

COURSE STRUCTURE (R20) AND DETAILED SYLLABUS (III YEAR)

MECHANICAL ENGINEERING

**For
B.Tech, Four Year Degree Course
(Applicable for the batches admitted from 2020-21)**



LENDI INSTITUTE OF ENGINEERING AND TECHNOLOGY

An Autonomous Institution

Approved by AICTE & Permanently Affiliated to JNTUK, Kakinada
Accredited 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

DEPARTMENT OF MECHANICAL ENGINEERING
B. Tech III-Year Course Structure and Syllabus –R20
III Year - I Semester

S.No	Course Code	Course Title	Category	Hours			Credits
				L	T	P	
1	R20MEC-PC3101	Design of Machine Members	PC	3	0	0	3
2	R20MEC-PC3102	Metal Cutting & Machine Tools	PC	3	0	0	3
3	R20MEC-PC3103	IC Engines & Turbo Machinery	PC	3	0	0	3
4	R20ECE-OE3103 R20EEE-OE3101 R20CSE-OE3103 R20BSH-OE3101	Open Elective -1 1) Mechatronics 2) Green Energy systems 3) Data Base Management System 4) Statistical Quality Control	OE	3	0	0	3
5	R20MEC-PE3101.1 R20MEC-PE3101.2 R20MEC-PE3101.3 R20MEC-PE3101.4	Professional Elective -1 1) Nuclear and Advanced Power Generation Technologies 2) Automobile Engineering 3) Mechanical Behaviour of Materials 4) Advanced Machining Process	PE	3	0	0	3
6	R20MEC-PC3104	Metal Cutting & Machine Tools lab	PC	0	0	3	1.5
7	R20MEC-PC3105	Thermal Engineering Lab	PC	0	0	3	1.5
8	R20CSE-SC3101	Python Programming (Skill Oriented Course-3)	SC	1	0	2	2
9	R20MEC-MC3101	3D Printing Technology (Mandatory Course)	MC	2	0	0	0
10	R20MEC-SI3101	Summer Internship-1 (Evaluations)	SI	0	0	0	1.5
Total credits							21.5
Honors Course -2/Minor Course-2							

III Year - II Semester

S.No	Code	Course Title	Category	Hours			Credits
				L	T	P	
1	R20MEC-PC3201	Design of Power Transmission Elements	PC	3	1	0	3
2	R20MEC-PC3202	Heat Transfer	PC	3	0	0	3
3	R20MEC-PC3203	Mechanical Measurements and Metrology	PC	3	0	0	3
4	R20MEC-PE3201.1 R20MEC-PE3201.2 R20MEC-PE3201.3 R20MEC-PE3201.4	Professional Elective -2 1) CAD/CAM 2) Composite Materials 3) Production Planning and Control 4) Refrigeration and Air Conditioning	PE	3	0	0	3
5	R20CSE-OE3204 R20EEE-OE3201 R20BSH-OE3201 R20ECE-OE3202	Open Elective -2 1) Internet of Things(IOT) 2) Non-Conventional Energy Sources 3) Operations Research 4) Image Processing	OE	3	0	0	3
6	R20MEC-PC3204	Computer Aided Engineering Lab	PC	0	0	3	1.5
7	R20MEC-PC3205	Heat Transfer Lab	PC	0	0	3	1.5
8	R20MEC-PC3206	Mechanical Measurements and Metrology Lab	PC	0	0	3	1.5
9	R20CSE-SC3201	OOPs through JAVA (Skill Oriented Course-4)	SC	1	0	2	2
10	R20BSH-MC3202	Entrepreneurship & Incubation (Mandatory Course)	MC	2	0	0	0
Total credits							
Honors Course -3/Minor Course-3							
Summer Internship-2(After Second Year & Evaluated in IV-I Semester)							

**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
R20MEC-PC3101	Design of Machine Members	3	0	0	3

Course Objectives:

The objectives of the course are to

- understand the significance of design in mechanical engineering and the steps involved in designing.
- select the proper materials to different machine elements based on their physical and mechanical properties.
- explain the criteria for different types of failure modes.
- learn the design procedure of different machine elements.

Course Outcomes:

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

1. Analyse the effects of built-up edge, chip thickness ratio, and chip breakers on machining (L2)
2. Apply principles to calculate machining time for lathe operations. (L3)
3. Demonstrate knowledge of the nomenclature for tools like twist drills, boring tools, and taps (L2)
4. Analyze the geometry of milling cutters, methods of indexing, and accessories to milling machines of these machining processes (L4)
5. Analyze the stresses induced in shafts and couplings (L4)

UNIT – I

Introduction: General considerations in the design of Engineering Materials and their properties–selection–Manufacturing consideration in design, tolerances and fits–BIS codes of steels- safety and reliability in design.

Stresses in Machine Members: Simple stresses–combined stresses–torsional and bending stresses–impact stresses–stress strain relation–various theories of failure–factor of safety– design for strength and rigidity–preferred numbers. The concept of stiffness in tension, bending, torsion and combined situations–static strength design based on fracture toughness.

Applications: In design of Automobiles, Mechanical Components etc..

Learning Outcomes:

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

- **understand** the basic design considerations (L2)
- **explain** the stresses in different machine members (L2)

UNIT – II

Strength Of Machine Elements: Stress concentration–theoretical stress concentration factor– fatigue stress concentration factor notch sensitivity–design for fluctuating stresses–endurance limit–estimation of endurance strength–Goodman’s line– Soderberg’s line–modified Goodman’s line.

Applications: In design of Automobiles, Mechanical Components etc..

Learning Outcomes:

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

- **identify** various stresses for the cause of fracture (L3)
- **explain** the factors considered for safe design (Understand)

UNIT – III

Riveted joints– Introduction- Methods of Riveting- Caulking and Fullering -Material of Rivets- Types of Rivet Heads. Types of Riveted Joints-Lap Joint- Butt Joint-Important Terms

Used in Riveted Joints- Failures of a Riveted Joint- Strength of a Riveted Joint- Efficiency of a Riveted Joint-Eccentric Loaded Riveted Joint.

Welded joints – design of joints with initial stresses – eccentric loading

Bolted joints–Design of bolts with pre-stresses–design of joints under eccentric loading–locking devices– both of uniform strength.

Applications: In construction of bridges, Assemblies of automobiles etc

Learning Outcomes:

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

- **explain** the types of welded, riveted and bolted joints(Understand)
- **understand** the procedure for design of bolts(Understand)
- **identify** various stresses induced in design of weld joints(Apply)

UNIT – IV

Keys: Design of keys-Introduction-Types of Keys-Sunk Keys- Saddle Keys-Strength of Sunk Key-stresses in the key

Pinned Joints: cotters- cotter joints-spigot and socket, sleeve and cotter, jib and cotter joints-Knuckle Joint- introduction-design

Applications: In Automobile Industry etc

Learning Outcomes:

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

- **explain** about design of keys and cotters used in machine members(Understand)
- **determine** the stresses induced in keys and cotters (Analyze)

UNIT-V

Shafts: Design of solid and hollow shafts for strength and rigidity–design of shafts for combined bending and axial loads.

Shaft coupling: Introduction- Requirements of a Good Shaft Coupling-Types of Shaft Couplings- Advantages and limitations.

Rigid couplings–muff Clamp or Compression Coupling and flange couplings

Flexible Coupling- Bushed Pin Flexible Coupling.

Applications: In heavy Trucks, four wheelers, etc

Learning Outcomes:

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

- **understand** the concept of tolerances in the design of shafts (Understand)
- **explain** the types of loads to be considered in design of shafts(Understand)
- **identify** the loads and stresses induced in couplings(Apply)

Note: Design data book is NOT Permitted for examination

Textbooks:

1. Machine Design/V. Bandari/ TMH Publishers
2. Machine design/NC Pandya & CSShah / Charotar Publishing House Pvt. Limited
3. Design data book of Engineers

References:

1. Design of Machine Elements /V.M.Faires / McMillan
2. Machine design/ Schaum Series/ McGraw Hill Professional
3. Machine Design/ Shigley,J.E/ McGraw Hill.
4. Design data handbook/K.Mahadevan & K.Balaveera Reddy/CBS publishers.
5. Design of machine elements-Spotts /Pearson Publications
6. Machine Design–Norton/Pearson publishers

Subject Code	Subject Name	L	T	P	C
R20MEC-PC3102	Metal Cutting & Machine Tools	3	0	0	3

Course Objectives:

The objectives of the course are to

- Explain the parameters in 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 with 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. Calculate the cutting forces and tool life (L3)
2. Classify the different lathe operations (L2)
3. Understand the boring, tapping and drilling operations. (L2)
4. Illustrate milling, shaping and slotting operations. (L2)
5. Examine the factors influencing the selection of grinding processes for different materials. (L4)

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 thickness ratio, chip breakers, Merchant's force diagram and numerical on Merchant Force Diagram

Learning Outcomes:

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

- **differentiate** orthogonal and oblique cutting (L2)
- **classify** types of chips, cutting tool materials and cutting fluids. (L2)
- **calculate** cutting force and tool life (L3)
- **explain** the geometry of single point cutting tool, speed and feed finding techniques. (L2)

Applications:

- Machining of Metals, Plastics and Glasses in the Mechanical Workshops

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.

Learning Outcomes:

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

- **Explain** types of lathes and boring machines. (L2)
- **Elucidate** the taper turning attachments. (L2)

Applications: Wood turning, turning, facing, grooving, parting, threading, drilling, boring, knurling operations in machine tool industry

UNIT-III

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

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

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

- **explain** the working Principles of drilling, boring and taping machines.(L2)
- **understand** the tool geometry of twist drill and taps(L2)

Applications:

- Accurate holes in the work pieces
- Metalworking and woodworking industries.

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 planning machines- Principles of working- principal parts, specification, classification, and operations performed.

Learning Outcomes:

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

- **Understand** the parts of the milling, shaping, slotting, and planning machine. (L2)
- **Compare** tool geometry for milling, shaping, slotting, and planning operations. (L2)

Applications:

- Gears, straight/flat surfaces, cutting keys and accurate flat surfaces.
- used to machine flat surfaces, produce irregular 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** types of grinding machines, jigs and fixtures and their applications. (L2)
- **explain** the design principles of jigs and fixtures. (L2)

Applications:

- Finishing operations on flat and cylindrical objects.
- Work holding devices in machining and cutting operations

Textbooks

1. P.N.Rao, Manufacturing Technology: Metal Cutting and n,(Volume2),3/e, Tata McGraw-Hill Education.
2. R.K.Jain and S.C.Gupta, Production Technology,17/e, Khanna Publishers.

Reference books

1. ``Kalpakjian S and Schmid SR, Manufacturing Engineering and Technology 7/e,Pearson.
2. Milton C. Shaw, Metal Cutting Principles, 2/e, Oxford.
3. Hindustan Machine Tools, Production Technology, TMH.
4. V.K.Jain, Advanced Machining Process,12/e, Allied Publications.
5. AB.Chattopadhyay, Machining and Machine Tools,2/e ,Wiley.
6. Halmi A Yousuf & Hassan, Machine Technology: Machine Tools and Operations, CRCPress Taylor and `Francis Group.

