment: Scope, Cleaners, Methods of cleaning, Surface coating types, and ceramic and organic methods of coating, economics of coating. Electro forming, Chemical vapour deposition, thermal spraying, Ion implantation, diffusion coating, Diamond coating and cladding.

Applications : Coatings for wear resistance and corrosion resistance

Learning outcomes:

After completion of this unit, students will be able to

- Identify the phenomenon related to different surface modification by physical and chemical treatments: (L3)
- Develop the basics of CVD (Chemical Vapour Deposition) and PVD (Physical Vapour Deposition) technologies for surface coating deposition, description of thermal spraying technology for surface coating applications. (L3)
- Explain properties and characteristics of different surface coatings and their applications.(L2)

Unit II

Processing of Powder Metals: Introduction, production of metal powders, compaction of metal powders, sintering, secondary and finishing operations, design considerations for powder metallurgy, Process capabilities, economics of powder metallurgy

Applications : Self lubricating bearings and filters, friction materials like clutch liners and brake bands.

Learning outcomes:

After completion of this unit, students will be able to

- Understand the concept of powder metallurgy. (L2)
- Analyze the different techniques in powder metallurgy and its applications. (L4)
- Demonstrate processing of powders and sintering techniques. (L2)

Unit III

Processing of Ceramics: Processing of particulate ceramics, Powder preparations, consolidation, Drying, sintering, Hot compaction, Area of application , finishing of ceramics.

Processing of Plastics, injection and blow moulding, calendaring, thermo forming, compression moulding, transfer moulding, High energy rate forming methods.

Applications : Thermal insulation, abrasives, laboratory glassware,

Learning outcomes

After completion of this unit, students will be able to

- Explain ceramics applications. (L2)
- Outline the mechanism of sintering properties and characteristics of powder metals (L2)
- Illustrate the different moulding methods for manufacturing of plastics. (L2)
- Explain the rapid prototyping methods in plastic processing. (L2)

Unit IV

Fabrication of Microelectronic devices: Crystal growth and wafer preparation, Film Deposition oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, computer aided design in microelectronics, surface mount technology, Integrated circuit economics.

Applications : Thin film batteries, optical coatings, PCB assembly

Learning outcomes:

After completion of this unit, students will be able to

- Illustrate wafer preparation, optical lithography. (L2)
- Explain the basic packaging and its levels, different IC chip mounting and interconnect methods. (L2)
- Develop CAD mechanisms in microelectronics like E-Manufacturing, nanotechnology and micromachining, high speed machining. (L3)

Unit V

Processing of Composites: Composite Layers, Particulate and fiber reinforced composites, Elastomers, Reinforced plastics, MMC, CMC, Polymer matrix composites.

Applications: Space crafts, Heat exchangers, Fusion Reactor walls, Biomedical applications

Learning outcomes:

After completion of this unit, students will be able to

- Interpret the use of fibre-reinforced composites in engineering applications. (L2)
- Summarize the use of composite materials, micromechanics of layered composites. (L2)
- Apply the methods of liquefied, solidified and particulate methods for MMC, CMC, Polymer matrix composites. (L3)

TEXT BOOKS:

1. Schmid and Kalpakjin, Manufacturing Engineering and Technology, 7/e, Pearson Education India, 2001.
2. 2.P.N. Rao, Manufacturing Technology, Foundry forming and welding, Vol I, 2/e, Tata McGraw-Hill, 2001.
3. 3.Rafiq Noorani, Rapid Prototyping Principles and Applications, Illustrated edition, Wiley, 2006.

REFERENCE BOOKS:

1. R.K. Jain, Production Technology, 17/e, Khanna Publishers, 2012.
2. Roy A. Lindberg, Process and materials of manufacturing, 2/e, Allyn and Bacon.

Subject Code	Subject Name	L	T	P	C
R19MEC-PE3201.4	Supply Chain Management **(Professional Elective-2)**	3	0	0	3

Course objectives

The students will learn

- Identify the strategies and models of Supply Chain Management
- Describe the criteria for Supply Chain Management decisions
- Understand the Key issues in supply chain management
- understand the uncertainties in supply chain management.

Course Outcomes

Students will be able to

1. Explain the strategies and models of Supply Chain Management(L2)
2. Apply the inventory management concepts in Supply Chain Management(L3)
3. Choose the criteria for Supply Chain Management decisions(L3)
4. Outline the role of suppliers. (L2)
5. Understand the significance of the reverse logistics in Supply Chain Management(L2)

UNIT I

Introduction to Supply Chain Management (SCM): Concept of Logistics Management, Conceptof SCM, Core competency, Value chain, Elements of supply chain efficiency, Flow in supply chains, Key issues in supply chain management.

Application: Automobile plants, Machinery units, Machine tools industry, Electronic goods industry

Learning Outcomes:

At the end of this unit, the student will be able to

- Compare Logistics and Supply Chain Management(L2)
- Explain the key issues in supply chain management(L2)

UNIT II

Sourcing and Procurement: Outsourcing benefit, Importance of suppliers, Evaluating a potential supplier, Vendor rating, Competitive bidding and Negotiation, E-procurement

Application: Online ordering system, Purchase of capital goods in large scale industries, Selection of supplies in manufacturing plants.

