Shirpur Education Society's

R. C. Patel Institute of Technology, Shirpur

(An Autonomous Institute)

Syllabus Structure

Final Year B.Tech in Mechanical Engineering

(RCP22 Scheme) with effect from Year 2025-26

Shahada Road, Near Nimzari Naka, Shirpur, Maharashtra 425405 Ph: 02563 25[illegible]802,

Web: www.rcpit.ac.in/mechanical-engineering-syllabus

Department of Mechanical Engineering
(Autonomous - RCP22)

Semester – VII (w.e.f.2025-26)

Sr. No.	Course Category	Course Code	Course Title	Teaching Scheme (hrs.)			Evaluation Scheme (CA) (marks)				ESE (marks)	Total	Credit	
				L	T	P	TA	Term Test 1 (TT1)	Term Test 2 (TT2)	Average (TT1 & TT2)				
							[A]			[B]	[C]	[A+B+C]		
1	PC	22PCME7010T	Design of Mechanical Systems	3	-	-	25	10	10	10	65	100	3	4
	PC	22PCME7010L	Design of Mechanical Systems Laboratory	-	-	2	25	-	-	-	25	50	1	
2	PC	22PCME7020T	Production Planning and Control	3	-	-	25	10	10	10	65	100	3	4
	PC	22PCME7020L	Production Planning and Control Laboratory	-	-	2	25	-	-	-	25	50	1	
3 @	PE	22PEME703_T	Professional Elective - III	3	-	-	25	10	10	10	65	100	3	4
	PE	22PEME703_L	Professional Elective - III Laboratory	-	-	2	25	-	-	-	-	25	1	
4 &	PE	22PEME704_T	Professional Elective - IV	3	-	-	25	10	10	10	65	100	3	3
5 #	OE	22OEME705_T	Open Elective - I	3	-	-	25	10	10	10	65	100	3	3
6	PJ	22PJME7060L	Project Stage-II	-	-	4	50	-	-	-	50	100	2	2
7	ES	22ESME7070L	Full Stack Development Laboratory	-	-	2	25	-	-	-	25	50	1	1
			Total	15	0	12	275	50	50	50	450	775	21	21

PC-Professional Course, PE – Professional Elective, OE- Open Elective, PJ- Project, Engineering Science.

@,&,# Any 1 Elective from given list.

Prepared by
Prof. R. R. Ozarkar

Checked by
Prof. S. V. Yeole

BOS Chairman
Prof. Dr. P. L. Sarode

Dean Academic &Dy. Director
Prof. Dr. P. J. Deore

C.O.E.
Prof. S. P. Shukla

Mechanical Department R.C.P.I.T. OFFICE SEAL SHIRPUR

Director
Prof. Dr. J. B. Patil

Course Code	Semester – VII : Professional Elective - III
22PEME7031T	Flexible Manufacturing Systems
22PEME7032T	Design of Automotive Systems
22PEME7033T	Piping Engineering
22PEME7034T	Bionics Engineering
22PEME7035T	Computational Fluid Dynamics
22PEME7036T	Business Model Design
22PEME7037T	Soft Computing

Course Code	Semester – VII : Professional Elective - IV
22PEME7041T	Digital Manufacturing
22PEME7042T	Automotive Materials and Manufacturing
22PEME7043T	Design for X
22PEME7044T	Renewable Energy Systems
22PEME7045T	Startup Registration and Development
22PEME7046T	Big Data Analytics

Course Code	Semester – VII : Open Elective - I
22OEME7051T	Product Life Cycle Management
22OEME7052T	Management Information System
22OEME7053T	Operations Research
22OEME7054T	Cyber Security and Laws
22OEME7055T	Personal Finance Management
22OEME7056T	Energy Audit and Management
22OEME7057T	Disaster Management and Mitigation Measures
22OEME7058T	Science of Well-being
22OEME7059T	Research Methodology
22OEME70510T	Public Systems and Policies

Course Code	Semester – VII : Professional Elective Laboratory - III
22PEME7031L	Flexible Manufacturing Systems Laboratory
22PEME7032L	Design of Automotive Systems Laboratory
22PEME7033L	Piping Engineering Laboratory
22PEME7034L	Bionics Engineering Laboratory
22PEME7035L	Computational Fluid Dynamics Laboratory
22PEME7036L	Business Model Design Laboratory
22PEME7037L	Soft Computing Laboratory

Mechanical Department R.C.P.I.T. OFFICE SEAL SHIRPUR

Department of Mechanical Engineering

(Autonomous - RCP22)

Semester – VIII (w.e.f.2025-26)

Sr. No.	Course Category	Course Code	Course Title	Teaching Scheme (hrs.)			Evaluation Scheme (CA) (marks)				ESE (marks)	Total	Credits	
				L	T	P	TA	Term Test 1 (TT1)	Term Test 2 (TT2)	Average (TT1 & TT2)				
							[A]			[B]	[C]	[A+B+C]		
1 @	PE	22PEME801_T	Professional Elective-V	3	-	-	25	10	10	10	65	100	3	3
2 &	PE	22PEME802_T	Professional Elective-VI	3	-	-	25	10	10	10	65	100	3	3
3	INT	22INTME8030L	Internship	-	-	20	150	-	-	-	150	300	10	10
			Total	6	0	20	200	20	20	20	280	500	16	16

PE – Professional Elective, PJ- Project, INT- Internship.

@, & Any 1 Elective from given list.

1. *Professional Elective Courses offered for the students doing In-house Internship at institute level.
2. #Professional Elective Courses offered for the students doing Outhouse Internship at Industry. These courses are to be studied in self-study mode using NPTEL/SWAYAM platform.
3. Students doing internship at industry shall submit certificate of NPTEL examination **OR** they have to appear examinations conducted by institute like TT1, TT2 and ESE.
4. Students undergoing internship have the option to appear for both the NPTEL examination and the End Semester Examination (ESE) conducted by the institute for the respective course. In such cases, the better of the two scores (NPTEL or ESE) shall be considered for final grading.
5. List of NPTEL courses will be declared by concerned BOS at the beginning of semester VIII.