Subject Code	Subject Name	L	T	P	C
R20MEC-PC3103	IC Engines & Turbo Machinery	3	0	0	3

Course Objectives:

The objectives of the course are to

- Understand the concepts of internal combustion engines.
- Study the stages of combustion in spark ignition engines and diesel engines.
- Learn the process of carburetion, injection, ignition, cooling, lubrication and governing systems.
- Impart knowledge about various engine performance characteristics and its testing.
- Summarize the effects of volatility on the operation of I.C. Engines.
- Explain the principle of operation of turbo machines.

Course outcomes:

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

1. Compare the engine working on Air cycles and Air-fuel cycles (L3)
2. Analyze the combustion process and factors effecting Knocking (L4)
3. Identify the suitable injection, ignition, cooling, lubrication and governing systems of an Light motor and Heavy Vehicle (L3)
4. Analyze engine performance characteristics for the given operating conditions (L4)
5. Calculate the efficiency of turbo machinery for the given operating conditions. (L4)

UNIT-I

Introduction to I.C Engines: Engine classification, Two and four stroke engines, SI and CI 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 the course, the student will be able to

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

UNIT-II

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

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, Anti-freeze 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)
- **compare** centrifugal and axial flow compressors.(L2)

TEXTBOOKS

1. I.C Engine, by V. Ganeshan, Tata McGraw Hill Publishers
2. A Course in International Combustion Engines, by Mathur & Sharma, Dhanpat Rai & Sons.

3. Yahya, S.H, Turbines, Compressor and Fans, Tata McGraw Hill

REFERENCES

1. Fundamentals of Internal Combustion Engine by Gill, Smith, Ziurs, Oxford & IBH Publishing CO.
2. Internal combustion engine fundamentals by John B.Heywood, TataMcGraw Hil lPub, 1988.
3. Earl Logan, Jr, Hand book of Turbo machinery, Marcel Dekker Inc.
4. Shepherd, D.G, Principles of Turbo machinery, Macmillan.

Subject Code	Subject Name	L	T	P	C
R20ECE-OE3103	Mechatronics (Open Elective–1)	3	0	0	3

Course Objectives:

- To introduce the integrative nature of Mechatronics.
- To describe the different components and devices of mechatronics systems
- To describe various applications and future trends of mechatronics systems

Course Outcomes:

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

1. Describe Mechatronics design process and mechatronics system devices (L2)
2. Illustrate Solid state electronic devices and its applications in various mechatronics systems (L2)
3. Identify the different types of electro mechanical systems and its applications (L4)
4. Analyze different types of Digital electronics and systems and its applications(L4)
5. Design of mechatronics systems for future trends. (L3)

Unit I

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

Learning Outcomes:

- Different examples for mechatronics systems (L1)
- Advantages of mechatronics systems(L2)
- Application of different types of Sensors and transducers (L1)

Unit II

Solid state electronic devices - PN junction diode, BJT, FET, DIAC, TRIAC and LEDs. Analog signalconditioning, operational amplifiers, noise reduction, filtering.

Learning Outcomes:

- Different examples for Solid state electronic devices (L1)
- Different types of amplifiers and its applications (L1)

Unit III

Hydraulic and pneumatic actuating systems - Fluid systems, Hydraulic systems, and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems. Mechanical actuating systems and electrical actuating systems – basic principles and elements.

Learning Outcomes:

- Know about electro-pneumatic, hydro-pneumatic systems (L2)

- Applications of Mechanical actuating systems and electrical actuating systems (L4)

Unit IV

Digital electronics and systems, digital logic control, micro processors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control. Dynamic models and analogies, System response. Process Controllers – Digital Controllers, Programmable Logic Controllers

Learning Outcomes:

- Know about Digital electronics and systems (L2)
- Know about comparison of PLCs and computers (L2)
- Distinguish between Process Controllers and Programmable Logic Controllers (L4)

Unit V

System and interfacing and data acquisition – Data Acquisition Systems, Analog to Digital and Digital to Analog conversions; Digital Signal Processing – data flow in DSPs, block diagrams, typical layouts, Interfacing motor drives. Design of mechatronics systems & future trends.

Learning Outcomes:

- How to interface the systems for the purpose of data acquisition (L2)
- Different types of ADC and DAC converters (L4)
- Design of mechatronics systems for future trends (L3)

Text Books:

1. MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran, GK Vijaya Raghavan & MS Balasundaram/WILEY India Edition

References:

1. Mechatronics /Smaili A, Mrad F/ Oxford Higher Education, Oxford University Press
2. Mechatronics Source Book / Newton C Braga/Thomson Publications, Chennai.
3. Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
4. Mechatronics System Design / Devdas shetty/Richard/Thomson.
5. Mechatronics/M.D.Singh/J.G.Joshi/PHI.
6. Mechatronics – Electronic Control Systems in Mechanical and Electrical Engg. 4th Edition / W.Bolton/ Pearson.
7. Mechatronics – Principles and Application / Godfrey C. Onwubolu/Elsevier, Indian print

Subject Code	Subject Name	L	T	P	C
R20EEE-OE3101	Green Energy systems (Open Elective-1)	3	0	0	3

Course objectives:

- Understand the link between energy, environment and sustainable development
- Familiarize with energy ecosystems and its impact on environment
- Classify energy conversion system in solar and wind energy systems.
- Learn basics of various types of renewable and clean energy technologies
- Explain about Hydropower, Nuclear fission and fusion-Geothermal energy (L2)

Course Outcome:

After completion of the course, the student will be able to:

1. Understand the relationship between energy, environment and sustainable development (L2).
2. To know about energy ecosystems and its impact on environment (L2)
3. Classify energy conversion system in solar and wind energy systems (L4).
4. Learn basics of various types of ocean and bio-energy technologies(L2)
5. Understand about Hydropower, Nuclear fission and fusion-Geothermal energy (L2)

Unit I

Energy Sources: Introduction to the nexus between energy, environment and sustainable development, Energy sources over view and classification, sun as the source of energy, fossil fuel reserves and resources - overview of global/ India's energy scenario. Energy consumption models – Specific Energy Consumption

Learning Outcomes:

- Understand about different sources of energy (L2).
- Know about global/India's energy scenario (L2).

Unit II

Ecology and Environment: Concept and theories of ecosystems, - energy flow in major man-made ecosystems- agricultural, industrial and urban ecosystems - sources of pollution from energy technologies and its impact on atmosphere - air, water, soil, and environment - environmental laws on pollution control, The environmental protection act :Effluent standards and ambient air quality, innovation and sustainability, eco-restoration: phyto-remediation.

Learning Outcomes:

- Familiarize with the ecology and environmental concepts (L2).
- To know about environmental protection act. (L2)

Unit III

Solar and Wind Energy:

Solar Energy: Solar radiation: measurements and prediction. Indian's solar energy potential and challenges, solar energy conversion principles and technologies: Photosynthesis, Photovoltaic conversion and Photo thermal energy conversion.

Wind Energy: Atmospheric circulations, atmospheric boundary layers, classification, factors influencing wind, wind shear, turbulence, wind energy basics and power Content, wind speed monitoring, Betz limit, wind energy conversion system: classification, characteristics and applications.

Learning Outcomes:

- Understand the basic principles of solar energy conversion (L2).
- Classify the wind energy conversion systems. (L4)

Unit IV

Ocean and Bio-Energy:

Ocean Energy: Ocean energy resources-ocean energy conversion principles and technologies: ocean thermal, ocean wave & ocean tide

Bioenergy Biomass as energy resources; bio-energy potential and challenges, Classification and estimation of biomass; Source and characteristics of biofuels: Biodiesel, Bioethanol, Biogas. Types of biomass energy conversion systems - waste to energy conversion technologies.

Learning Outcomes:

- Understand the ocean energy conversion principles and technologies(L2).
- To know about bio-energy potential and challenges (L2).

Unit V

Other Energy Sources and Systems:

Hydropower, Nuclear fission and fusion-Geothermal energy: Origin, types of geothermal energy sites, site selection, geothermal power plants; hydrogen energy, Magneto-hydrodynamic (MHD) energy conversion – Radioisotope Thermoelectric Generator (RTG), Bio-solar cells, battery & super capacitor, energy transmission and conversions.

Learning Outcomes:

- Understand about geothermal power plants (L2).
- Understand about MHD energy conversion (L2)

Textbooks:

1. Energy and Environment Set: Mathematics of Decision Making, Loulou, Richard; Waaub, Jean-Philippe; Zaccour, Georges (Eds.).
2. Energy and the Challenge of Sustainability, World Energy assessment, UNDP, N York.
3. Solar Energy: principles of Thermal Collection and Storage, S.P. Sukhatme, Tata McGraw-Hill
4. Geothermal Energy: From Theoretical Models to Exploration and Development by Ingrid Soberand Kurt Bucher, Springer.
5. Ocean Energy: Tide and Tidal Power by R. H. Charlier and Charles W. Finkl, Springer.

Reference Books:

1. Energy and the Environment, Ristinen, Robert A. Kraushaar, Jack J. AKraushaar, Jack P. Ristinen,Robert A., 2nd Edition, John Wiley.
2. D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis,Philadelphia.
3. Wind Energy Conversion Systems, L.L. Freris, Prentice Hal.

Subject Code	Subject Name	L	T	P	C
R20CSE-OE3103	Data Base Management System (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. (L2)
2. Design and implement ER-model and Relational models. (L3)
3. Construct simple and Complex queries using SQL. (L2)
4. Analyze schema refinement techniques. (L4)
5. Design and build database system for a given real world problem (L3)

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)

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)

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)

Unit-IV

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

Learning Outcomes: Student will be able to

- Summarize transaction properties and recoverability (L2)

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

- Understand basic concepts of File Organization and Indexing (L2)

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
R20BSH-OE3101	Statistical Quality Control (Open Elective-1)	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. Apply the concept of Quality function deployment to meet the customer quality requirements in product development (L3)
2. Determine the Process capability index for the given design specifications. (L3)
3. Identify the assignable causes for process variations with quality control tools and techniques (L3)
4. Construct control charts for variables and attributes. (L3)
5. Develop acceptance sampling plan to minimize producer risk and consumer risk. (L3)

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)
- Analyze assignable causes for variations in specification of manufactured components(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, Mc Graw Hill.
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, SKotz, 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 Qualitycontrol manufacturing.](https://nptel.ac.in/courses/112/107/112107259/-Inspection%20and%20Quality%20control%20manufacturing)
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](https://freevideolectures.com/course/4539/nptel-operations-management/49?cf_chl_managed_tk=pmd) –

Subject Code	Subject Name	L	T	P	C
R20MEC-PE3101.1	Nuclear and Advanced Power Generation Technology (Professional Elective-1)	3	0	0	3

Course Objective:

The objectives of the course are to

- To Familiarize students with various areas of power generation
- To Acquaint students with the operation of power plant
- To educate students with safety & environmental concepts
- Learn about equipment, plant structure and operating principles of various types of power plants
- Learn various cutting-edge technologies in power plants

Course Outcomes:

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

1. understand the types of sources available to generate power (L2).
2. describe the nuclear power plant main components & its operation (L1).
3. analyze the methods to improve the performance of gas turbines (L4).
4. explain the methods to improve the performance with combined cycle power plant (L1).
5. learn advance technologies in power generation (L1).