Learning Outcomes:

At the end of this unit, the student will be able to

- Outline the sources to get suppliers information. (L2)
- Identify the prospective supplier with Vendor rating(L3)

UNIT III

Introduction to Inventory Management: Selective Control Techniques, ABC analysis – procedure, VED analysis, Inventory control costs. Deterministic Inventory Models with out shortages, Quantity Discounts -Make-or-buy decisions. -Exercises

Application: Stores management in manufacturing plants

Learning Outcomes:

At the end of this unit, the student will be able to

- Explain the significance of Inventory Management. [L2]
- Analyze the inventory control costs related to deterministic models. [L4]

UNIT IV

Independent Demand Systems (Probabilistic Models): Q- system, P- system, Reorder level, buffer stock, and service level, -Exercises, Bullwhip effect, Information system for Supply Chain Management

Application: Inventory management with uncertainties in manufacturing plants

Learning Outcomes:

At the end of this unit, the student will be able to

- Develop the parameters of practical inventory systems. [L3]
- Explain *the* bullwhip effect to meet demand in managing the Supply Chain[L2]

UNIT V

Decision making and application: Decision making in SC – Applications of SCM – warehouse management system – product data management – E –Commerce – Reverse logistics – Cases in Automobile industry – Machine tools industry, Electronic goods industry

Application: Ware house management in manufacturing plants, Automobile industry –Machine tools industry, Electronic goods industry

Learning Outcomes:

At the end of this unit, the student will be able to

- Outline the applications of SCM
- Explain the functions of the warehouse management system
- Summarize the issues related to Reverse logistics

Text Books

1. Doebler, D.W. and Burt, D.N., Purchsing and Supply Chain Management: Text and Cases, McGraw-Hill Publishing Company Limited, New Delhi.

Reference Books

1. Chopra, S., and Meindl, P., Supply Chain Management: Strategy, Planning andOperations. Second Edition, Pearson Education (Singapore) Pte. Ltd, 2004.
2. Simchi-Levi, D., Kaminsky, P., and Simchi-Levi, E., Designing & Managing the Supply Chain: Concepts, Strategies & Case studies. Second Edition, Tata McGraw-Hill Edition

Subject Code	Subject Name	L	T	P	C
R19EEE-OE3202	**Energy Conservation and Management (Open Elective-1)**	3	0	0	3

Course Objectives:

- To design energy efficient lighting systems.
- To estimate/calculate power factor of systems and propose suitable compensation techniques.
- To understand energy conservation in HVAC systems.
- To understand energy efficiency, scope, conservation and technologies.
- To calculate life cycle costing analysis and return on investment on energy efficient technologies.

Course Outcomes:

1. Design energy efficient lighting systems
2. Design suitable power factor correcting equipment for an electrical system and energy monitoring system to analyze the energy consumption in an organization.
3. Explain energy conservation of HVAC systems
4. Understand the concept of energy audit, conservation schemes and consumption.
5. Calculate payback period, NPV, IRR etc. on an investment/project/technology.

Unit–I:

Lighting: Introduction- Definition of terms and units – Luminous efficiency – Polar curve – Calculation of illumination level – Illumination of inclined surface to beam – Luminance or brightness – Types of lamps – Types of lighting – Electric lighting fittings (luminaries) – Flood lighting – White light LED and conducting Polymers – Modification of existing systems – Replacement of existing systems –Energy conservation measures.

Learning outcomes: After completion of this unit students will be able to

- Understand energy efficiency technologies of lighting (L2).
- Design energy efficient lighting system (L4).

Unit–II:

Power Factor and energy instruments: Power factor – Methods of improvement – Location of capacitors – Power factor with non linear loads – Effect of harmonics on Power factor – Numerical problems. Energy Instruments – Watt–hour meter – Data loggers – Thermocouples – Pyrometers – Lux meters-Tong testers – Power analyzer.

Learning outcomes: After completion of this unit students will be able to

- Understand the power factor and its correcting methods. (L2).
- Calculate power factor of systems and propose suitable compensation techniques (L4).

Unit–III:

Space Heating and Ventilation: Ventilation – Air–Conditioning (HVAC) and Water Heating**:** Introduction – Heating of buildings – Transfer of Heat–Space heating methods – Ventilation and air–conditioning – Insulation–Cooling load – Electric water heating systems – Energy conservation methods.

Learning outcomes: After completion of this unit students will be able to

- Understand HVAC system (L2).
- Understand various electrical heating methods (L2).

Unit–IV:

Basic Principles of Energy Audit and management: Energy audit –Types of audit – Energy index – Cost index – Pie charts –Sankey diagrams – Load profiles – Energy conservation schemes and energy saving potential – Numerical problems – Principles of energy management – Initiating, planning, controlling, promoting, monitoring, reporting – Energy manager – Qualities and functions – Language – Questionnaire – Check list for top

management.