Course Code	Semester – VIII : Professional Elective - V
22PEME8011T	Industrial Engineering and Management*
22PEME8012T	Automation and IoT*
22PEME8013T	Sustainable manufacturing*
22PEME8014T	Motorsports Engineering*
22PEME8015T	Project Management*
22PEME8016T	Entrepreneurship Development and Management*
-	NPTEL/SWAYAM Course #

Course Code	Semester – VIII : Professional Elective - VI
22PEME8021T	Business Analytics*
22PEME8022T	Energy Audit and Management*
22PEME8023T	Human Resource Management*
22PEME8024T	Logistic and Supply Chain Management*
22PEME8025T	IPR and Patenting*
22PEME8026T	Environmental Management*
-	NPTEL/SWAYAM Course #

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R. C. Patel Institute of Technology, Shirpur

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Syllabus Details of Semester-VII

Final Year B.Tech
in Mechanical Engineering

(RCP22 Scheme) with effect from Year 2025-26

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Web: www.rcpit.ac.in/mechanical-engineering-syllabus

Department of Mechanical Engineering R.C.P.I.T. OFFICE SEAL SHIRPUR

Program: Mechanical Engineering	Final Y. B.Tech.	Semester: VII
Design of Mechanical Systems (22PCME7010T)		
Design of Mechanical Systems Laboratory (22PCME7010L)		

Prerequisites:

1. Knowledge of Material Technology,
2. Mechanics of Materials, and
3. Design of Machine Elements.

Course Objectives:

1. To acquaint with functional and strength design principles of important machine elements used in mechanical systems.
2. To study the detailed design procedure of the different types of machine elements used in mechanical systems.
3. To familiarize selection of standard elements such as rolling contact bearings.
4. To study system design of various systems such as Gearbox, snatch block, belt conveyors and pumps.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Design gears based on the given conditions and develop multispeed gearboxes for a specified machine tool application.	L6	Create
CO2	Select bearings for a given application.	L4	Analyze
CO3	Design hoisting mechanism of an Electric overhead traveling crane.	L6	Create
CO4	Design belt conveyor systems.	L6	Create
CO5	Design pumps for a given application.	L6	Create

Design of Mechanical Systems (22PCME7010T)

Course Contents

Unit-I **10 Hrs.**

Design of Gears

Design of spur, helical, bevel and worm gears with strength, wear and thermal considerations.

Unit-II **09 Hrs.**

Design of Bearings

Rolling Contact Bearings : Types of bearing, designation, selection of rolling contact bearings based on constant / variable load (includes deep groove ball bearing, cylindrical roller, spherical roller, taper roller, self-aligning bearing and thrust bearing).
Sliding Contact Bearings: Design of hydro dynamically lubricated bearings (self-contained), Introduction to hydrostatic bearings, Types and selection of Mechanical seals.

Unit-III **04 Hrs.**

Introduction to Mechanical System Design

Design of Gear Box: Design of gear box (multi speed) for machine tool applications (Maximum two stages and nine speeds) Determination of variable speed range, Graphical representation of speeds, Structure diagram, Ray diagram, Selection of optimum ray diagram, Estimation of numbers of teeth on gears (Excluding Deviation diagram, Layout of gear box).

Unit-IV **07 Hrs.**

Design of Hoisting mechanism

Introduction to material handling system, Design of EOT crane system: Snatch Block assembly, Selection of wire rope, Design and selection of sheave pulley, axle and bearings, Design of nut, Selection of thrust bearing, Design of cross-piece with trunnion, Design of shackle plate, Design of rope drum, drum shaft and bearing, Selection of motor. (Excluding Selection of hook).

Unit-V **05 Hrs.**

Design of Belt Conveyors

Design of belt conveyor system for specified material and capacity: Selection of belt, Selection of motor, Design of drive pulley assembly, Design of driven pulley assembly, Design of over running idler assembly, Design of under running idler assembly.

Unit-VI **04 Hrs.**

Design of Gear Pump

Introduction of Gear pump, Design of gear pump for specified discharge and speed etc., Selection of motor, Design of gear, Selection of bearing, Design of bolts, Design of suction and delivery pipe.

Design of Mechanical Systems Laboratory (22PCME7010L)

Suggested Experiments

A Design and detailed assembly drawing (computer aided drawing on A3 size sheets) of minimum two design problems, from the following:

1 Design of hoisting mechanisms
2 Design of belt conveyors
3 Design of pumps

B Exercises on following topics in the form of design calculations with sketches and / or drawings:

1 Design of Gears
2 Rolling contact bearings/ Sliding contact bearing
3 Design of gearbox

C Course Project:

Students in a group (2 to 4 students) should be able to apply and integrate the knowledge gained during the course. Design and preparation of working drawings of any system having minimum 5 to 6 components is expected.

Books Recommended

Textbooks

1 Richard G. Budynas and J. Keith Nisbett, Shigley's Mechanical Engineering Design, McGraw-Hill Education, New York, 2024.

2 V. B. Bhandari, Design of Machine Elements, McGraw-Hill Education, New Delhi, 2021.

3 S. P. Patil, Mechanical System Design, Jaico Publishing House, Mumbai, 2004.

4 B. Sharma and H. Purohit, Design of Machine Elements, Prentice Hall India, New Delhi, 2008.

5 Robert L. Norton, Machine Design - An Integrated Approach, Pearson Education, Upper Saddle River, NJ, 2006.

6 J.E. Shigley, Mechanical Engineering Design, McGraw Hill, New York, 2009.

Reference Books

1 S. K. Basu and D. K. Pal, Design of Machine Tools, CBS Publishers Distributors, New Delhi, 2018.

2 N. K. Mehta, Machine Tool Design, McGraw-Hill Education, New Delhi, 2012.

3 PSG College of Technology, Design Data: Data Book of Engineers, Kalaikathir Achchagam, Coimbatore, 2023.

4 S. S. Khandare and A. V. Kale, Design of Engine Parts, Charotar Publishing House, Anand, 2008.

5 Pandya Shah, Machine Design, Charotar Publishing, Anand, 2020.

6 Reshetov, Machine Design, Mir Publication, Moscow, 2019.

7 Black Adams, Machine Design, McGraw Hill, New York, 2021.

8 Mahadevan, Design Data Book,CBS Publishers Distributors Pvt Ltd,2013.

Program: Mechanical Engineering	Final Y. B.Tech	Semester: VII
Production Planning and Control (22PCME7020T)		
Production Planning and Control Laboratory (22PCME7020L)		