UNIT-I

Nuclear Power Station: Introduction, Nuclear power station in India, India's 3-Stage Programme for Nuclear power development, Nuclear Fuel –Nuclear Fission, Chain Reaction, Breeding and Fertile Materials-Nuclear Reactor – Components-Operation.

Types of Reactors: Different types of Reactors, Pressurized Water Reactor, Heavy water-cooled and Moderated CANDU (Canadian-Deuterium Uranium) Boiling Water Reactor, Gas Cooled Reactor.

Applications: Nuclear power plant

Learning Outcomes

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

- **classify** types of power plants based on their applications (L4).
- **identify** different types of reactors used in a power plant (L1).

UNIT-II

Nuclear Materials: Introduction, Fuels, Cladding and Structural Materials coolants, Moderating and Reflecting Materials, Control Rod Materials, Shielding Materials

Nuclear Waste & its Disposal: Introduction, Radiation Hazards, Types of Nuclear waste, Effect of Nuclear Radiation, Radioactive waste disposal system, Gas disposal system

Applications: Nuclear waste Management, Nuclear power plant

Learning Outcomes

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

- **summarize** the importance of materials used in nuclear power plant (L2).
- **explain** the need for disposing the nuclear waste (L2).

UNIT-III

Gas Turbine Plant: Introduction - Classification - Construction - Layout with Auxiliaries - Principles of Working Closed and Open Cycle Gas Turbines. Regeneration, reheating, inter cooling, components of Gas turbine plant-compressor, combustion chamber, Turbine, Gas turbine.

Applications: Gas Power plants, Aircraft engine

Learning Outcomes:

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

- **classify** various types of gas turbine plants along with their schematic layout (L4).
- **analyze** the effect adding on auxiliaries to the plants (L4).

UNIT- IV

Combined cycle (CC) Power Plants: Limitations of steam turbine (ST) and gas turbine power plants (GT), Combined Brayton and Rankine cycle and GT-ST Plants; Advantages of CC Plants, storage type hydro-electric plant in combination with steam plant, run-of-river plant in combination with steam plant, pump storage plant in combination with steam or nuclear power plant, co-ordination of hydro-electric and gas turbine stations, co-ordination of hydro-electric and nuclear power stations, co-ordination of different types of power plants.

Applications: combined cycle power plants

Learning Outcomes

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

- **illustrate** the different combinations of various power plants (L3)
- **analyze** the effect of various combinations of power plants in enhancing the efficacy (L4).

UNIT- V

Futuristic Technologies: Fuel cells; MHD-Steam Power plant, Thermo electric steam plant, Thermo ionic steam plant

Applications: Conventional and un-conventional energy sources

Learning Outcomes

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

- **illustrate** the futuristic technologies in power generation (L3).
- **describe** the various energy conversion systems (L1).

Text Books

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

Reference Books

1. Rajput, A Textbook of Power Plant Engineering,4/e, Laxmi Publications.
2. Ramalingam, Power plant Engineering, Scitech Publishers.
3. P.C. Sharma, Power Plant Engineering, S.K. Kataria Publications.

Subject Code	Subject Name	L	T	P	C
R20MEC-PE3101.2	Automobile Engineering (Professional Elective-1)	3	0	0	3

Course Objectives

The objectives of the course are

- To understand the power transmission systems
- To understand steering geometry and classification of steering gear mechanisms.
- To create awareness on suspension system, braking system, and electrical system.
- To follow the safety standards and emissions controlling methods.

Course Outcomes

After completing the course, the student will be able to

1. Understand the layout, components, and functioning of four-wheeler automobiles, including power transmission, engine types, lubrication, and cooling systems. [L2]
2. Explain the function and types of clutches, gearboxes, transmission systems, drive types, differentials, axles, wheels, and tires in automobiles. [L2]
3. Describe the steering geometry, types of steering mechanisms, steering gears, and linkages in automobiles. [L3]
4. Explain the suspension, braking, and electrical systems in automobiles, including their components, functions, and working principles. [L2]
5. Explain automobile safety systems, emission control technologies, alternative fuels, and pollution standards. [L2]

UNIT-I

Introduction To Automobile and Engine Construction : Layout of four wheeler automobile - Chassis and body - –Power unit – power transmission – rear wheel drive, front wheel drive, 4 wheel drive – types of automobile engines, engine construction details, turbo charging and super charging- valve mechanisms-types– engine lubrication, splash and pressure lubrication systems, oil filters– crank case ventilation –cooling system –types

Applications: Automobile vehicles

Learning Outcomes:

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

- **identify** different types of automobiles.(L3)
- **explain** various parts of the engine.(L2)
- **explain** the lubrication and cooling system in IC Engines.(L2)

UNIT-II

Transmission system: Clutches-Function-Types-Single plate, Multiple plate, Cone clutch and Diaphragm Clutch – Fluid coupling - Gearbox - Sliding - Constant - Synchromesh - Overdrive– Torque converter-Continuously variable transmission-Universal joint- Propeller shaft- Drive types- Differential - rear axles– types – wheels and tyres.

Applications: Automobile vehicles, Marine Engines, Aerospace vehicles

Learning Outcomes:

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

- **explain** clutch functionality and transmission systems.(L2)
- **understand** the functionality of differential.(L2)
- **explain** the rear axle assembly. (L2)

UNIT-III

STEERING SYSTEM: Steering geometry – camber, castor, king pin rake, combined angle toe in, center point steering. types of steering mechanism – Ackerman steering mechanism, Davis steering mechanism, steering gears – types, steering linkages.

Application: Automobile vehicles, Marine Engines, Aerospace vehicles

Learning Outcomes:

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

- Explain types of steering mechanisms.[Level 2]
- Illustrate the steering geometry.(L2)

UNIT-IV

SUSPENSION SYSTEM: Objects of suspension systems – rigid axle suspension system, torsion bar, shock absorber, Independent suspension system.

BRAKING SYSTEM: Mechanical brake system, hydraulic brake system, master cylinder, wheel cylinder tandem master cylinder, pneumatic and vacuum brakes.

ELECTRICAL SYSTEM: Wiring diagram of 4-wheeler and 2-wheeler, battery construction- ignition types– current regulator - voltage regulator - current - voltage regulator – bendix drive
, solenoid switch, Charging circuit, horn circuit, wiper circuit.

Applications: Automobile vehicles

Learning Outcomes:

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

- *explain* the various electrical components in automobile.(L3)
- *Illustrate* the components of braking systems.(L3)

UNIT-V

Automobile safety and Emission control: Safety and security - Seat belts - Air bags - Electronic Control Unit (ECU) - Anti lock brake system (ABS) - Active Suspension System(ASP) - Electronic Brake Distribution (EBD) – Electronic Stability Program(ESP)- Traction Control System (TCS) - Global Positioning System (GPS) - Types of pollutants, mechanism of formation, exhaust gas treatment-thermal and catalytic converters- use of alternative fuels for emission control – National and International pollution standards

Applications: Automobile vehicles

Learning Outcomes:

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

- Identify the safety systems in automobile.(L2)
- Understand the emission controlling methods.(L3)

Textbooks:

1. Kirpal Singh, Automobile Engineering, Vol.1&2, Standard Publications.
2. Automobile engineering by R B Gupta , Satya Prakashan publications (P) Ltd.
3. Richard Stone, Jeffrey K.Ball, Automotive Engineering Fundamentals" SAE International.
4. Automobile engineering by R K Rajput- Laxmi publications (P) Ltd.

Reference Books:

1. William.H.Crouse, Automotive Mechanics, 10/e Edition, McGraw-Hill.
2. David A. Corolla , Automotive Engineering: Power train, Chassis System and Vehicle Body, Butterworth-Heinemann Publishing Ltd.
3. Bosch , Automotive Hand Book, 6/e SAE Publications year.
4. K. Newton and W. Steeds, The motor vehicle, 13/e Butterworth- Heinemann Publishing Ltd.

Subject Code	Subject Name	L	T	P	C
R20MEC-PE3101.3	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.
- Analyze mechanisms of failures of materials (fracture, fatigue and creep) and the irrelationship with the different types of stress.
- Familiarize the metallurgical factors affecting creep.

Course Outcomes:

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

1. Analyze the structure of the materials and failure modes(L4).
2. Explain the grain size and solid solution strengthening(L2)
3. Understand different types of fractures of materials (L2).
4. Determinate of fatigue behavior of materials(L5)
5. Understand the creep behavior in different materials (L2)

UNIT- I

Elastic and plastic behavior: Elastic behavior of materials–Hooke’s law, plastic behavior: 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 behavior of engineering materials (L2).
- **Explain** the dislocation theory(L2)
- **understand** the forces in 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 (L2).
- **Compare** strain aging and dynamic strain aging (L2).

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 IntensityFactor, 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).
- **understand** the Application of Griffith's theory (L3).
- **Predict** factors effecting on DBTT(L2).
- **Classify** various modes of fracture(L2).

UNIT-IV

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

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

Learning outcomes:

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

- **explain** the S-N curves for different materials(L2)
- **analyze** fatigue behavior of fiber's in fiber composites (L4)

UNIT-V

Creep behavior 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

- **explain** the stages in creep curve (L2).
- **predict** the metallurgical factors affecting creep(L2).
- **illustrate** the working of creep testing machines(L2).

Textbooks:

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

References:

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

Subject Code	Subject Name	L	T	P	C
R20MEC-PE3101.4	Advanced Machining Processes (Professional Elective-1)	3	0	0	3

Course Objectives:

The objectives of the course are to

- Understand idea about non-traditional machining processes
- Illustrate about ultrasonic machining in mechanical processes
- Explain concepts for electrical discharge machining
- Distinguish between chemical machining and electro chemical machining process
- Discuss the working of high energy machining processes

Course Outcomes:

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

1. Understand the modern manufacturing process with respect to process capability and economics(L2)
2. Explain the principles and process parameters of the process based on the mechanical energy.(L2)
3. Illustrate the electrical discharge machining processes and applications (L2)
4. Compare the chemical and electrical machining processes(L2)
5. Describe the working principles of high energy machining process(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 – Over view of all processes.

Application: pharmaceutical industries and fabrication of CNT

Learning outcomes:

After completion of this unit, student will be able to

- **classify** the non-traditional Machining Processes(L2)
- **understand** the source of energy in non traditional machining process(L2)
- **explain** Physical Parameters in non traditional machining process(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

- **understand** the working principle of Ultrasonic Machining(L2)
- **explain** working principle for Abrasive Jet 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

- **understand** the process of Electrical Discharge Machining(L2)
- **explain** flushing methods of electrical discharge machining(L2)
- **elucidate** advantages, limitations and applications of electrical discharge machine(L2)
- **illustrate** 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

- **understand** the process parameters about Chemical Machining process(L2)
- **explain** classification of chemical machining processes and their Applications(L2)
- **elucidate** Electrolyte and their Properties of electro chemical machining(L1)
- **compare** the features of the finishing processes.(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.