Learning outcomes: After completion of this unit students will be able to

- Understand the concept of energy audit, energy management and energy conservation schemes (L2).
- Develop the energy flow diagram to monitor the energy consumption in an organization (L3).

Unit–V:

Economic Aspects and Financial Analysis: Economics Analysis – Depreciation Methods – Time value of money – Rate of return – Present worth method – Replacement analysis – Life cycle costing analysis- Applications– Energy efficient motors (basic concepts) – Economics of energy efficient motors and systems.

Computation of Economic Aspects: Need of investment, appraisal and criteria - Calculation of simple payback period–Return on investment – Net present value – Internal rate of return – numerical examples – Lighting -Power factor correction.

Learning outcomes: After completion of this unit students will be able to

- Understand the concepts of Time value of money, Replacement analysis, Lifecycle cost analysis, energy efficient motors and systems.(L2)
- Determine Depreciation, Project measure of worth of an investment.(L4)

Text Books:

1. Hand Book of Energy Audit by Sonal Desai- Tata McGraw hill
2. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd–2nd edition, 1995

Reference Books:

1. Energy management by W.R. Murphy & G. Mckay Butter worth, Elsevier publications. 2012
2. Electric Energy Utilization and Conservation by S C Tripathy, Tata McGraw hill publishing company Ltd. New Delhi.
3. Energy management by Paul o' Callaghan, Mc–Graw Hill Book company–1st edition, 1998.
4. Energy management hand book by W.C.Turner, John wiley and sons.
5. Energy management and conservation –k v Sharma and pvenkataseshaiah-I K International Publishing House pvt.ltd,2011.

Subject Code	Subject Name	L	T	P	C
R19ECE-OE3202	**Image Processing (Open Elective-1)**	3	0	0	3

Course Objectives: This course will help to

- Understand the fundamentals of image processing.
- Apply various processes on images for image understanding.
- Understand the design aspects and realization of image processing applications.

Course Outcomes (COs)

1. Understanding the fundamental concepts of a digital image processing system.
2. Analyze different image sampling domains .
3. Understand the concept of image transforms and implementation
4. implement different image enhancement techniques for different applications
5. Estimate the different noises present in the image and restore the image quality.

UNIT 1

Introduction : Digital Image definitions ,Types of Operations ,Types of neighborhoods, Video parameters 2D convolution ,Properties of 2D convolution, 2D Fourier Transforms, Properties of 2D Fourier Transforms , Importance of phase and magnitude , Circularly Symmetric Signals,

Applications:

Fundamentals of image processing is used to analyze the images.

Learning Outcomes:

- Understand the fundamental concepts of a digital image processing signals
- Analyze the different types of signals

UNI T 2

Image Sampling: Two dimensional Sampling theory, Extensions of sampling theory, Non rectangular Grid sampling, Hexagonal sampling, Optimal sampling. Image Quantization: The optimum Mean Square Lloyd-Max quantizer, Optimum mean square uniform quantizer for non uniform densities, Analytic Models for practical quantizes, Visual quantization, Vector Quantization. MATLAB Implementations.

Applications:

- Image sampling is mainly used to get the clear image .
- Video processing and image processing

Learning Outcomes:

Analyze different image sampling theorems and simulation using MAT lab

UNIT 3

Image Transforms: Two dimensional orthogonal and unitary transforms, Separable unitary transforms, Basis images: Dimensionality of Image Transforms, Discrete linear orthogonal, DFT, WHT, KLT, DCT and SVD, Quantization of Transform coefficients, Transform Coding of Color images.

Applications:

Signature Verification-Preprocessing of Signature Patterns

Biometric Pattern Recognition-

Learning Outcomes:

- Understand the concept of image transforms and implementation

UNIT 4

Image Enhancement: Contrast and dynamic Range Modification, Histogram-based operations, Smoothing operations, Edge Detection-derivative based operation, Image Interpolation and Motion Estimation, Pseudo coloring.

Applications:
X-Ray Image Analysis
Spectral reflectance of various earth objects
Learning Outcomes:

- implement different image enhancement techniques for different applications

UNIT 5

Image Restoration: Degradation Estimation, Reduction of Additive Noise, Reduction of Image Blurring, Simultaneous reduction of noise and blurring, Reduction of Signal dependent noise, Temporal filtering for Image Restoration, Extrapolation of Band limited Signals.
Applications:
Pixel-based model- Shadow Detection-Surveillance system
Agriculture Industry-Robotics
Learning Outcomes:
Estimate the different noises present in the image and restore the image quality.

Text Books:

1. Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", 3rd Edition, Hardcover August 31, (2007).
2. J. R. Parker, "Algorithms for Image Processing and Computer Vision", Paperback, December 21, (2010).
3. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image Processing Using MATLAB", Hardcover – December 26, (2003).

Subject Code	Subject Name	L	T	P	C
R19CSE-OE3203	Database Management Systems **(Open Elective-1)**	3	0	0	3

Course objectives:

- Learn the fundamental concepts of database systems.
- Enable students to design ER diagram for any customized applications
- Learn simple and Complex queries using SQL.
- Learn schema refinement techniques (Normalization).
- Knowledge about transaction and recovery techniques.