Prerequisites:

Nil

Course Objectives:

1. To provide an exposure to Production Planning Control (PPC) and its significance in Manufacturing Industries.
2. To give insight into the ongoing futuristic trends in the Material Management and Inventory Control.
3. To appraise about need and benefits of planning functions related to products and the processes.
4. To give exposure to production scheduling and sequencing to optimize the resources.
5. To give exposure to latest trend in PPC.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Illustrate production-planning functions and manage manufacturing functions in a better way.	L3	Apply
CO2	Forecast the demand of the product and prepare an aggregate plan.	L4	Analyze
CO3	Develop the skills of Material Planning, Inventory Management Model and Control.	L6	Create
CO4	Develop the competency in scheduling and sequencing of manufacturing operations.	L6	Create
CO5	Understand the significance of implementation of ERP.	L2	Understand

Production Planning and Control (22PCME7020T)

Course Contents

Unit-I **08 Hrs.**

Manufacturing systems

Manufacturing systems - Components and types, Transformation from Industry 1.0 to Industry 4.0. Manufacturing Systems- projects jobbing products, batch, mass / flow production, continuous / process production, Introduction to JIT, Lean Production, FMS, Agile Manufacturing, etc.
PPC – Need and functions of PPC, relationship of PPC with other departments. Factors influencing PPC in the organization, Organization of PPC- status of PPC department, internal structure, degree of centralization, PPC as an integrated approach.
Prerequisites of PPC - data pertaining to design, equipment, raw materials, tooling, performance standards, labor operating systems.
Order preparation- works order preparation for various manufacturing methods, subsidiary orders, shop or production orders, inspection orders and stores issue orders, etc.

Unit-II **06 Hrs.**

Forecasting, Aggregate planning, Capacity planning

Forecasting for operations- requirements for forecasting, importance of forecasting, basic categories of forecasting methods, qualitative methods, quantitative methods, accuracy and control of forecasts.
Aggregate planning: Concept of aggregate planning, decision rules, strategies and methods.
Capacity Planning: Measurement of capacity, Measures of capacity, Factors influencing effective capacity, short range, medium range and long-range capacity planning, rough cut capacity planning.

Unit-III **05 Hrs.**

Material Planning

Role of Materials Management- materials and profitability, Purchase functions, Procurement procedures including bid systems, Vendor selection and development, Vendor rating, ethics in purchasing. Roles and responsibilities of purchase professionals. Concepts of lead-time, purchase requisition, purchase order, amendments, forms used and records maintained.

Unit-IV **08 Hrs.**

Independent & dependent Demand Inventory Models

Independent Demand Inventory Models - The nature and importance of inventories, requirements for effective inventory management, types of inventory models, Deterministic models, Quantity discount models, re-order point, concept of safety stock, Dynamic Models, Probabilistic models.
Dependent Demand Inventory models–MRP: An overview of material requirements planning, MRP inputs, MRP outputs MRP processing, MRP in service, benefits, requirement of MRP and MRP II systems.

Unit-V **07 Hrs.**

Job Shop Scheduling and Project Scheduling

Introduction to Job Sequencing, Objectives, Sequencing Problems, Solution to Sequencing Problem, processing of n Jobs on 1 machine, Johnson's Rule for optimal sequence of processing n jobs on 2 machines (n/2 problem), processing of n Jobs on 3 Machines (n/3 problem) and processing of 2 Jobs on m Machine (2/m) problem. Inputs for scheduling, loading and scheduling devices, factors influencing scheduling, scheduling techniques, use of Gantt Charts and basic scheduling problems. Concepts of project planning, monitoring and control, Project scheduling by using elements of network analysis –PERT and CPM, cost analysis and crashing, resource leveling.

Unit-VI **05 Hrs.**

Enterprise Resource Planning (ERP)

ERP Introduction, Benefits, Origin, Evolution and Structure, Conceptual Model of ERP, the Evolution of ERP, the Structure of ERP.
ERP- Functional Modules: Introduction, Functional Modules of ERP Software, Integration of ERP, Supply chain and Customer Relationship Applications.
ERP Implementation Basics, ERP Implementation Life Cycle, ERP E- Commerce, Future Directives-in ERP, ERP and Internet, Critical success and failure factors, Integrating ERP into organizational culture.

Production Planning and Control Laboratory (22PCME7020L)

Suggested Experiments

A Group: Lab Work

1 Case-study presentation on Manufacturing System and Importance of PPC department.
2 Case-study presentation on Forecasting Techniques and Capacity Management.
3 Case-study presentation on Material Management and Scientific Inventory Control.
4 Case-study presentation on Job Shop and Project scheduling.
5 Case-study presentation on structure, modules and implementation of an ERP.

B Group B : List of Assignments

1 Assignment on Manufacturing System and Importance of PPC department.
2 Assignment on Forecasting Techniques and Capacity Management.
3 Assignment on Material Management and Scientific Inventory Control.
4 Assignment on Job Shop and Project scheduling.
5 Assignment on structure, modules and implementation of an ERP.