Laser Beam Machining (LBM)-Principle, Laser system, Construction and operation of LBM, Laser materials Advantages and disadvantages of LBM.

Application:

- custom cosmetic aircraft interior components,
- rocket engines components, combustor liners

Learning outcomes:

After completion of this unit, student will be able to

- **understand** the process parameters about Electron Beam Machining(L2)
- **explain** the applications of laser beam machining(L2)
- **elucidate** the process parameters of Laser Beam Machining(L2)

TEXTBOOKS

1. P.C Pandey And H.S.Shan,“ Modern Machining Process”, Tata McGraw–Hill Publishing Company Limited, New Delhi.

2. V.K.Jain, “Advanced Machining Process”, Allied Publishers Pvt Limited

REFERENCES

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

Subject Code	Subject Name	L	T	P	C
R20MEC-PC3104	Metal Cutting and Machine Tools Lab	0	0	3	1.5

Course objectives:

The objectives of the course are to

- 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 planning 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 and Centre Drill Operations on Lathe Machine
2. The Step Turning And Taper Turning Operations on Lathe Machine
3. Thread Cutting And Knurling Operations on Lathe Machine
4. Drilling And Tapping Operations on Radial Drilling Machine Using Aluminum Specimen
5. Make A Rectangular “V” Block on Shaping Machine
6. Make Slots In The Given Hollow Cylinder With Slotting Machine
7. Make A Spur gear on Milling Machine By Using Given Wooden Piece
8. Grind The Surface Of MS Flat Plate on Surface Grinding Machine
9. Perform Straight Slots on Planning Machine Using Wooden Specimen
10. Grind The Single Point Cutting Tool on Tool End Cutter Machine
11. Cutting force measurement using Tool Dynamometer

Note : Any 10 Experiment from above list

Subject Code	Subject Name	L	T	P	C
R20MEC-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. Draw the valve and port timing diagrams for 4-stroke CI engines and 2-stroke SI engines (L3)
2. Analyze the performance parameters of engines and compressors using load tests. (L4)
3. Determine friction power of engines through retardation, motoring and Morse test. (L5)
4. Evaluate performance, fuel economy and heat balance sheet for engines. (L5)
5. Demonstrate experimental techniques in the thermal engineering lab. (L2)

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 aircompressor by conducting load test on it.
9. Calculate the economical speed by conducting Economical speed test on 4-stroke multi cylinder SI engine.
10. Find FP by conducting Morsetest on 4-stroke multi cylinder SI engine.

Subject Code	Subject Name	L	T	P	C
R20CSE-SC3101	Python Programming	1	0	2	2

Course Objectives:

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

Course Outcomes:

1. Understand program structure python REPL shell environment.
2. Implement iterators and functions for data processing.
3. Implement different modules and objects to organise data.
4. Implement different data structures and their functionalities
5. Understand Object oriented concepts and handle different errors through exceptions.

Unit I:

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 II:

Control Flow: Control Flow- if, if-elif-else, for, while, break, continue, pass.

Functions: Defining Functions, Calling Functions, Passing Arguments, Keyword Arguments, Default Arguments, Variable-length arguments, Fruitful Functions (Function Returning Values), Scope of the Variables in a Function - Global and Local Variables, Anonymous Functions, Lambdas, 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 III:

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 data science libraries. (L2)

Unit IV:

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

Learning Outcomes:

After completing this chapter, student will be able to

- Implement String operations and formatting. (L3)
- Understand fundamentals of data structures and their methods. (L2)
- Implementing file operations for data processing. (L3)

Unit V:

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

- Implement Object oriented concepts with real world scenarios. (L3)
- Understand class hierarchies and abstraction. (L2)
- Understand error handling and handle exceptions. (L2)

Text Books:

1. Python Programming: Using Problem Solving Approach by Reema Theraja, Oxford publications
2. Python Programming: A Modern Approach, Vamsi Kurama, Pearson.

Reference Books:

1. Fundamentals of Python by Kenneth H Lambert, Cengage
2. Learning Python, Mark Lutz, Orielly.
3. Python Programming by Ashok N Kamathane, McGrawhill

Subject Code	Subject Name	L	T	P	C
R20MEC-MC3101	3D Printing Technology	2	0	0	0

Course Objectives:

This course will enable students to

- To exploit technology used in 3D printing.
- To understand importance of 3D printing in advance manufacturing process.
- To acquire knowledge, techniques and skills to select relevant 3D Printing process.
- To explore the potential of 3D Printing in different industrial sectors.

Course Outcomes

Upon completion of this course, students will be able to

1. Know the importance of 3D printing in Manufacturing (L1)
2. Understand the liquid-based 3D printing system (L2)
3. Illustrate the solid-based 3D printing system (L2)
4. Explain the powder based 3D printing system (L2)
5. Elucidate the application 3D printing in medical field (L2)

UNIT – I

INTRODUCTION: 3D Printing, Generic 3D Printing Process, Benefits of 3D Printing, Distinction Between 3D Printing and CNC Machining, Classification of 3D Printing Processes, Metal Systems, Hybrid Systems, Milestones in 3D Printing Development, 3D Printing around the World.

Learning outcomes:

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

- *distinguish* between 3D printing and CNC Machining (L1)
- *classify* the various 3D printing Processes

UNIT-II

LIQUID-BASED 3D PRINTING SYSTEM: Stereo lithography Apparatus (SLA): models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages.

Learning outcomes:

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

- *understand* the Basic Principle of Liquid based system. (L2)
- *explain* the working process of Stereo lithography. (L2)

UNIT-III

SOLID-BASED 3D PRINTING SYSTEMS:- Models and specifications, process, working principle, applications, advantages and disadvantages, case studies. Fused deposition modelling (FDM) - models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

Learning outcomes:

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

- *elucidate* the Basic Principle of Solid based systems. (L2)
- *explain* the working process of Fused deposition modelling. (L2)

UNIT – IV

POWDER BASED 3D PRINTING SYSTEMS: Selective laser sintering (SLS): models and specifications, process, working principle, applications, advantages, disadvantages and case studies.

Learning outcomes:

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

- *illustrate* the working principle of 3D printing machine. (L2)

- **explain** the working principle of Selective laser sintering.(L2)
- **explain** the working principle of Three dimensional printing.(L2)

UNIT-V

MEDICAL APPLICATIONS & FUTURE DIRECTION FOR 3D PRINTING - Use of 3D Printing to Support Medical Applications, Limitations of 3D Printing for Medical Applications, Further Development of Medical 3D Printing Applications. Use of Multiple Materials in 3D Printing - Discrete Multiple Material Processes, Blended Multiple Material Processes, Commercial Applications Using Multiple Materials, Business Opportunities and Future Directions

Learning outcomes:

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

- **apply** knowledge of 3D printing for real-life applications.(L2)
- **select** the suitable types of materials used in 3D printing.(L2)

TEXT BOOK(S):

1. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Ian Gibson, David W Rosen, Brent Stucker, Springer, 2nd Edition.
2. 3D Printing and Additive Manufacturing: Principles & Applications, Chua Chee Kai, LeongKah Fai, World Scientific, 4th Edition.

REFERENCE(S):

1. Rapid Prototyping: Laser-based and Other Technologies, Patri K. Venuvinod and Weiyin Ma, Springer.
2. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, D.T. Pham, S.S. Dimov, Springer.
3. Rapid Prototyping: Principles and Applications in Manufacturing, Rafiq Noorani, John Wiley & Sons.
4. Additive Manufacturing, Second Edition, Amit Bandyopadhyay Susmita Bose, CRC Press Taylor & Francis Group.
5. Additive Manufacturing: Principles, Technologies and Applications, C.P Paul, A.N Junoop, McGrawHill.
6. J.D. Majumdar and I. Manna, Laser-assisted fabrication of materials, Springer Series in Material Science.
7. L. Lu, J. Fuh and Y. S. Wong, Laser-induced materials and processes for rapid prototyping, Kluwer Academic Press.
8. Zhiqiang Fan and Frank Liou, Numerical modeling of the additive manufacturing (AM) processes of titanium alloy, InTech.

Online resources:

1. <https://www.nist.gov/additive-manufacturing>
2. <https://www.metal-am.com/>
3. <http://additivemanufacturing.com/basics/>
4. <https://www.3dprintingindustry.com/>
5. <https://www.thingiverse.com/>
6. <https://reprap.org/wiki/RepRap>

III YEAR –II SEMESTER

Subject Code	Subject Name	L	T	P	C
R20MEC-PC3201	Design of Power Transmission Elements	3	0	0	3

Course Objectives:

The objectives of the course are

- 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 the suitable bearing depending upon the application and predict life of that bearing. (L3)
2. Analyze the curved beams under the action of axial loads for different cross sections. (L4)
3. Analyze different I.C Engine parts under the action of forces. (L4)
4. Analyze the power transmission using power screws. (L4)
5. Examine the load concentration factor, dynamic load factor, surface compressive strength, bending strength of spur & helical gear drives. (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, turbofans, 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 – crankpins, crankshafts.

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/NCPandya & CSShaw/ 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 Mech. Engg. Design/JE Shigley /Tata McGraw Hill education.

Subject Code	Subject Name	L	T	P	C
R20MEC-PC3202	Heat Transfer	3	0	0	3

Course Objectives

The objectives of the course are

- 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 principles of heat transfer to analysing conduction mechanisms, solve steady-state heat transfer problems in slabs, cylinders, and spheres, and evaluate the critical radius of insulation. (L3)
2. Apply heat transfer principles to analysing fin performance, and solving transient conduction problems using Biot and Fourier numbers. (L3)
3. Analyse convection heat transfer in external and internal flows by evaluating boundary layer concepts, non-dimensional numbers, and empirical correlations for various geometries and flow conditions. (L4)
4. Analyse heat transfer coefficients for natural convections, rate of condensation and Evaporation by applying Boiling and Condensation heat transfer mechanism. (L4)
5. Analyse heat exchanger performance and radiation heat transfer between black body & gray body surfaces. (L4)

UNIT-I

Introduction: Modes and mechanisms of heat transfer – basic laws of heat transfer –General discussion about applications of heat transfer.

Conduction Heat Transfer: Fourier rate equation – general heat conduction equation in cartesian, cylindrical and Spherical coordinates. Steady, unsteady and periodic heat transfer – initial and boundary conditions.

One Dimensional Steady State Conduction Heat Transfer: Homogeneous slabs, hollow cylinders and spheres – overall heat transfer coefficient – electrical analogy – critical radius of insulation.

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

Extended surface (Fins): heat Transfer – long fin, fin with insulated tip and short fin, application to error measurement of temperature.

One Dimensional Transient Conduction Heat Transfer: Systems with negligible internal resistance significance of biot and fourier numbers - chart solutions of transient conduction systems.