Course Outcomes:

1. Understand File System Vs Databases.
2. Design and implement ER-model and Relational models.
3. Construct simple and Complex queries using SQL.
4. Analyze schema refinement techniques.
5. Design and build database system for a given real world problem

UNIT-I

Introduction-Database system, Characteristics (Database Vs File System), Database Users (Actors on Scene, Workers behind the scene), and Advantages of Data base systems, Database applications. Brief introduction of different Data Models; Concepts of Schema, Instance and data independence; Three tier schema architecture for data independence; Database system structure, environment, Centralized and Client Server architecture for the database.

Learning outcomes: Student will be able to

- Distinguish between Database System and File System (L2)
- Categorize different kinds of data models (L2)

Applications:

1. Universities and Colleges

UNIT-II

Relational Model: Introduction to relational model, concepts of domain, attribute, tuple, relation, importance of null values, constraints (Domain, Key constraints, integrity constraints) and their importance , Relational algebra, Relational Calculus.

Entity Relationship Model: Introduction, Representation of entities, attributes, entity set, relationship, relationship set, constraints, sub classes, super class, inheritance, specialization, generalization using ER Diagrams.

Learning Outcomes: Student will be able to

- Develop E-R model for the given problem (L6)
- Knowledge about integrity constraints in relational model (L1)

Applications:

Railway reservation Systems

UNIT-III

Schema Refinement (Normalization): Purpose of Normalization or schema refinement, concept of functional dependency, normal forms based on functional dependency(1NF, 2NF and 3NF), concept of surrogate key, Boyce-codd normal form(BCNF), Lossless join and dependency preserving decomposition, Fourth normal form(4NF).

Learning Outcomes: Student will be able to

- Differentiate between various normal forms based on functional dependency (L2)
- Apply Normalization techniques to eliminate redundancy (L3)

Applications:
Library Management systems.

UNIT-IV

Transaction And Recovery: Transaction State, Implementation of Atomicity and Durability, Concurrent Executions, Serializability,Deadlocks in transactions, Recoverability, Implementation of Isolation, Testing for Serializability, Failure Classification, Storage, Recovery and Atomicity, Recovery algorithm.

Learning Outcomes: Student will be able to

- Summarize transaction properties and recoverability (L2)

Applications:
Banking
Credit card transactions

UNIT-V

File Organization and Indexing, File Types, File Operations ,Cluster Indexes, Primary and Secondary Indexes , Index data Structures, Hash Based Indexing: Tree based Indexing, Indexes and Performance Tuning

Learning Outcomes: Student will be able to
1. Understand basic concepts of File Organization and Indexing (L2)

Applications:
1. Telecom
2. Online shopping

Text Books:

1. Database Management Systems, 3/e, Raghurama Krishnan, Johannes Gehrke,TMH
2. Database System Concepts,5/e, Silberschatz, Korth, TMH
3. Introduction to Database Systems, 8/e C J Date, PEA..

Reference Books:

1. Database Management System, 6/e Ramez Elmasri, Shamkant B. Navathe, PEA
2. Database Principles Fundamentals of Design Implementation and Management, Carlos Coronel, Steven Morris, Peter Robb, Cengage Learning.

Subject Code	Subject Name	L	T	P	C
R19BSH-OE3204	Statistical Quality Control **(Open Elective-2)**	3	0	0	3

Course Objectives

- Provide the concept of Quality and various techniques associated with quality control(L2)
- Enhance the complexity of statistical analysis and interpretation.(L2)
- Identify various statistical tools of quality monitoring. (L1)
- Analyze the acceptance sampling plans. (L3)
- Demonstrate the application of the control charts. (L2)

Course Outcomes:

1. Comprehend the importance of quality & role of statistical quality control.(L2)
2. Build knowledge of theoretical and practical aspects of process capability.(L3)
3. Analyse the philosophy of statistical process control to interpret results. (L3)
4. Develop an understanding on quality control charts philosophies and frameworks.(L3)
5. Identify accepting sampling plans to meet producer and consumer requirements.(L4)

UNIT-I

Introduction To Quality Control: Concept of quality-quality characteristics. Quality control, History of quality control, Inspection and quality control, Quality design ,Quality policy and objectives, Economics of quality, Quality function deployment(QFD).

Learning Outcomes:

After completion of this unit student will be able to

- Comprehend various terms associated with quality control(L2)
- Elucidate the concept of QFD.(L2)

Application:

Identify Manufacturing and write about their quality control techniques used in the organisation.

UNIT-II

Process Capability: Foundation of process capability, Natural Tolerance limits, Process capability index and Analysis –process performance index.

Learning Outcomes:

After completion of this unit student will be able to

- Demonstrate the process capability with an example(L2)
- Illustrate the process performance index(L2)

Application:

Observe and study Process capability index in manufacturing company.

UNIT- III

Statistical Process Control: Statistical basis of the Control Charts-principles, choices of control limits, significance of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on control charts.

Learning Outcomes:

After completion of this unit student will be able to

- Recognize statistical concepts related to control charts.(L2)
- Analyzeassignablecausesforvariationsinspecificationsofmanufacturedcomponents.(L4)

Application:

Identify assignable causes Quality control in machine shop by analyzing reasons.