Books Recommended

Textbooks

1 L. C. Jhamb, Production Planning and Control, Everest Publishing House, 2016.

2 L. C. Jhamb, Inventory Management, Everest Publishing House, 2013.

3 D. S. Hira and P. K. Gupta, Problems in Operations Research (Principles and Solutions), S Chand Publications, 2010.

4 Rahul V. Altekar, Enterprise-wide Resource Planning: Theory and Practice, PHI Publication, 2004.

Reference Books

1 Samuel Eilon, Elements of Production Planning and Control, Universal Publishing Corporation, 2015.

2 W. Bolton, Production Planning and Control, Pearson Education Limited, 1994.

3 James L. Riggs, Production Systems - Planning, Analysis Control, John Wiley Sons, 2018.

4 Thomas E. Vollman, William L. Berry Others, Manufacturing Planning and Control Systems, Galgotia Publishers, 1984.

5 Anand Bewoor, Manufacturing Process Planning and Systems Engineering, Dreamtech Press, 2019.

6 S. N. Chary, Production and Operations Management, TMH Publishing Company, 2019.

Program: Mechanical Engineering	Final Y. B.Tech	Semester: VII
Flexible Manufacturing Systems (22PEME7031T)		
Flexible Manufacturing Systems Laboratory (22PEME7031L)		

Prerequisites:

Nil

Course Objectives:

1. To introduce the basic concepts of flexible manufacturing system (FMS) like material handling, loading, scheduling, storage etc.
2. Developing skills to design and optimize manufacturing cells.
3. Incorporate advanced tools like Petri nets enabling students for modeling manufacturing processes, enhancing system analysis and decision-making.

Course Outcomes:

On completion of the course:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Students will have a solid foundation in the evolution, principles, and economic justification of FMS, along with the role of CIM (Computer Integrated Manufacturing) in enhancing flexibility. Also will be able to distinguish between job shop, batch production, and mass production systems	L2	Understand
CO2	Students will be able to design efficient workstations, integrate automated systems like AGVS and ASRS, and manage storage and work-in-progress inventories in FMS.	L6	Create
CO3	Students will be able to form part families, apply part classification systems, design machine cells, and use clustering algorithms to enhance manufacturing efficiency.	L6	Create
CO4	Students will be capable of applying algorithms to assess FMS flexibility and determine the necessary resources to support manufacturing cells.	L3	Apply
CO5	Students will learn how to use Petri nets to model and analyze complex manufacturing systems, improving production planning, system coordination, and resource utilization.	L4	Analyze

Flexible Manufacturing Systems (22PEME7031T)

Course Contents

Unit-I **09 Hrs.**

Introduction

Introduction – FMS evolution, need for flexibility, economic justification of FMS, role of CIM in FMS, case studies.
Production systems in FMS - Types of Production-Job Shop, Batch and Mass production; Organization and information processing in manufacturing - Plant layout - Batch production – Work in progress inventory.

Unit-II **09 Hrs.**

FMS components

Workstations, Computer control system (data file, reports, hardware and software development), types of automated guided vehicle system (AGVS)and automated storage retrieval system (ASRS), carousel storage system,
WIP storage, analysis of AGV and AS/RS systems.

Unit-III **09 Hrs.**

Cellular manufacturing

Formation of part families, Part classification, Coding system optiz, Machine cells design, clustering methods, modern algorithms, benefits of GT, system planning, cell characteristic - system definition and sizing, human resources and its objective, staffing, supervisor role.

Unit-IV **04 Hrs.**

Evaluation of FMS

Algorithms for cell evaluations, measure of flexibility.

Unit-V **08 Hrs.**

Production control in FMS

scheduling in FMS, line balancing in FMS and inventory control in FMS. Applications of Petri net methodology to manufacturing systems.

Flexible Manufacturing Systems Laboratory (22PEME7031L)

Suggested Experiments

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1 Determine the components and configuration of the FMS to simulate machines, robots, conveyors, automated Guided Vehicles (AGVs), and storage.

2 Define various inputs to be given to FMS system - product types, production rates, machine setup times, processing times.

3 Simulation on software (Arena, Simul8, FlexSim) , create a digital model of the flexible manufacturing system and set up various operational parameters.

4 Analyze system performance measures with given production schedules.

5 Optimize the material handling system by testing different transport methods (e.g., conveyor vs. AGVs), using simulation software

6 Implement scheduling algorithms such as First-Come-First-Served (FCFS), Shortest Job First (SJF), or Priority Scheduling in a simulated FMS setup.

7 Use Value Stream Mapping (VSM) to identify and eliminate waste in the FMS setup.

All seven experiments from the above list or any other experiment based on the syllabus will be included, which would help the learner apply the concept.

Books Recommended

Reference Books

1 B. S. Nagendra Parashar, Cellular Manufacturing System –An integrated approach, PHI learning private ltd, 2009.

2 Mikell Groover., Automation Production Systems Computer Integrated manufacturing, PHI, 4th edition, 2016.

3 H. K. Shivananda, “Flexible manufacturing Systems”, Dhanpat Rai publications, New Delhi, 2006.

4 N. K. Jha, Handbook of Flexible manufacturing system, Academic press Inc., 1991.

5 William W. Luggen., Flexible Manufacturing Cells and Systems, Prentice Hall, NJ, 1991

Program: Mechanical Engineering	Final Y. B.Tech	Semester: VII
Design of Automotive Systems (22PEME7032T)		
Design of Automotive Systems Laboratory (22PEME7032L)		

Prerequisites:

1. Engineering mechanics; Machine design; Material science; Thermodynamics
2. Fundamentals of electronics, and electrical engineering.

Course Objectives:

1. To impart fundamental knowledge of automotive system design, including material selection and optimization techniques.
2. To develop competency in designing critical engine components such as cylinders, pistons, crankshafts, and valve mechanisms.
3. To enable students to design and analyze power transmission components, including clutches, gearboxes, and driveline systems.
4. To familiarize students with braking and suspension system design, including performance considerations and material selection.
5. To introduce modern automotive technologies such as ABS, ESC, CVTs, and advanced driveline configurations for improved vehicle performance.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Demonstrate an understanding of the fundamental principles of automotive system design and component optimization.	L2	Understand
CO2	Apply engineering principles to design and analyze key engine and power transmission components.	L3	Apply
CO3	Develop clutch and transmission system designs based on torque transmission requirements and material properties.	L6	Create
CO4	Design braking and suspension systems, considering safety, performance, and material constraints.	L6	Create
CO5	Evaluate driveline components, including propeller shafts, differentials, and axle designs, for various vehicle configurations.	L5	Evaluate
CO6	Analyze and propose improvements for vehicle systems using modern automotive technologies, enhancing efficiency and performance.	L4	Analyze

Design of Automotive Systems (22PEME7032T)

Course Contents

Unit-I **07 Hrs.**

Design of Engine Components

- Engine Design (Petrol and Diesel): Design of cylinder, Design of piston with pin and rings, Design of connecting rod, Design of crank shaft with bearings
- Valve mechanism design: push-rods, valves, valve springs, tappets, and rocker arms (theory only).