Applications: Radiator used in automobile, Air-cooled I.C. engines, Condensers of Air Conditioners, Electric transformers, Reciprocating air compressors, Electric motors, Heating or cooling of the engines, Heat transfer in buildings in day, Cooling or heating of foods

Learning Outcomes :

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

- **design** a Fins for a given application(L3)
- **calculate** time to reach particular temperature or vice verse, temperature, time historyof any location in the bodies. (L3)

UNIT-III

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

Forced Convection:

External Flows: Concepts about hydrodynamic and thermal boundary layer and use of empirical correlations for convective heat transfer -flat plates and cylinders.

Internal Flows: Concepts about hydrodynamic and thermal entry lengths – division of internal flow based on this –use of empirical relations for convective heat transfer- horizontal pipe flow and annulus flow.

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)
- **apply** fluid friction concept to solve convective heat transfer problems.(L3)

UNIT-IV

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

Boiling: Different regimes of boiling-nucleate, transition and film boiling.

Condensation: film wise and drop wise condensation.

Application: free air cooling without the aid of fans; 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

- **understand** the natural convection heat transfer(L2)
- **understand** the regimes of boiling. (L2)
- **understand** the condensation heat transfer(L2)

UNIT-V

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.

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

Applications: Heat exchangers are used in many engineering applications, such as refrigeration, heating and air-conditioning systems, power plants, chemical processing systems, food processing systems, automobile radiators, and waste heat recovery units.

Heat transfer through vacuum, electromagnetic radiation, heat transfer from campfire, Heat radiated from I.C. Engine, solar radiation.

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 rate of heat transfer in heat exchangers(L3)

- **find out** the surface area required for a given application(L3)
- **calculate** the radiation heat transfer between two bodies(L2)

Text Books:

1. Heat and Mass Transfer-R.K Rajput, Publishers-S Chand &CoL td.
2. Heat & Mass Transfer-D.S. Kumar, S.K. Kataria & Sons Publishers.
3. Fundamentals of Engineering Heat and Mass Transfer- R.C.Sachdeva, New Age Publications.
4. P.K. Nag, HeatTransfer, 3/e,Tata McGraw-Hill.
5. Heat and Mass Transfer Databook - C.P. Kothandaramanand S. Subramanyan, New Age Publications

Reference Books:

1. Heat Transfer- A Practical Approach- Cengel. A. Yunus, Tata McGraw-Hill.
2. Fundamentals of Heat and Mass Transfer-F.P.Incropera and D.P.Dewitt, JohnWiley.
3. Heat Transfer- J.P.Holman, Tata McGraw-Hill.
4. A Textbook of Heat Transfer-S.P. Sukhatme, Universities Press.

Subject Code	Subject Name	L	T	P	C
R20MEC-PC3203	Mechanical Measurements and Metrology	3	0	0	3

Course Objectives:

The objectives of the course are

- To learn basic principles of measurement systems, errors occurred in measurementsystems andmeasurement of displacement
- To learn the operating principles and working of different instruments used for temperaturepressure, for level, flow and speed measurement
- To learn the operating principles and working of different instruments used for force,torque andpower and concepts of control systems
- To learn Inspection of engineering parts with various precision instruments
- To know the Principles of measuring instruments and gauges and their uses

Course Outcomes:

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

1. Understand the fundamental principles of measurement for displacement, temperature, level, and various types of flow. (L2)
2. Compare the mechanical and electrical tachometers related to their working principle and applications. (L2)
3. Select the limits, fits, and tolerances for designing limit gauges based on given requirements. (L3)
4. Explain the measurement of surface, screw and gear profiles. (L2)
5. Compare working principles of dynamometers and suitability for the given applications. (L2)

UNIT-I

Basic Principles of Measurement-Measurement of Displacement, Temperature, Level & Flow Types, generalized configuration and functional descriptions of measuring instruments - examples, Static &dynamic performance characteristics - sources of error, classification and elimination of error. Types of transducers to measure displacement, Types of transducers to measure temperature, Types of transducers for level measurement, Type of transducer for flow measurement

Learning outcomes:

- Understand the Measurement of Displacement, Temperature, Level & Flow (L2)

Unit -II

Measurement of Pressure, Speed, Force, Torque, Power and Humidity: Principle and working of various low and high pressure measuring instruments, types of Mechanical and electrical tachometers for speed measurement, principles of seismic instruments-vibrometer and accelerometer, Elastic force meters, load cells and torsion meters. Principle of dynamometer-types of dynamometers, humidity introduction , Principle and working of various humidity measuring instruments

Learning outcomes:

- Understand the Measurement of Pressure, Speed, Force, Torque, Power and Humidity (L2)

Unit -III

Systems of Limits and Fits-Measurement of Angles and Tapers: Introduction, normal size, tolerance limits, deviations, allowance, Fits & their types- unilateral and bilateral tolerance systems, hole & shaft basis systems- Inter change ability and Selective assembly. Class &grade of tolerance, Numerical on limits, fit and tolerance. sine bar - sine plate, rollers and spheres used to determine the tapers. Taylor's principle, Design of GO & NO-GO gauges ,Types of limit gauges, Numerical on limit gauge design

Learning outcomes:

Students will be able to

- Analyze the design tolerances and fits for selected product quality.(L4)
- Understand the International standard system of tolerances(L2)
- Understand the standards of length, angles,(L2)
- understand the Measurement Of Angles And Tapers(L2)

Unit IV

Comparators-Screw Thread & Gear Teeth Measurement: Comparators – types and their uses in mass production. Flat surface measurement: surface plates - optical flat and autocollimator. Screw thread measurement: errors in screw thread , Measurement of effective diameter, angle of thread and thread pitch, Gear measuring instruments, Gear tooth profile measurement, Measurement of diameter, pitch pressure angle and tooth thickness, Coordinate Measuring Machines- Types of CMM, blue light scanning, white light scanning, Role of CMM, and its applications

Learning outcomes:

Students will be able to

- understand the Measurement of flatness of surfaces(L2)
- Describe The Different Types Of Interferometry And Their Applications (L2)
- Choose appropriate method and instruments for inspection of various gear elements and thread elements.(L2)
- Explain errors in screw threads-concept of virtual effective diameter, measurement of effective diameter(L2)
- Understand the different types of comparators and their uses(L2)

UNIT-V

Applied mechanical measurement: Measurement of force, Torque, Pressure, Types of Dynamometers, Absorption dynamometer, Prony brake and Rope brake dynamometer, and Power Measuring Instruments. Use of elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge.

Learning outcomes:

Students will be able to

1. Understand the Measurement of force, Torque, Pressure (L2)
2. Understand the different types of Dynamometers (L2)

Textbook (s)

1. N V Raghavendra and Krishnamurthy, Engineering Metrology and Measurement, Oxford University Press, Reprint edition, 2018
2. D.S. Kumar, Mechanical Measurement & Control, Metropolitan Book Co. (P) Ltd, 5th reprinted edition, 2015
3. R. K. Rajput, Mechanical Measurements and Instrumentation, S.K. Kataria & Sons, 2nd edition, 2015

Reference (s)

1. R. K. Jain, Mechanical and Industrial Measurements: Process Instrumentation and Control, Khanna Publishers, 12th reprint edition, 2018
2. Beckwith, Thomas G., Marangoni, Roy D., Lienhard V, John H., Mechanical Measurements, 6th Edition, Prentice Hall, 10th reprint, 2018
3. I.C. Gupta, Engineering Metrology, Dhanpat Rai and Sons, 10th edition, 2017
4. R. K. Jain, Engineering Metrology, Khanna Publishers, 20th edition, 2017
5. M. Mahajan, A Textbook Of Metrology, Dhanpat Rai & Co, 17th edition, 2017

Subject Code	Subject Name	L	T	P	C
R20MEC-PE3201.1	CAD/CAM (Professional Elective-2)	3	0	0	3

Course Objectives:

The objectives of the course are to

- Familiarize the important elements of CAD/CAM, geometric representation and transformations.
- Introduce the various parametric representations of curves and surfaces in geometric modelling.
- Impart knowledge related to methods and techniques in geometric modeling of solids in CAD.
- Create awareness among the students with numerical control (NC), computer numerical control (CNC) and direct numerical control (DNC) machines.
- Understand the principles and concepts of robotics and various elements of Computer Integrated Manufacturing (CIM).

Course Outcomes:

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

1. Apply the basics of geometric transformations to position objects, shape object and change viewing positions of 2D or 3D images. (L3)
2. Construct parametric representation of curves and surfaces (L3)
3. Choose suitable geometric modeling method for building CAD models. (L3)
4. Develop the coding system for CNC programming to produce the designated part on the specified CNC machine. (L3)
5. Explain the concepts of Group Technology and Computer Integrated Manufacturing in automated systems. (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

- **explain** various input and output devices(L2)
- **understand** geometric transformations in 2D and 3D(L2)

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

- **explain** the concepts of parametric representation to curves and surfaces.(L2)
- **understand** the surfaces such as Coons, Bezier and B-spline (L2)

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 modeling 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 modeling (L4)

UNIT- IV

Computer Aided Manufacturing (CAM): Structure of numerical control (NC) machine tools, designation of axes, drives and actuations 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

- **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 the elements of computer integrated manufacturing (L2)
- Explain the part coding in group technology (L2)

Text books:

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

Reference books:

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

Subject Code	Subject Name	L	T	P	C
R20MEC-PE3201.2	Composite Materials (Professional Elective-II)	3	0	0	3

Course objectives:

The objectives of the course are to

- Understand the composite materials and their applications.
- Understand the different manufacturing methods available for composite material.
- Create awareness among the students in preparation of composites like MMCs, PMCs, CMCs.
- Explain the behavior of constituents in the composite materials.
- Build proper background for stress analysis in the design of composite structures.
- Focus on Advances in biodegradable composites.

Course Outcomes:

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

1. Explain the practical applications of composites.(L2)
2. illustrate the methods of the polymer matrix composites.(L2)
3. outline the types of metal matrix composite.(L2)
4. summarize the types of ceramic matrix materials.(L2)
5. Illustrate the Properties and applications of bio- degradable composites.(L2)

UNIT-I

Introduction to composites: Fundamentals of composites– Definition –classification– based on Matrix–based on structure–Advantages and applications of composites– Reinforcement – whiskers – glass fiber – carbon fiber - Aramid fiber – ceramic fiber –Properties and applications

Learning Outcomes:

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

- Explain the fundamentals of composites.(L2)
- Classify the composites based on matrix and structure.(L2)
- Illustrate the practical applications of composites.(L2)
- Summarize the properties and advantages of rein for cement materials.(L2)

Applications:

Space craft: Antenna structures, solar reflectors, Satellite structures, Radar, Rocket engines, etc.

UNIT-II

Polymer matrix composites: Polymers - Polymer matrix materials – PMC processes – hand layup processes – spray up processes – resin transfer moulding – Pultrusion – Filament winding Auto clave based methods - Injection moulding – sheet moulding compound – properties and applications of PMCs.

Learning Outcomes:

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

- Explain the properties of polymer matrix composites.(L2)
- Illustrate the polymer matrix composites. (L2)
- Explain various process used in making the polymer matrix composites.(L2)
- Discuss the auto clave based methods.(L2)

Applications:

Aerospace, automobile, sporting goods, medical implants, reciprocating industrial machinery, storage and transportation of corrosive chemicals, and military vehicles and weapons.