UNIT-IV

Control charts for variables and attributes: Control limits for X and R-Charts, Type I and Type II errors, p chart, c chart construction. Simple Numerical Problems.

Learning Outcomes:

After completion of this unit student will be able to

- Construct control charts for variables and attributes(L3)
- Identify type I and type II errors(L3)

Application:

Construct control charts related to manufacturing process in an industry.

UNIT-V

Acceptance Sampling: Fundamental concept in acceptance sampling, Need of acceptance sampling, operating characteristics curve. Producer risk and consumer risk in sampling plans. Acceptance plans, single sampling plan, double sampling plan –exercises.

Learning Outcomes:

After completion of this unit student will be able to

- Describe the concepts of acceptance sampling(L2)
- Choose appropriate acceptance sampling plan to minimize producer risk and consumer risk.(L5)

Application:

Selection of sampling plan to minimize risk in manufacturing units.

TEXT BOOKS:

1. Statistical Quality Control. M. S. Mahajan, Dhanpat Rai Publishing Co Pvt Ltd
2. Statistical Quality Control – R.C. Gupta– Khanna Publishers, Delhi

REFERENCE BOOKS:

1. Grant,E,L.and Laven Worth,R.S.:Statistical Quality Control, McGrawHill.
2. Introduction to statistical quality control: By D.C. Montgomery 4th Edition, John Wiley &Sons.Inc.
3. Multivariate Q C in Encyclopedia of statistical sciences, Vol. 6: Edited by WL Johnson, S Kotz, John Wiley,N.Y.
4. Quality Control and Industrial Statistical: By A J Duncan, 5th Edition, Irwin, Homewood, Ille.
5. Principle of Quality Control: By Jery Banks, John Wiley.

WEBLINKS

1.https://nptel.ac.in/courses/112/107/112107259/- Inspection and Quality control manufacturing.

2.http://www2.ing.unipi.it/lanzetta/stat/Chapter20.pdf

3.https://www.youtube.com/watch?v=qb3mvJ1gb9g

4.https://freevideolectures.com/course/4539/nptel-operations-management/49?__cf_chl_managed _tk__=pmd

Subject Code	Subject Name	L	T	P	C
R19ECE-OE3208	Neural Networks and Fuzzy Techniques **(Open Elective-2)**	3	0	0	3

Course Objectives:

Students are able to study

- Fundamental concepts of fuzzy logic and artificial neural networks.
- analyze the various intelligent control systems
- Design the various intelligent control systems

Course outcomes:

Upon completion of the course, the student will be able to

1. 1Comprehend the concepts of feed forward neural networks
2. 2Analyze the various feedback networks.
3. Understand the concept of fuzziness involved in various systems and fuzzy set theory.
4. Understand the principle of competitive neural networks and Adaptive resonance theory.
5. To learn the architecture and algorithm of Cognitron, Neo cognitron along with the concepts of fuzzy associative memory and fuzzy systems.

Unit-I

Architecture Of Neural Networks: Architectures: motivation for the development of natural networks-artificial neural networks-biological neural networks-area of applications.

Learning Outcome: students will be able to

- Understand what feed forward neural networks are and how they function.

Applications:

Artificial neural networks are used for solving real world problem

Unit II

Basic Neural Network Techniques: Back propagation neural net: standard back propagation-architecture algorithm- derivation of learning rules number of hidden layers--associative and other neural networks- hetro associative memory neural net, auto associative net- Bidirectional associative memory-applications-Hopfield nets-Boltzman machine

Learning outcome:students will be able to

1Examine the different feedback networks.

Applications:

Neural Networks are used in the field of character and face recognition

Unit-III

Fundamentals Of Fuzzy Logic: Basic concepts: fuzzy set theory- basic concept of crisp sets and fuzzy sets- complements- union intersection combination of operation- general aggregation operations- fuzzy relations-compatibility relations-orderings- morphisms- fuzzy relational equations-fuzzy set and systems

Learning Outcome: Students will be able to

- Familiarize with the notion of fuzziness as it applies to different systems and fuzzy set theory.

Applications:

Speech recognition, facial characteristics recognition are the important application of Fuzzy Logic

UNIT IV

Competitive Neural Networks : Neural network based on competition: fixed weight competitive nets- Kohonenself organizing maps and applications-learning vector quantization-counter propagation nets and applications adaptive resonance theory: basic architecture and operation-architecture, algorithm, application and analysis of ART1 & ART

Learning Outcome: Students will be able to

- Understand the competitive neural network concept as well as adaptive resonance theory.

Applications:

Fuzzy Logic is used in the Aerospace industry to control the altitude of aircraft and satellites

UNIT V

Special Neural Networks: Cognitron and Neocognitron - Architecture, training algorithm and application-fuzzy associate memories fuzzy system architecture- comparison of fuzzy and neural systems.

Learning Outcome: Students will be able to

- Learn the design and algorithm of Cognitron and Neo cognitron, as well as fuzzy associative memory and fuzzy systems ideas.