Unit-II **06 Hrs.**

Design of Clutches

- Selection criteria, torque transmission capacity, and lining materials.
- Design requirements of friction clutches.
- Design of single plate, and multi-plate clutches.

Unit-III **06 Hrs.**

Design of Transmissions System

- Design considerations and material selection.
- Types of gearboxes: sliding mesh, constant mesh, synchromesh, and epicyclic gearboxes.
- Design of synchromesh gearbox.

Unit-IV **06 Hrs.**

Design of Powertrain

- Powertrain types, Design approaches for IC engine based vehicles and EVs. Layouts of electric and hybrid electric powertrains and their design approaches and considerations.
- Design of Propeller shaft design for bending, torsion, and rigidity.
- Universal joints, slip joints, and differential design.

Unit-V **07 Hrs.**

Braking Systems

- Design of internal expanding shoe brakes and disc brakes.
- Braking force calculation and thermal considerations.
- Materials for Brake Lining.

Unit-VI **07 Hrs.**

Suspension Systems

- General design considerations of suspension systems.
- Design of MacPherson strut suspension system.
- Air (pneumatic) and hydro-elastic suspension systems (theory).

Design of Automotive Systems Laboratory (22PEME7032L)

Suggested Experiments

A Study-Type/ Case-Study-based Experiments (Theoretical and Conceptual Learning) (any 2):

1 Study the design and materials of various engine components (cylinder, piston, crankshaft) from different vehicle models.
2 Compare the working principles, advantages, and disadvantages of different transmission systems (manual, automatic, CVT).
3 Research and present a report on the evolution of braking systems, including ABS and ESC technologies.
4 Study the design and characteristics of different suspension systems (leaf spring, coil spring, air suspension) in various vehicles.

B Numerical Analysis/ Simulation-based Experiments (Python/ MATLAB/ Simulink, etc.) (any 2):

1 Simulate the performance of an IC engine under varying loads and speeds using software.
2 Simulate the effect of different gear ratios on vehicle acceleration and fuel economy.
3 Simulate the torque distribution in an AWD system under different road conditions.
4 Simulate the dynamic behavior of a suspension system over rough terrain using MATLAB or ADAMS.

C Design-Based Experiments (any 2):

1 Design a braking system for a passenger car
2 Design transmission system for a two-wheeler
3 Design a suspension system for a bus.
4 Design a clutch system for a heavy duty trucks.

D Performance-Based Experiments (Hands-on and Simulation Tools) (any 2):

1 Performance evaluation of a single-plate clutch system.
2 Braking performance and thermal response analysis.
3 Propeller shaft torsional and bending rigidity test.
4 Suspension system response and ride comfort testing (MacPherson Strut).

A minimum of eight experiments from the above-suggested list (02 from each group) or any other experiment based on the syllabus will be included, which would help the learner to apply the concept.

Books Recommended

Textbooks

1 Kirpal Singh, Automobile Engineering Volume 1, Standard, 2000.

2 R. K. Rajput, A Text Book of Automobile Engineering, Laxmi Publication, 2008.

3 V. B. Bhandari, Design of Machine Elements, Tata McGraw-Hill, 2010.

4 Tom Denton, Automobile Mechanical and Electrical Systems, CRC Press, 2017.

5 G. K. Awari, V. S. Kumbhar, R. B. Tirpude, Automotive Systems: Principles and Practices, CRC Press, 2021.

6 Günther Prokop, Hermann Winner, and Markus Maurer, Automotive Systems Engineering II, Springer International Publishing, 2017.

7 Kirpal Singh, Automobile Engineering Volume 2, Standard, 1993.

Reference Books

1 Design Data Book by P.S.G. College of Technology, Coimbatore, 2022.

2 S. S. Khandare and A. V. Kale, Design Data Book – Design of Engine Parts, 2018.

3 Tom Denton, Advanced Automotive Fault Diagnosis, Taylor Francis, 2006.

4 Tom Denton, Automobile Electrical and Electronic Systems, CRC Press, 2017.

5 Hermann Winner, and Markus Maurer, Automotive Systems Engineering, Springer Berlin Heidelberg, 2013.

6 Mark van den Brand, Yanja Dajsuren, Automotive Systems and Software Engineering: State of the Art and Future Trends, Springer International Publishing, 2019.

7 Harald Naunheimer, Bernd Bertsche, Joachim Ryborz, Peter Fietkau and Wolfgang Novak, Automotive Transmissions Fundamentals, Selection, Design and Application, Springer Berlin Heidelberg, 2010.

8 John C. Dixon, Suspension Geometry and Computation, Wiley, 2009.

9 Julian Happian-Smith, An Introduction to Modern Vehicle Design, Elsevier Science Technology Books, 2001.

Web References

1 Fundamentals of Automotive Systems
https://nptel.ac.in/courses/107106088

2 Ergonomics In Automotive Design
https://nptel.ac.in/courses/107103084

Program: Mechanical Engineering	Final Y. B.Tech	Semester: VII
Piping Engineering (22PEME7033T)		
Piping Engineering Laboratory (22PEME7033L)		

Prerequisites:

1. Fundamentals of mechanical elements

Course Objectives:

1. To study components, materials and standards of piping systems
2. To study piping layout and drawings
3. To study basic loading conditions and failure nodes.
4. To study compliance and regulatory requirements for piping systems.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Discuss needs and requirements of a piping system.	L2	Understand
CO2	Design and analyze piping parts and its layout.	L6	Create
CO3	Analyze the piping materials, codes, stress- strain and their flexibility.	L4	Analyze
CO4	Select and analyze a pipe network for specified application.	L4	Analyze
CO5	Calculate pressure drop in piping system using fluid mechanics fundamentals.	L3	Apply

Piping Engineering (22PEME7033T)

Course Contents

Unit-I **010 Hrs.**

Introduction of Piping systems and Components

Importance of piping engineering in Industrial application. Types of pipes and their systems, fittings, flanges, valves, their types and their selection with sizes. Expansion of joints and flexible connectors. Pipe supports, types, selection and design.