UNIT-III

Metal matrix composites: Metals - types of metal matrix composites – Metallic Matrices. Processing of MMC – Liquid state processes – solid state processes – In situ processes. Properties and applications of MMCs.

Learning Outcomes:

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

- **outline** the various types of metal matrix composite.(L2)
- **explain** liquid state processes and solid state processes in MMCs preparation. (L2)
- **explain** Insitu processes.(L2)
- **summarize** the properties and applications of MMCs.(L2)

Applications: Aircraft structures, spacecraft structures

UNIT-IV

Ceramic matrix composites: Processing of CMCs –Sintering - Hot pressing – Infiltration – Lanxide process – In situ chemical reaction techniques – solgel polymer pyrolysis –SHS - Cold isostatic pressing (CIPing) – Hot isostatic pressing (HIPing). Properties and Applications of CCMs.

Learning Outcomes:

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

- **summarize** the various types of ceramic matrix materials.(L2)
- **explain** the sintering, hot pressing, infiltration and lanxide process.(L2)
- **compare** between cold and hot isostatic pressing.(L2)
- **summarize** the properties and applications of CCMs.(L2)

Applications:

Gas turbines components (combustion chambers, stator vanes and turbine blades), Rocket engines, Components for burners, Flame holders, Hot gas ducts

UNIT-V

Advances in composites: Advantages of carbon matrix – limitations of carbon matrix carbon fibre– chemical vapour deposition of carbon on carbon fibre perform. Properties and applications of Carbon- carbon composites.

Biodegradability: introduction of biocomposites, classification, processing of biocomposites, applications of biocomposites

Learning Outcomes:

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

- **lucidate** the Properties and applications of Carbon-carbon composites.(L2)
- **explain** the Advantages and limitations of carbon matrix carbon fibre. (L2)
- **illustrate** composites for aerospace applications. (L2)
- **classify** the bio- degradable composites. (L2)

Applications: Aerospace, Biomedical, Automobile Engineering.

Textbooks

1. Chawla K.K, Composite materials,2/e, Springer–Verlag,1998.
2. Materials Science and Engineering: An Introduction – William D Callister Jr
3. Mathews F.L. and Rawlings R.D., Chapman and Hall, Composite Materials: Engineering and Science, 1/e, England,1994.

References

1. ASM Handbook Volume 2 Composites
2. HK Shivan and, BVBabu Kiran, Composite Materials, ASIANBOOKS, 2011.

3. A.B.Strong, Fundamentals of Composite Manufacturing, SME,1989.
4. S.C.Sharma, Composite materials, NarosaPublications,2000.
5. Maureen Mitton, Hand Book of Bioplastics & Biocomposites for Engineering applications, JohnWiley publications.

Subject Code	Subject Name	L	T	P	C
R20MEC-PE3201.3	Production Planning & Control (Professional Elective-2)	3	0	0	3

Course objectives:

The objectives of the course are

- To understand the characteristics of production and service systems.
- To Apply principles and techniques in the development of integrated systems
- To understand the challenges faced by the production manager in manufacturing and service organizations
- To Identify different strategies employed in manufacturing and service industries to control inventory.
- To apply scheduling methodology in mass production and job order production systems
- To Understand the concepts of dispatching and methods of dispatching .

Course outcome:

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

1. Summarize the production planning and control functions. (L2)
2. Compare inventory management systems applicable to optimize cost to control different types of inventories. (L4)
3. Analyze factors affecting in preparation of route sheets to make the product. (L4)
4. Evaluate Scheduling methodologies applicable to job order and mass production system. (L4)
5. Illustrate the Dispatching procedure (L2)

UNIT-I

Introduction: Definition – characteristics of production systems, layouts used, objectives and functions of production planning and control — organization of production planning and control department–internal organization of department.

Learning outcomes

After completion of this unit, students will be able to

- Understand the functions of production planning and control (L2)
- Compare the characteristics of the production systems(L2)

UNIT-II

Forecasting – importance of forecasting – types of forecasting, their uses– Quantitative Forecasting technique: Least Square Method, Exponential Smoothing Method, Moving Average Method, Seasonal forecasting. Errors in forecasting methods, Qualitative Forecasting technique: opinion survey method, executive opinion method, customer and distributor survey method, marketing trails method, market research method and Delphi method.

Learning outcomes:

After completion of this unit, students will be able to

- Explain qualitative and quantitative methods of forecasting (L2)
- Develop regression equation for demand forecasting(L3)

UNIT-III

Inventory management – functions of inventories – relevant inventory costs – Selective control methods-ABC analysis –VED analysis –EOQ model–exercises, Inventory control systems–P–Systems and Q–Systems, MRP I, MRP II, ERP, JIT and KANBAN systems

Learning outcomes:

After completion of this unit, students will be able to

- **explain** the functions of inventories(L2)
- **illustrate** the applications of P–Systems and Q–Systems. (L2)

UNIT–IV

Routing: Definition – routing procedure – route sheets – bill of material –factors affecting routing procedure, schedule – definition – difference with loading.

Scheduling: Scheduling in mass production system, Line Balancing, Scheduling in jobproduction system, n jobs-2machines, n jobs-3 machineproblems.

Learning outcomes:

After completion of this unit, students will be able to

- **understand** routing procedure (L2)
- **differentiate** loading and scheduling. (L4)
- **explain** various scheduling methods. (L2)

UNIT–V

Dispatching – dispatching procedure – dispatching rules- Mean flow time, mean latenessof the job orders, follow up and controlling aspects ,applications of software modules in production planning and control.

Learning outcomes:

After completion of this unit, students will be able to

- **understand** the activities of dispatching (L2)
- **explain** the dispatching rules (L2)
- **explain** the application of software modules in production planning and control(L2)

Text Books:

1. Elements of Production Planning and Control/Samuel Eilon / Universal Book Corp.
2. Production and Operations Management. R. Panneerselvam,. Prentice Hall India Pvt. Ltd.

References:

1. Inventory Control Theory and Practice/ MartinK. Starr and David W.Miller/Prentice-Hall
2. Production Planning and Control/ Mukhopadyay/ PHI.
3. Production Control/ Franklin G Moore & Ronald Jablonski/ Mc-Graw Hill
4. Production and Operations Management/Ajay K Garg /Mc Graw Hill

Subject Code	Subject Name	L	T	P	C
R20MEC-PE3201.4	Refrigeration and Air conditioning (Professional Elective-2)	3	0	0	3

Course Objective:

The students will acquire the knowledge

- To illustrate the operating cycles and different systems of refrigeration
- To analyze cooling capacity and coefficient of performance of vapour compression refrigerationsystems and understand the properties of refrigerants
- To identify VCR system components and calculate coefficient of performance by conducting teston vapour absorption and steam jet refrigeration systems
- To calculate cooling load for air conditioning systems and identify the requirements of comfortair conditioning
- To describe different component of refrigeration and air conditioning systems

Course Outcomes:

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

1. Illustrate the operating cycles and different systems of refrigeration (L2)
2. Analyze coefficient of performance of vapour compression Refrigeration systems (L3)
3. calculate coefficient of performance by conducting test on vapour absorption and steam jetrefrigeration systems (L3)
4. solve cooling load for air conditioning systems and the requirements of comfort airconditioning. (L2)
5. explain different component of refrigeration and air Conditioning systems. (L2)

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 craft's 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 superheating.(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)

Note: Refrigeration and Psychometric tables and charts allowed

Text Books:

1. A Course in Refrigeration and Airconditioning /S C Arora & Domkundwar/Dhanpatrai
2. Refrigeration and Air Conditioning/CPA 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
R20CSE-OE3201.1	Internet of Things(IOT) (OPEN ELECTIVE -2)	3	0	0	3

Course Objectives:

Faculty are going to

- Introduce the basic terminology and functions of Internet of things.
- List the connectivity and networking of devices in IoT.
- Show the development of a Arduino and raspberry Pi based systems.
- Provide the data processing in a IoT system.
- List the domains and case studies in extended IoT systems.

Course Outcomes:

At the end of the Course, the Student will be able to:

1. Summarize the IoT characteristics, principles and design methodology. (L2)
2. Examine the typical connectivity and networking protocols typically used in a IoT design. (L4)
3. Demonstrate design and development of embedded applications using Arduino and Raspberry Piplatforms. (L3)
4. Recognize the importance of data processing and cloud services for IoT. (L2)
5. Illustrate the different domains and applications of IoT eco-system. (L4)

UNIT-I

Introduction to Internet of Things: Definition & Characteristics of IoT, Physical design of IoT, Logical Design of IoT, IoT Enabling Technologies, IoT Levels & Deployment Templates, M2M, Difference between IoT and M2M, SDN and NFV for IoT.

IoT platforms design methodology: purpose & requirement specification, process specification, domain model specification, information model specification, service specifications, IoT level specification, functional view specification, operational view specification, device & component integration, application development.

Learning Outcomes:

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

- Explain the Characteristics of IoT. (L2)
- Explain the physical design and logical design of IoT. (L2)
- Understand IoT and Machine to machine communication differences and working. (L2)
- Show the typical IoT design methodology. (L2)

UNIT-II

Networking and Connectivity Technologies: Connectivity terminology, gateway prefix allotment, impact of mobility on addressing, multihoming, deviations from regular web, IoT identification and data protocols- IPv4, IPv6, MQTT, CoAP, XMPP, AMQP. Connectivity technologies- IEEE 802.15.4, Zigbee, 6LoWPAN, RFID, NFC, Bluetooth, Z-wave.

Learning Outcomes:

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

- list the challenges and requirements in networking of IoT systems. (L2)
- analyze the connectivity technologies for device communication. (L4)
- examine the different networking protocols for IoT requirements. (L4)

UNIT-III

Basics of Arduino and Raspberry Pi: Sensor classification, working principle of sensors, criteria to choose a sensor, generation of sensors. **Arduino:** Introduction to Arduino, Arduino Uno, Arduino Mega, Arduino Nano, Arduino IDE, Stepsto Install Arduino IDE,

Basic Commands for Arduino, LCD Commands, Serial Communication Commands Programming with Arduino, working with analog Input.

Raspberry Pi: Basics of Raspberry Pi, Introduction to Raspberry Pi, Raspberry Pi Components, Installation of Raspbian, Terminal Commands, Installation of Libraries on Raspberry Pi, Getting the Static IP Address of Raspberry Pi, Raspberry Pi Programming- Reading the Digital Input, I2C and SPI programming, Interfacing Raspberry pi-LED, Relay, DC Motor, LCD, DHT11.

Learning Outcomes:

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

- List the sensors and their classification for IoT. (L2)
- Practice the basic programming of Arduino platform. (L3)
- Employ Raspberry pi and python programming to develop simple embedded applications. (L3)

UNIT-IV

Data Processing: Data acquiring and storage, Organizing the data, Transactions, business processes, Integration and Enterprise systems, cloud computing paradigm for data collection, storage and computing, everything as service and cloud service models, IoT cloud-based services.