Applications:

The target can be recognized easily using Fuzzy Logic, be it underwater or above the ground in the defence sector

Text books

1. T1. Kliryvan- Fuzzy System & Fuzzy logic Prentice Hall of India, First Edition.
2. Lawrence Fussett- fundamental of Neural network Prentice Hall , First Edition.

Reference Books:

1. Bart Kosko, ―Neural network and Fuzzy System‖ - Prentice Hall-1994.
2. J.Klin and T.A.Folger, ―Fuzzy sets‖ University and information- Prentice Hall -1996.
3. J.M.Zurada, ―Introduction to artificial neural systems‖-Jaico Publication house,Delhi 1994.
4. VallusuRao and HayagvnaRao , ―C++ Neural network and fuzzy logic‖-BPB and Publication, New Delhi,1996.
5. Intelligent Systems and Control-http://nptel.ac.in/courses/108104049/16

Subject Code	Subject Name	L	T	P	C
R19CSE-OE3201	**OOPs through JAVA**	3	0	0	3

Course Objectives:

- To understand the structure and environment of Java.
- To implement the relationship between objects.
- To apply data hiding strategy in objects.
- To implement text processing and error handling.
- To organize data using different data structures.
- To create multi threaded graphical user interface applications.

Course Outcomes:

1. Understand the environment of JRE and Control Statements.
2. Implement real world objects using class Hierarchy.
3. Implement generic data structures for iterating distinct objects.
4. Implement error handling through exceptions and file handling through streams.
5. Design thread-safe GUI applications for data communication between objects.

Unit I:

Java Environment and Program Structure: History of Java, Features, Applications, Java Installation - JDK and JRE, JVM Architecture, OOPS Principles, Class and Object, Naming Convention, Data Types, Type Casting, Type Conversion, Wrapper classes, Operators, instance of operator, Command Line Arguments, Decision making, Arrays, and Looping statements.

Learning Outcomes: Student will be able to

1. Understand architecture of Java Virtual Machine.(L2)
2. Understand the structure of java program and its environment. (L2)

Unit II:

Class Hierarchy & Data Hiding: Property, Method, Constructor, Inheritance (IS-A) , Aggregation and Composition (HAS-A), this and super, static and initialize blocks, Method overloading and overriding, static and final keywords, Types of Inheritance, Compile time and Runtime Polymorphism, Access Specifiers and scope, packages and access modifiers, Abstract class, Interface, Interface Inheritance, Achieving Multiple Inheritance, Class casting, Object Cloning, Inner Classes.

Learning Outcomes: Student will be able to

1. Understand the class hierarchy and their scope. (L2)
2. Implement relationship between objects. (L3)
3. Understand data hiding and nested classes. (L2)
4. Implement data type casting and cloning of objects. (L3)

Unit III:

Strings and Collections: String: Methods, StringBuffer and StringBuilder, StringTokenizer, **Collections:** Exploring java.util.*, Scanner, Iterable, Collection Hierarchy, Set, List, Queue and Map, Comparable and Comparator, Iterators: foreach, Enumeration, Iterator and ListIterator.

Learning Outcomes: Student will be able to

1. Understand the usage of String and its properties and methods.(L2)
2. Understand data structures and Iterators. (L2)
3. Create the data structures and implement different utility classes. (L3)

Unit IV:

IO and Error Handling

IO Streams: Exploring java.io.*, Character and Byte Streams, Reading and Writing, Serialization and De-serialization,

Error Handling: Error vs Exception, Exception hierarchy, Types of Exception, Exception handlers, User defined exception, Exception propagation.

Learning Outcomes: Student will be able to

1. Understand character and byte streams. (L2)
2. Understand the hierarchy of errors and exceptions. (L2)
3. Implement data streams and exception handlers. (L3)

Unit V:

Threads and GUI

Multi Threading: Process vs Thread, Thread Life Cycle, Thread class and Runnable Interface, Thread synchronization and communication.

GUI: Component, Container, Applet, Applet Life Cycle, Event delegation model, Layouts, Menu, MenuBar, MenuItem.

Learning Outcomes: Student will be able to

1. Understand the Thread Life Cycle and its scheduling.(L2)
2. Implement the synchronization of threads. (L2)
3. Create graphical components using Abstract window toolkit. (L3)

TEXT BOOKS:

1. The complete Reference Java, 8th edition, Herbert Schildt, TMH.
2. Programming in JAVA, Sachin Malhotra, SaurabhChoudary, Oxford.
3. Introduction to java programming, 7th edition by Y Daniel Liang, Pearson.
4. Java: How to Program, 9th Edition (Deitel) 9th Edition.
5. Core Java: An Integrated Approach, Java 8 by R. Nageswara Rao.

REFERENCE BOOKS:

1. Swing: Introduction, JFrame, JApplet, JPanel, Componets in Swings, Layout Managers in
2. Swings, JList and JScrollPane, Split Pane, JTabbedPane, JTree, JTable, Dialog Box.