Unit-II **06 Hrs.**

Piping materials

Material selection, including metals, plastics and composites. Material properties and characteristics. Material specifications and material data sheets. Material testing and quality assurance. Materials of piping required for transportation of gas like H2.

Unit-III **13 Hrs.**

Piping design

Piping codes and standards. Piping layout and routing principles, Isometric drawings, piping drawings graphics and Piping design for different plants. Software used for Piping and Instrumentation diagram (PIDs). Maintain PID symbols and legends. Geotagging and aligning diagrams. Design of basic piping parts. Basic formulae. Pipe sizing methods. Pressure drop based pipe sizing. Piping design for transportation of gas like H2. Use of Generative technology in Piping design.

Unit-IV **07 Hrs.**

Piping stress analysis

Basic stress and strain in piping systems. Piping Flexibility Analysis. Concepts of flexibility analysis with software usage. Introduction on CAESAR II and Autopipe software.

Unit-V **03 Hrs.**

Piping Code compliance and regulatory requirements

Compliance with piping codes and standards. Regulatory requirements. Inspection and testing procedures.

Piping Engineering Laboratory (22PEME7033L)

Suggested Experiments

A Study-Type/ Case-Study-based Experiments (Theoretical and Conceptual Learning):

1 Analysis of stress induced in piping systems using software like CAESAR II.
2 Analyze vibrations in piping systems to identify potential problems and ensure safe operation.
3 Simulation of the thermal expansion and contraction of pipes to assess their behavior under temperature variations.
4 Simulation of pressure test and leak test of piping systems.
5 Case study on safety training required in piping systems.
6 Simulation of different flow conditions in piping systems.
7 Calculation head loss due to friction, velocity or pressure drop using the Darcy-Weisbach equation.
8 Calculation of the required pipe size and flow velocity based on flow rate and fluid properties in piping system.
9 Designing piping layouts using software like AutoCAD.

All experiments from the group A list or any other experiment based on the syllabus will be included, which would help the learner apply the concept.

Books Recommended

1 M.W. Kellogg Co. Design of Piping Systems. Wiley, 1961.
2 Silowash, Brian. Piping Systems Manual. McGraw Hill Professional, 2009.
3 Peng, Liang-Chuan and Tsen-Loong Peng. Pipe Stress Engineering. ASME press, 2009.
4 Menon, Shashi. Piping calculations manual. McGraw Hill Professional, 2004.
5 Wilson, B. Detail Engineering and Layout of piping systems, 2011.

Program: Mechanical Engineering	Final Y. B.Tech	Semester: VII
Bionics Engineering (22PEME7034T)		
Bionics Engineering Laboratory (22PEME7034L)		

Prerequisites:

1. Fundamentals of Mechanical Engineering.
2. Fundamentals of Design, Manufacturing, Assembly.

Course Objectives:

1. To introduce the fundamentals of bionics and biomimetics in engineering applications.
2. To develop an understanding of bio-inspired design methodologies and their practical applications.
3. To explore the mechanical properties of biological materials and their relevance to engineering.
4. To examine biomimetic manufacturing techniques for sustainable and efficient production.
5. To investigate bio-inspired locomotion and robotic systems for engineering applications.
6. To analyze real-world applications of bionics in aerospace, automotive, biomedical, and renewable energy sectors.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Explain the core principles of biomimetics and how biological systems inspire engineering solutions	L2	Understand
CO2	Apply biomimetic design methodologies to develop innovative mechanical systems.	L3	Apply
CO3	Analyze the mechanical properties of biological materials and their applications in engineering.	L4	Analyze
CO4	Evaluate biomimetic manufacturing techniques, including 3D printing and self-assembly methods.	L5	Evaluate
CO5	Develop bio-inspired robotic mechanisms by applying principles of natural locomotion and Assess the impact of bionic innovations in aerospace, automotive, biomedical, and renewable energy fields.	L6	Create

Bionics Engineering (22PEME7034T)

Course Contents

Unit-I **06 Hrs.**

Introduction to Bionics & Biomimetic

- Definition, scope, and importance of bionics in engineering
- Historical background and key advancements
- Nature-inspired design principles
- Biological systems as models for engineering solutions.

Unit-II **10 Hrs.**

Fundamentals of Bio-Inspired Design

- Fundamentals of Bio-Inspired Design
- Biomimetic design methodology
- Case studies in bio-inspired mechanical systems
- Structural and functional adaptations in nature
- Computational approaches in bio-inspired design.

Unit-III **06 Hrs.**

Materials & Mechanics in Bionics

- Biological materials and their mechanical properties
- Smart materials inspired by nature (e.g., self-healing, shape memory)
- Nanomaterials and their bio-inspired applications
- Soft robotics and bio-inspired actuation.

Unit-IV **07 Hrs.**

Biomimetic Manufacturing & Fabrication Techniques

- Bio-inspired 3D printing and additive manufacturing
- Nano- and micro-fabrication techniques
- Self-assembly and biofabrication
- Sustainable and green manufacturing approaches inspired by nature.