Learning Outcomes:

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

- Summarize the Data collection and storage at node and cloud systems. (L2)
- Understand the processing of data at different levels of IoT. (L2)

UNIT-V

IoT Case Studies: Domains-Home automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health & Lifestyle. Case Studies- Home Intrusion detection, smart parking, weather monitoring system, Smart Irrigation.

Security and future of IoT Ecosystem:

Learning Outcomes:

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

- Categorize the domains of IoT development. (L4)
- Examine the different IoT applications with detailed case study. (L4)

Text Books

1. Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on-Approach)”, 1e, UniversityPress Private Limited-2016.
2. Internet of Things: Architecture, Design Principles and Applications, Rajkamal, McGraw HillHigher Education.
3. Rajesh Singh, Anita Gehlot, Lovi Raj Gupta, Bhupendra Singh, and Mahendra Swain “Internet ofThings with Raspberry Pi and Arduino”, CRC Press.
4. Dr Jeeva Jose, “Internet of Things”, Khanna Book Publishing Co. (P)LTD, 2018

Reference Books:

1. Donald Norris, Internet of things do-it-yourself projects with Arduino, Raspberry Pi, and BeagleBone Black,1st Edition, McGraw-Hill,2015
2. Getting Started with the Internet of Things Cuno Pfister, Oreilly.
3. Richard Blum, Arduino Programming in 24 Hours, Sams Teach Yourself, Pearson Education,2017
4. Jain, Prof. Satish, Singh, Shashi, Internet of Things and its Applications, 1st Edition, BPB, 2020.

Subject Code	Subject Name	L	T	P	C
R20CSE-OE3201.2	Non-Conventional Energy Sources (OPEN ELECTIVE -2)	3	0	0	3

Course Objectives:

- To study the solar radiation data, extraterrestrial radiation, radiation on earth's surface.
- To study solar thermal collections.
- To study maximum power point techniques in solar Photovoltaic Systems
- To study wind energy conversion systems, Betz coefficient, tip speed ratio and geothermalsystems.
- To study basic principle and working of tidal, biomass and fuel cell

Course Outcomes: After completion of the course, the student will be able to:

1. Understand the classification of energy sources and their global and India-specific implications for sustainable development. (L2)
2. Recognize the impact of solar thermal systems and solar power plants and explain the role of environmental laws in mitigating these impacts. (L2)
3. Between solar thermal systems and solar photovoltaic systems and evaluate their potential for addressing energy needs (L3)
4. Explain the concept of wind energy conversion and assess the significance of geothermal energy as a renewable energy resource. (L2)
5. Analyse various alternative energy sources, including tidal power, bio-mass energy and fuel cell emerging technologies and their contributions to the energy landscape (L4)

UNIT-I:

Fundamentals of Energy Systems and Solar energy: Energy conservation principle – Energy scenario (world and India) – various forms of renewable energy - Solar radiation: Outside earth's atmosphere – Earth surface – Analysis of solar radiation data – Geometry Numerical problems.

Learning Outcomes: The students are able to

- Understand solar radiation data, extraterrestrial radiation, and radiation on earth's surface(L2)
- Demonstrate the demand supply gap of energy in Indian, world scenario (L2)
- Understand the need of energy conservation(L2)

UNIT-II:

Solar Thermal Systems: Liquid flat plate collectors – Numerical problems, Introduction to solar air heaters – Concentrating collectors, solar pond and solar still, solar heating/cooling technique, solar distillation and drying, solar cookers – solar thermal plants.

Learning Outcomes: The students are able to

- Explain solar thermal collectors, solar thermal plants(L2)

UNIT-III:

Solar Photovoltaic Systems: Solar photovoltaic cell, module, array – construction – Efficiency of solar cells – Developing technologies – Cell I-V characteristics – Equivalent circuit of solar cell – Series resistance – Shunt resistance – Applications and systems – Maximum power point techniques: Perturb and observe (P&O) technique – Hill climbing technique.

Learning Outcomes: The students are able to

- Construct solar photo voltaic systems. (L3)
- Develop maximum power point techniques in solar PV (L3)

UNIT-IV:

Wind Energy and Geothermal Systems: Sources of wind energy - Wind patterns – Types of turbines –Horizontal axis and vertical axis machines - Kinetic energy of wind – Betz coefficient – Tip–speed ratio – Efficiency – Power output of wind turbine – Selection of generator(synchronous, induction). Geothermal: Classification – Dry rock and hot aquifer – Energy analysis – Geothermal based electric power generation

Learning Outcomes: The students are able to

- Explain wind energy conversion systems, wind power generators(L2)
- Understand maximum power point techniques in wind energy systems(L2)
- Explain basic principle and working of geothermal systems (L2)

UNIT–V:

Tidal power systems, Biomass and fuel cells: Tidal power – Basics – Kinetic energy equation – Turbines for tidal power – Numerical problems – Wave power – Basics – Kinetic energy equation – Wave power devices – Linear generators.

Biomass Energy: Pyrolysis – Direct combustion of heat – Different digesters and sizing. Fuel cell: Classification of fuel for fuel cells – Fuel cell voltage– Efficiency – V-I characteristics.

Learning Outcomes: The students are able to

- Explain basic principle and working of tidal power plants and Biomass (L2)
- Understand the concept of converting chemical energy to electrical energy (L2)

Text Books:

1. Non-conventional energy source –B. H. Khan- TMH-2nd edition.
2. G.D. Rai, 'Non Conventional Energy Sources', Khanna Publishers, New Delhi.

Reference Books:

1. Energy Science: Principles, Technologies and Impacts, John Andrews and Nick Jelly, OxfordUniversity Press.
2. Renewable Energy- Edited by Godfrey Boyle-oxford university.press,3rd edition,2013.
3. S.P. Sukhatme, Solar Energy: Principles of Thermal Collection And Storage, Tata McGraw-Hill
4. Renewable Energy Technologies /Ramesh & Kumar /Narosa.
5. Renewable energy technologies – A practical guide for beginners – Chetong Singh Solanki, PHI.
6. Fuel Cell Technology -Hand Book / Gregor Hoogers / BSP Books Pvt. Ltd.

Weblinks:

1. <https://nptel.ac.in/courses/103103206>

Subject Code	Subject Name	L	T	P	C
R20BSH-OE3201	Operations Research (Open Elective -2)	3	0	0	3

Course Objectives:

The objectives of the course are to

- impart the concepts of mathematical modeling for optimization of the resources.
- apply the algorithms to solve the Linear Programming, transportation and assignment problems.
- optimize the channels in waiting lines of manufacturing and service systems.
- determine the best strategy under competitive business environment
- understand Project scheduling and optimizing the duration of the project
- simulate real life probabilistic situations with Montecarlo simulation technique.

Course Pre-Requisites: Basic concepts of statistics: random variables, discrete probability distributions, Poisson and normal Probability distributions.

Course Outcomes

After completing the course, the student will be able to

1. construct mathematical model for allocation problems. (L3)
2. test for optimality to arrive optimal solution for transportation and assignment problems(L 4)
3. solve the problems of waiting lines and scheduling to arrive the optimal decisions. (L3)
4. apply the concepts of PERT and CPM for project management. (L3)
5. develop simulation model of discrete systems under uncertainties. (L4)

UNIT I

Introduction to Operations Research (OR): OR definition - Classification of Models, modeling – Methods of solving OR Models, limitations and applications of OR models.

Linear Programming(LP): Problem Formulation, Graphical Method, Special Cases of LP-Degeneracy, Infeasibility and Multiple Optimal Solutions; Simplex Method, Big- M simplex Method, Dual simplex method, application of L.P.P. in manufacturing firms.

Learning Outcomes:

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

- **understand** the development of models in Operations Research (L2)
- **explain the** application areas of operations research in manufacturing and service firms. (L2)
- **construct** the mathematical model for allocation problems (L3)
- **solve** linear programming problems(L3)

UNIT II

Transportation and Assignment Problems: Transportation Problem – Formulation; Different Methods of Obtaining Initial Basic Feasible Solution –North West Corner Rule, Least Cost Method, Vogel's Approximation Method; Optimality Method – Modified Distribution (MODI) Method; Special Cases – Unbalanced Transportation Problem, Degenerate Problem. Assignment Problem – Formulation, Hungarian Method for Solving Assignment Problems, Traveling Salesman problem. application of Transportation and Assignment Problems in manufacturing firms.

Learning Outcomes:

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

- **develop** mathematical model for transportation and assignment Problems(L4)
- **apply** algorithms to obtain initial basic feasible solution for transportation Problem(L3)
- **determine** the optimal solution for Transportation problems. (L3)
- **test for** optimality to arrive optimal solution for transportation problem(L4)
- **apply** hungarian algorithm to assignment and traveling Salesman problems. (L3)

UNIT III

Game theory: Optimal solution of two person zero sum games, the max min and min max principle. Games without saddle points, mixed strategies. algebraic method, Reduction by principles of dominance, graphical method for $[2 \times n]$ and $[m \times 2]$ game problems.

Sequencing: Sequencing the jobs in flow shop scheduling, Solution of Sequencing Problem, Processing of n Jobs through two machines, Processing of n Jobs through three machines, priority rules.

Learning Outcomes:

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

- **identify** the optimal strategies in competitive situations (L3)
- **solve** pay off matrix games using dominance rules and algebraic method. (L3)
- **choose** optimal sequence of jobs for scheduling (L3)

UNIT IV

Network Analysis: Network Representation, rules for drawing network, Fulkerson's Rule, Determination of Earlier Starting Time and Earliest Finishing Time in the Forward Pass – Latest Starting Time and Latest Finishing Time in Backward Pass, determination of critical path, total float calculation, Time estimates in PERT, Probability of completing the project, project cost, project crashing, Optimum project duration, Project management.

Learning Outcomes:

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

- **construct** the network diagram (L3)
- **compute** the starting time, finishing times in the forward Pass and backward Pass methods(L2)
- **identify** the Critical Path in the project(L3)
- **find** the probability of completing the project with PERT (L3)
- **understand** the concept of Project management (L2)
- **determine** the optimum project duration(L3)

UNIT V

Queuing Theory: Introduction – Basic queuing process, basic structure of queuing models terminology: arrival Pattern, service channel, population, departure pattern, queue discipline, Kendall's notation. Single Channel model with poisson arrivals, exponential service times with infinite queue length

Simulation: Basic concept of simulation, applications of simulation, merits and demerits of simulation, Monte Carlo simulation, simulation of Inventory system, simulation of Queuing system.

Learning Outcomes:

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

- **understand** the basic structure of queuing models and characteristics (L2)
- **explain** the goals of designing waiting line model (L2)
- **compute** parameters of the single channel waiting line (L3)
- **design** the discrete event simulation model for waiting line (L4)

Text books:

1. Sharma S.D., Operations Research: Theory, Methods and Applications, 15th

Edition, KedarNath Ram Nath.