Subject Code	Subject Name	L	T	P	C
R19MEC-PC3204	Heat Transfer Lab	0	0	3	1.5

Course Objectives

- To explain basics of radiation heat transfer.
- To Understand different modes of heat transfer
- To Gain knowledge about natural and force convection phenomenon
- To Estimate experimental uncertainty in measurements
- To provide the practical exposure about various heat exchanger methods and to determine the effectiveness of heat exchangers
- To Acquire practical knowledge about phase change process occurs in boiling and condensation
- To Apply concept of radiation heat transfer and to calculate Stefan boltzman constant for different bodies.

Course Outcomes

After completing the course, the student will be able to

1. Evaluate heat transfer through lagged pipe, insulating powder and Drop and Film wise condensation. (L4)
2. Experiment the Thermal conductivity of a given metal Rod and Determine the overall heat transfer coefficient for a composite slab. (L4)
3. Measure the Heat transfer coefficient for Pin Fin, Forced convection, Natural Convection (L3)
4. Design the Fins and Heat Exchangers(L5)
5. Test Emissivity, Stefan Boltzmann Constant. (L3)

LIST OF EXPERIMENTS

1. Determine the overall heat transfer coefficient across the width of composite wall
2. Determine the thermal conductivity of a metal rod
3. Determine the thermal conductivity of insulating powder material through concentric sphere apparatus
4. Determine the thermal conductivity of insulating material through lagged pipe apparatus
5. Determine the efficiency and effectiveness of a pin fin in natural and forced convection.
6. Determine the heat transfer coefficient for a vertical cylinder in natural convection
7. Determine the heat transfer coefficient in forced convection of air in a horizontal tube.
8. Determine the heat transfer coefficients on film and drop wise condensation apparatus.
9. Determine the effectiveness of a parallel and counter flow heat exchanger.
10. Determine the emissivity of the test plate surface.
11. Experiment on Stefan-Boltzmann apparatus

Subject Code	Subject Name	L	T	P	C
R19MEC-PC3205	Computer Aided Engineering Lab	0	0	2	1

Course Objectives:

- To introduce fundamentals of the analysis software, its features and applications.
- To learn basic element types in finite element analysis.
- To know the concept of discretization of continuum, Loading conditions and analyse the structure using preprocessor and postprocessor conditions

Course outcomes:

Upon successful completion of this course student should be able to:

1. Classify the types of Trusses (Plane Truss & Spatial Truss) and Beams (2D & 3D) with various cross sections to determine Stress, Strains and deflections under static, thermal and combined loading. (L2)
2. Determine Plane stress, plane strain conditions & axisymmetric loading on inplane members to predict the failure behavior and finding the SCF. (L3)
3. Analyse connecting rod with tetrahedron and brick elements, performing static analysis on flat & curved shells to determine stresses, strains with different boundary conditions. (L4)
4. Predict the natural frequencies and modes shapes using Modal, Harmonic analysis. Also finding the critical load using Buckling analysis (L5)
5. Evaluate various part programming methods using different NC or CNC packages. (L4)

1. **DRAFTING:** Development of part drawings for various components in the form of orthographic and isometric representation of dimensioning and tolerances scanning and plotting. study of script, DXE and IGES files.
2. **PART MODELING:** Generation of various 3D models through protrusion, revolve, shell sweep, creation of various features, study of parent child relation, feature based and boolean based modeling surface and assembly modeling, study of various standard translators, design simple components.
3. a) Determination of deflection and stresses in 2D and 3D trusses and beams.
   b)Determination of deflections component and principal and Von-mises stresses in plane stress, plane strain and axisymmetric components.
4. a)Determination of stresses in 3D and shell structures (at least one example in each case)
   b)Estimation of natural frequencies and mode shapes, Harmonic response of 2D beam
   c) Steady state heat transfer Analysis of plane and axisymmetric components.
5. a). Study of various post processors used in NC Machines.
   b). Machining of simple components on NC lathe and Mill by transferring NC Code / from a CAM package through RS 232.
6. CNC programming for milled components using FANUC Controller
7. Automated CNC Tool path & G-Code generation using Pro/E/Master CAM

Subject Code	Subject Name	L	T	P	C
R19MEC-PC3206	Theory of Machines Lab	0	0	3	1.5

Course Objectives:

- To find whirling speed of shaft
- To find the position of sleeve under controlling force.
- To analyze the motion of a gyroscope.
- To determine frequency of damped and undamped free vibration.
- To determine frequency of damped and undamped forced vibration.
- To perform static and dynamic balancing using rigid blocks.