Unit-V **10 Hrs.**

Bio-Inspired Motion & Robotics and Applications

- Bio-Inspired Motion & Robotics
  - Locomotion principles in biological systems
  - Bio-inspired robotic mechanisms (e.g., insect-inspired robots, snake robots)
  - Fluid dynamics in natural locomotion (e.g., fish, birds)
  - Energy-efficient motion strategies from nature
- Applications of Bionics in Engineering
  - Aerospace: Bio-inspired wings, drag reduction techniques
  - Automotive: Nature-inspired aerodynamics and materials
  - Biomedical: Prosthetics, exoskeletons, and tissue engineering
  - Renewable Energy: Bio-inspired energy harvesting (solar panels, wind turbines)

Bionics Engineering Laboratory(22PEME7034L)

Suggested Experiments

A Study-Type/ Case-Study-based Experiments (Theoretical and Conceptual Learning):

1 Biomimetic Surface Experiment (Lotus Effect Shark Skin)
2 Bio-Inspired Structural Strength (Honeycomb vs. Conventional Structures)
3 Bio-Inspired Aerodynamics (Kingfisher Beak Bullet Train Nose)
4 Soft Robotics Bio-Inspired Actuation (Octopus-Inspired Grippers)
5 Biomimetic Energy Harvesting (Butterfly Wing-Inspired Solar Panels)
6 Locomotion Analysis in Bio-Inspired Robotics (Snake vs. Quadruped Robots)
7 Biomimetic Cooling System (Termite Mound-Inspired Ventilation)
8 Bio-Adhesion Study (Gecko Feet-Inspired Dry Adhesives)
9 Case Study Presentation on Biomimetic Innovations

A minimum of eight experiments from the above-suggested list or any other experiment based on the syllabus will be included, which would help the learner to apply the concept.

Books Recommended

Textbooks

1 Yoseph Bar-Cohen, Biomimetics: Nature-Based Innovation, CRC Press, 2011.
2 Wole Soboyejo and Leo Daniel, Bioinspired Structures and Design: Butterfly Wings, Lotus Leaves, and Other Natural Wonders, Cambridge University Press, 2018.
3 Janine M. Benyus, Biomimicry: Innovation Inspired by Nature, Harper Perennial, 2002.
4 Junzhi Yu, Bioinspired Robotics: Mechanisms and Control, Elsevier, 2022.
5 Nathan F. Lepora, Anna Mura, and Tony J. Prescott (Eds.), Biomimetic and Biohybrid Systems, Springer, 2013.

Reference Books

1 Alicia Kim, Bioinspired Engineering, Wiley, 2021.

2 Chad S. Korach, Mechanics of Biological Systems and Materials, Springer, 2015.

3 Lígia Rodrigues and Manuela E. Gomes (Eds.), Bioinspired Materials for Medical Applications, Woodhead Publishing, 2017.

4 Xin-She Yang, Nature-Inspired Optimization Algorithms, Elsevier, 2014.

Web References

1 Introduction to Biomimicry
https://onlinecourses.nptel.ac.in/noc22_ge24/preview

2 Wyss Institute for Biologically Inspired Engineering –Harvard University
https://wyss.harvard.edu

3 Journal of Bionic Engineering – Springer
https://www.springer.com/journal/42235

4 Biomimicry Institute
https://biomimicry.org

5 Biological Inspired Design – Georgia Tech
https://bid.isye.gatech.edu

6 MIT Biomimetics Robotics Lab
http://biomimetics.mit.edu

Program: Mechanical Engineering	Final Y. B.Tech	Semester: VII
Computational Fluid Dynamics (22PEME7035T)		
Computational Fluid Dynamics Laboratory (22PEME7035L)		

Prerequisites:

1. Fundamentals of Engineering Mechanics and Applied Mathematics
2. Fundamentals of Fluid Mechanics and Heat Transfer.

Course Objectives:

1. To understand the basics of CFD and its working methodology.
2. To gain knowledge about the governing equations applicable for CFD problems.
3. To study various concepts related to Turbulence.
4. To understand the working of Finite Difference method and its application to CFD problems.
5. To evaluate and solve problems of conduction, convection and diffusion in 1-D using Finite Volume Method.
6. To explore the various boundary conditions and solution algorithms.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Understand the concept and Methodology working of CFD.	L2	Understand
CO2	Understand the governing equations applicable in CFD problems.	L2	Understand
CO3	Recognize the application of turbulence model for various CFD Problems.	L3	Apply
CO4	Analyse and solve 1D problems of Conduction, Convection and diffusion using Finite Volume Method.	L4	Analyze
CO5	Explain the various boundary conditions.	L2	Understand
CO6	Explain the various solution algorithms.	L2	Understand

Computational Fluid Dynamics (22PEME7035T)

Course Contents

Unit-I **04 Hrs.**

Introduction to CFD

What is CFD, Scope and Application of CFD, Methods of Predictions like Experimental and theoretical, Working of Commercial CFD Software's, Solution methodology: Pre-processing, Solver, Post processing, Types of Grids and their application.

Unit-II **06 Hrs.**

Mathematical description of Physical Phenomenon

Governing Differential Equations, Meaning of Differential equation, The Continuity Equation, Momentum equation, Energy Equation, General Differential Equation.

Unit-III **06 Hrs.**

Turbulence Modelling and Finite Difference Method

Introduction to Turbulence Modelling, Turbulence Models, The Time-Averaged Equation for Turbulent Flow.

Unit-IV **13 Hrs.**

Finite Volume Method applied to Heat Conduction, Convection and Diffusion

Steady One-dimensional Conduction, Convection, Diffusion, Unsteady One- dimensional Conduction, Introduction to two and three-dimensional Situations.

Unit-V **04 Hrs.**

Boundary Conditions

Types of Boundary Conditions and their applications, Initial and Boundary Conditions, Initial and Boundary Value problems.

Unit-VI **06 Hrs.**

Solution Algorithms for Pressure Velocity Coupling

Staggered Grid, SIMPLE Algorithm, SIMPLEC Algorithm.

Computational Fluid Dynamics Laboratory (22PEME7035L)

Suggested Experiments

A Simulations using ANSYS Workbench:

1 Introduction to Ansys Spaceclaim, Meshing and Fluent
2 Mixing elbow for fluid under steady incompressible conditions
3 Double Pipe Counterflow Heat Exchanger
4 Wind Pipe

B Python Programming:

1 Introduction to Grid Generation. Solving algebraic equations.
2 Solution to 1 D Steady Conduction.

C A mini project

A Mini Project would help the learner to apply the concept

A minimum of five experiments from the above-suggested list and a Mini Project.