2. Prem kumar Gupta and Hira, Operations Research, 3rd Edition, S Chand Company Ltd.,New Delhi.

Reference books:

1. Hiller F.S., and Liberman G.J., Introduction to Operations Research, 7th Edition, TataMcGraw Hill.
2. Sharma J.K., Operations Research:Theory and Applications, 4thEdition, LaxmiPublications.
3. Taha H.A., Operations Research, 9th Edition, Prentice Hall of India, New Delhi.
4. Pannerselvam R., Operations Research, 2nd Edition, Pentice Hall of India, New Delhi.
5. Sundaresan.V, and Ganapathy Subramanian.K.S, Resource Management Techniques: OperationsResearch, A.R Publications.

Subject Code	Subject Name	L	T	P	C
R20ECE-OE3202	Image Processing (Open Elective -II)	3	0	0	3

Course Objectives:

- To introduce fundamentals of Image Processing.
- To expose various intensity transformations in spatial and frequency domains.
- To impart concepts of wavelets and various coding techniques for image compression.
- To dissimilate various segmentation techniques for images.
- To teach various color models and to introduce the concepts of colour image segmentation.

Course Outcomes:

1. Analyze various types of images mathematically
2. Compare image enhancement methods in spatial and frequency domains
3. Demonstrate various segmentation algorithms for given image
4. Justify DCT and wavelet transform techniques for image compression
5. Analyze various colour models for color image processing

Unit 1

Digital Image Fundamentals-Elements of visual perception, image sensing and acquisition, image sampling and quantization, basic relationships between pixels – neighbourhood, adjacency, connectivity, distance measures.

Learning outcomes:

- Explain mathematical models of various types of images (L2)
- Define image processing parameters such as adjacency and distance measures (L1)

Unit 2

Image Enhancements and Filtering- Gray level transformations, histogram equalization and specifications, pixel-domain smoothing filters – linear and order-statistics, pixel-domain sharpening filters – first and second derivative, two-dimensional DFT and its inverse, frequency domain filters – low-pass and high-pass.

Learning outcomes:

- Compare image enhancement methods in spatial and frequency domains (L5)
- Apply frequency Domain filtering techniques for image enhancement (L3)

Unit 3

Image Segmentation, Detection of discontinuities, edge linking and boundary detection, thresholding –global and adaptive, region-based segmentation.

Learning outcomes:

- Describe various Image segmentation techniques (L2)
- Illustrate detection of discontinuities in an image (L2)

Unit 4

Wavelets and Multi-resolution image processing- Uncertainty principles of Fourier Transform, Time- frequency localization, continuous wavelet transforms, wavelet bases and multi-resolution analysis, wavelets and Sub-band filter banks.

Image Compression, -Redundancy, inter-pixel and psycho-visual; Loss less compression – predictive, entropy; Lossy compression- predictive and transform coding; Discrete Cosine Transform; Still image compression standards – JPEG and JPEG-2000.

Learning outcomes:

- Describe various transform techniques for lossy compression (L2)
- Apply various coding techniques for lossless compression (L3)

Unit 5

Colour Image Processing-Colour models–RGB, YUV, HSI; Colour transformations–formulation, colour complements, colour slicing, tone and colour corrections; Colour image smoothing and sharpening; Colour Segmentation.

Learning outcomes:

- Describe various colour models for colour image processing (L2)
- Apply various techniques for colour image smoothing, sharpening and segmentation (L3)

Text Books:

1. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Second Edition, Pearson Education, 2008.
2. Anil Kumar Jain, Fundamentals of Digital Image Processing, Prentice Hall of India, 2nd edition 2004.
3. Yao wang, Joem Ostarmann and Ya – quin Zhang, "Video processing and communication", 1st edition, PHI
4. M. Tekalp, "Digital video Processing", Prentice Hall International

References:

1. Rafael C. Gonzalez, Richard E woods and Steven L. Eddins, "Digital Image processing using MATLAB", Tata McGraw Hill, 2010.
2. Milan Sonka, Vaclav Hlavac, Roger Boule, Image Processing, Analysis, and Machine Vision, Third Edition, Cengage Learning, 2016.
3. S Jayaraman, S Esakkirajan, T Veerakumar, "Digital Image processing", Tata McGraw Hill. William K. Pratt, "Digital Image Processing", John Wiley, 3rd Edition, 2004

Subject Code	Subject Name	L	T	P	C
R20MEC-PC3204	Computer Aided Engineering Lab	0	0	3	1.5

Course Objectives:

The students will acquire the knowledge

- 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 post processor conditions

Course outcomes:

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

1. Apply part modelling and assembly modelling techniques to design mechanical components and sub-assemblies using CAD software. (L3)
 2. Construct orthographic, isometric, and sectional views with appropriate dimensioning and tolerances for part and assembly models using drafting tools. (L6)
 3. Analyze the structural behaviour of 2D and 3D trusses, beams, and shell structures under static loads, and evaluate natural frequencies, mode shapes, and harmonic response using CAE tools." (L4)
 4. Evaluate the heat transfer behavior of 2D and axisymmetric components under thermal loads using CAE tools to determine temperature distribution and thermal gradients (L5)
 5. Develop CNC part programming and perform machining operations on CNC Machine. (L6)
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)
a. Estimation of natural frequencies and mode shapes, Harmonic response of 2D beam
b. 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 RS232.
 6. CNC programming for milled components using FANUC Controller
 7. Automated CNC Toolpath & G-Code generation using Pro/E/Master CAM

Subject Code	Subject Name	L	T	P	C
R20MEC-PC3205	Heat Transfer Lab	0	0	3	1.5

Course Objectives:

The students will acquire the knowledge

- 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. Calculate heat transfer through lagged pipe, insulating powder and Drop and Film wise condensation.(L3)
2. Find out the Thermal conductivity of a given metal Rod and Determine the overall heat transfer coefficient for a composite slab.(L3)
3. Calculate the Heat transfer coefficient for Pin Fin, Forced convection, Natural Convection(L3)
4. Design the Fins and Heat Exchangers(L5)
5. test for 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 pipe 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
R20MEC-PC3206	Mechanical Measurements and Metrology Laboratory	0	0	3	1.5

Course Objectives: The students will acquire the knowledge:

- The Engineering Metrology Lab course is designed for measuring and gauging instruments for inspection of precision linear, geometric forms, angular and surface finish measurements.
- The student can learn the measurements with and calibration of instruments.
- To study and calibrate displacement, temperature, speed, capacitance and pressure measuring instruments

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

1. Measure linear and angular dimensions using Vernier calipers, micrometers, bevel protractors, and sine bars with precision. (L5)
2. Examine surface characteristics such as straightness, flatness, and roughness using spirit levels and roughness measuring instruments. (L1)
3. Inspect threads, bores, and dimensional features using toolmakers' microscopes, internal micrometers, and dial bore indicators. (L4)
4. Calibrate mechanical and electrical transducers, including pressure gauges, LVDTs, strain gauges, temperature and capacitive transducers. (L4)
5. Find the speed and displacements with photoelectric, magnetic pickups. (L4)

List of Experiments:

1. Measurement of angular displacement using capacitive transducer
2. Study and calibration of a rotameter for flow measurement
3. Study and calibration of LVDT transducer for displacement measurement
4. Calibration of thermistor and RTD
5. Calibration of thermocouple
6. Study and calibration of photo and magnetic speed pickups for the measurement of speed
7. Use of gear tooth vernier caliper for tooth thickness inspection and flange micrometer for checking the chordal thickness of spur gear.
8. Measurements of Surface roughness using Talysurf
9. Measurement of lengths, heights, diameters by vernier calipers, micrometers etc.
10. Performance on angular measurement of given specimen by using Vernier bevel protractor, sine bar.
11. Thread inspection with two wire/three wire method & tool makers microscope.
12. Use of spirit level in finding the straightness of a bed and flatness of a surface.
13. Measurement of bores by internal micrometers and dial bore indicators.
14. Machine tool alignment test on lathe machine

Note: Any 12 Experiments form above list

Subject Code	Subject Name	L	T	P	C
R20CSE-PC3201	OOPS through JAVA (Skill Oriented Course-4)	1	0	2	2

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, String Buffer and String Builder, String Tokenizer, Collections: Exploring java.util.*, Scanner, Iterable, Collection Hierarchy, Set, List, Queue and Map, Comparable and Comparator, Iterators: foreach, Enumeration, Iterator and List Iterator.

Learning Outcomes: Student will be able to

- Understand the usage of String and its properties and methods.(L2)
- Understand data structures and Iterators. (L2)
- 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

- Understand character and byte streams. (L2)
- Understand the hierarchy of errors and exceptions. (L2)
- 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

- Understand the Thread Life Cycle and its scheduling.(L2)
- Implement the synchronization of threads. (L2)
- 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, Saurabh Choudary, 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
R20BSH-MC3201	Entrepreneurship & Incubation (Mandatory Course)	1	0	2	2

Course Objectives:

- Creation of environment and facilities to instruct students and assist in identifying products or services.
- Develop innovative products, services, processes and techniques.
- Able to prepare financial proposals and start-ups.
- Promote the ideas to collaborate with entrepreneur skills in establishment of start-ups.
- Encourage the students to learn current trends of Science and Technology opportunities.

Course outcomes:

1. Enriches the knowledge of Entrepreneurial behavior, and skill development. (L2)
2. Initiate business ideas that have value in the end-market. (L3)
3. Identify the validity of idea and its unique selling proposition. (L4)
4. Comprehend opportunity and challenges of start-up. (L2)
5. Analyze various Government and non-Government financial resources. (L4)

Unit-I:

Fundamentals of Entrepreneurship: Entrepreneurship-Concept, Importance, Characteristics –Myths of Entrepreneurship -Role of Entrepreneurs in Indian economy– Social and Ethical Perspectives of Entrepreneurship.

Application: Case lets: Business cases of young entrepreneurs

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

- Interpret the concepts of entrepreneurship and the characteristics of an entrepreneur.(L2)
- 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 –Technological Innovation and Entrepreneurship - Product/ Service design–Design Thinking.

Case lets: Business cases of OYO.

Activity: Collection of novel business ideas.

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

- Choose the right business ideas.(L3)
- Evaluate the business idea. (L2)

Unit-III:

Feasibility Analysis and Business plan: Thrust areas of entrepreneurship- Techno-economic feasibility assessment-Financial feasibility – Market feasibility– Preparation of Business plan–Business canvas & Lean canvas.

Activity: Preparation of business plan(draft)

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

- Evaluate technical feasibility.(L1)
- Develop Lean canvas. (L4)

Unit-IV:

Business Incubation and startups: Fundamentals of business incubation-Services of incubators-Start-ups-meaning, significance-startup strategy-Present scenario of startups.

Activity: Analyze and evaluate new start-up..

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

- Describe 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–MSMEs-Crowd Funding–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)
- Analyze the 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.
2. Datsy Davies, Indian Startups, Amazon Asia –Pacific Holdings Private Limited

Reference Books:

1. P. N. Rath, Sarjue Pandita, Entrepreneurship: Startup India& Standup India, Lexicon Publishing House.
2. Madhurima Lall, Shikha Sahai, Entrepreneurship, Excel Books(P)Ltd.
3. Rajeev Roy, Entrepreneurship, Oxford Higher Education.
4. H.Nandan, Fundamentals of Entrepreneurship, PHI Learning (P)Ltd.