Course Outcomes:

On completion of this lab student will be able to

1. Evaluate critical speed of shaft, by varying different speeds at which the shaft tends to vibrate i.e. at which resonance occurs.(L4)
2. Determine the working of different governors. And determine the different characteristic curves for the governor. (L3)
3. Assess the effect of Gyroscopic couple , velocity of precision at precise angles and its moments using gyroscope experimentation setup. (L5)
4. Measure the frequency of damped and undamped at free and forced vibration of an equivalent spring mass system. (L3)
5. Formulate balancing mass for rotating mass systems in static and dynamic condition (L6)
6. Determine the mechanical advantage, velocity ratio and efficiency of screw jack (L3)
7. Analyze various types of cam and followers with different kinds of follower motion(L4)

List of Experiments:

1. To determine the whirling speed of the shaft theoretically and experimentally.
2. To determine the position of sleeve against controlling force and speed of a Hartnell governor and to plot the characteristic curve of radius of rotation.
3. To analyze the motion of a motorized gyroscope when the couple is applied along its spin axis
4. To determine the frequency of undamped free vibration of an equivalent spring mass system.
5. To determine the frequency of damped force vibration of an equivalent spring mass system.
6. To study the static and dynamic balancing using rigid blocks.
7. To find the moment of inertia of a flywheel
8. To plot follower displacement vs cam rotation for various Cam Follower systems.
9. To plot slider displacement, velocity and acceleration against crank rotation for single slider crank mechanism/Four bar mechanism
10. To find coefficient of friction between belt and pulley.
11. To study simple and compound screw jack and determine the mechanical advantage , velocity ratio and efficiency
12. To study various types of gears- Spur, Helical, Worm and Bevel Gears

Subject Code	Subject Name	L	T	P	C
R19BSH-MC3202	Entrepreneurship & Incubation	3	0	0	0

Course Objectives:

- Emphasize the importance of entrepreneurship as an alternative to employment (L2)
- Initiate well founded ideas that have value in the end-market.(L1)
- Enable students, understand the opportunities available to start a business.(L1)
- Familiarize the process of business incubation/incubators.(L2)
- Impart knowledge about various financial sources available to start an enterprise.(L2)

Course outcomes:

1. Choose entrepreneurship as an alternative career. (L3)
2. Identify the validity of idea and it evaluation. (L3)
3. Develop suitable business plan.(L3)
4. Helping idea to translate into reality and upgrade them to the level of commercial value. (L2)
5. Analyze various financial support schemes provided by Government of India. (L3)

Unit I:

Fundamentals of Entrepreneurship: Fundamentals of Entrepreneurship – Characteristics of Entrepreneurs –Myths of Entrepreneurship –Elements of leadership –Role of Entrepreneurs in Indian economy – Social and Ethical Perspectives of Entrepreneurship - Corporate entrepreneurship – Social Entrepreneurship.

Case lets: Business cases of TATA, Infosys, Bajaj Auto.

Learning Outcomes:

At the end of this unit students will be able to:

- Define entrepreneurship and the characteristics of an entrepreneur. (L1)
- Explain the significance of entrepreneurship in the economic development of a nation.(L3)

Unit II:

Ideation and Evaluation of Business Ideas: Opportunity identification – Ideations process - Sources of business ideas – Role of creativity – Sources of Innovation - Business Idea Evaluation - Product/ Service design – Design Thinking – Customer.

Case lets: Business cases of OYO, Paytm and Flipkart/ Smartmart

Activity: Idea generation in groups.

Learning Outcomes:

- At the end of this unit students will be able to:
- Choose the right business ideas. (L3)
- Explain the business idea evaluation process. (L2)

Unit III:

Business Organizations and Feasibility Analysis: Forms of business Organisations/ownership – Techno-economic feasibility assessment – Financial feasibility – Market feasibility – Preparation of Business plan – Business canvas & Lean canvas – Challenges & Pitfalls in selecting new venture.

Activity: Preparation of business plan (draft)

Learning Outcomes:

At the end of this unit students will be able to:

- recall different forms of business organizations.(L1)
- Develop and analyze business canvas. (L4)

Unit IV:

Business Incubation: Fundamentals of business incubation - Business incubator models - Services of incubators - Pre requisites of incubator - Legal challenges for Entrepreneurship -

Intellectual Property Protection-Principles and practices of business incubation - Types of incubators and benefits-Technical aspects required for startups- Start-ups.
Activity: Business plan presentation.

Learning Outcomes:

At the end of this unit students will be able to:

- Describe/define the process of business incubation/incubators (L2)
- Select a suitable incubator and build a feasible business model. (L3)

Unit V:

Financial resources: Sources of finance – Bootstrapping - Government Support – Financial & Non-financial– Venture Capitalists & Angel Investors.
Activity: Business plan final version

Learning Outcomes:

At the end of this unit students will be able to:

- Knowledge about various sources of finance for entrepreneurship. (L2)
- Organize opportunities Seed capital /Angel financiers and understand operation.(L3)

Text Book:

1. T.V Rao, Donald F. Kuratko, Entrepreneurship,A South-Asian Perspective, Cengage Learning, 2012
2. Datsy Davies, Indian Startups, Amazon Asia-Pacific Holdings Private Limited, 2016

Reference Books:

1. P.N.Rath, Sarjue Pandita, Entrepreneurship: Startup India & Stand up India, Lexicon Publishing House, 2018
2. MadhurimaLall, Shikha Sahai, Entrepreneurship, Excel Books (P) Ltd. 2008
3. Rajeev Roy, Entrepreneurship, Oxford Higher Education. 2011
4. H. Nandan, Fundamentals of Entrepreneurship, PHI Learning (P) Ltd, 2013