Books Recommended

Textbooks

1 H. K. Versteeg, W. Malalasekera, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Pearson, England, 2007.

Reference Books

1 D. A. Anderson, I. I. Tannehill, and R. H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Hemishphere Publishing Corporation, New York, USA, 1984.

2 P. Niyogi, M. K. Laha, S. K. Chakrabarty, Introduction to Computational Fluid Dynamics, Pearson Education, India, 2006.

3 K. Muralidhar, and T. Sundararajan, Computational Fluid Flow and Heat Transfer, Narosa Publishing House, New Delhi, 2003.

4 P. S. Ghoshdasdidar, Computer Simulation of Flow and Heat Transfer, Tata McGraw-Hill Publishing Company Ltd, 2017.

Program: Mechanical Engineering	Final Y. B.Tech	Semester: VII
Business Model Design (22PEME7036T)		
Business Model Design Laboratory (22PEME7036L)		

Prerequisites:

Nil

Course Objectives:

1. Understanding business model frameworks.
2. Analyze value creation strategies.
3. Assess revenue and cost structures.
4. Evaluate customer segmentation and market fit.
5. Integrate innovation into business models

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Illustrate the components of a business model.	L2	Understand
CO2	Analyse market needs and develop value propositions.	L4	Analyze
CO3	Evaluate cost and revenue structures for financial sustainability.	L5	Evaluate
CO4	Assess customer segmentation strategies for market alignment.	L5	Evaluate
CO5	Apply innovation-driven strategies to enhance business models.	L3	Apply

Business Model Design (22PEME7036T)

Course Contents

Unit-I **08 Hrs.**

Introduction to Business Models

- Definition and Importance
- Components of a Business Model
- Case Studies on Successful Business Models

Unit-II **08 Hrs.**

Value Creation and Market Positioning

- Identifying Customer Needs
- Competitive Advantage and Differentiation
- Market Research and Business Fit.

Unit-III **06 Hrs.**

Revenue and Cost Considerations

- Revenue Models and Pricing Strategies
- Cost Structure and Financial Sustainability
- Key Financial Metrics

Unit-IV **06 Hrs.**

Customer Segmentation and Market Alignment

- Identifying Target Segments
- Business Model Adaptation for Different Markets
- Consumer Behavior and Decision Making
- Collaborative Business Models

Unit-V **06 Hrs.**

Business Model Development

- Developing and Structuring Business Models
- Leveraging Technology in Business Models
- Business Model Evolution in Emerging Industries
- Digital Transformation Strategies

Unit-VI **05 Hrs.**

Business Model Validation

- Business Model Testing and Refinement
- Risk Assessment and Contingency Planning
- Final Business Model Development and Evaluation

Business Model Design Laboratory (22PEME7036L)

Suggested Experiments

A Exercises:

1 Business Model Analysis
- Detailed Description : Study and evaluate business models of successful companies using real- world case studies. Identify key components such as value proposition, revenue streams, and customer segments.

2 Customer Value Proposition Mapping
- Detailed Description : Develop customer value propositions for a selected business idea. Define key benefits offered to customers and create differentiation strategies.

3 Business Model Canvas Development
- Detailed Description : Construct a Business Model Canvas for a proposed startup, detailing key partners, activities, customer relationships, cost structure, and revenue models.

4 Revenue and Cost Structure Analysis
- Detailed Description : Identify and analyze various revenue streams and cost drivers for a given business idea. Assess financial sustainability and explore monetization strategies.

5 Market Opportunity Identification
- Detailed Description : Conduct primary and secondary market research to validate business ideas. Identify customer needs, potential market size, and growth opportunities

6 Competitive Analysis and Positioning
- Detailed Description : Assess competition in a given industry. Identify direct and indirect competitors, analyze market positioning, and develop differentiation strategies.

7 Business Model Testing and Validation
- Detailed Description : Apply structured testing frameworks (e.g., Lean Startup methodology) to refine business assumptions. Conduct customer interviews and prototype testing.

8 Scalability and Sustainability Assessment
- Detailed Description : Evaluate the long-term scalability and sustainability of a business model. Assess factors such as resource allocation, market expansion potential, and financial growth.

9 Innovative Business Model Design

- Detailed Description : Design a business model for an emerging industry or disruptive technology. Develop creative approaches to solving market problems.

10 Final Business Model Presentation

- Detailed Description : Prepare and present a refined business model to a panel. Justify business assumptions, financial projections, and growth strategies. Receive feedback for improvement.

B Continuous Assessment:

Assignment on Each Module (total 6 Assignment)

A minimum of ten experiments (all six from the group A list and any four from the group B list) or any other experiment based on the syllabus will be included, which would help the learner apply the concept.

Books Recommended

1 Baisya, Rajat K. Indian Entrepreneurship: Analysis of Business Practices. SAGE Publications, New Delhi, 2021.

2 Blank, Steve, and Bob Dorf. The Startup Owner's Manual. K&S Ranch Publishing, Pescadero, 2012.

3 Desai, Vasant. Entrepreneurship Development in India. Himalaya Publishing House, Mumbai, 2019.

4 Joshi, M.V. Entrepreneurship Development and Startup India. Himalaya Publishing House, Mumbai, 2020.

5 Kumar, S. Ramesh. Business Development: A Comprehensive Approach. McGraw Hill, New Delhi, 2018.

6 Osterwalder, Alexander. Value Proposition Design. Wiley, New Jersey, 2014.

7 Osterwalder, Alexander, and Yves Pigneur. Business Model Generation. Wiley, New Jersey, 2010.

8 Prasad, Rohit. Start-up Sutra: What the Angels Won't Tell You About Business and Life. Hachette India, New Delhi, 2013.

9 Purohit, Prachi. Startup India: The Complete Guide to Launching and Managing a Business. Notion Press, Chennai, 2021.

10 Ries, Eric. The Lean Startup. Crown Business, New York, 2011.

11 Thiel, Peter. Zero to One. Crown Business, New York, 2014.

12 Van der Pijl, Patrick. Business Model Shifts. Wiley, New Jersey, 2020.

Program: Mechanical Engineering	Final Y. B.Tech	Semester: VII
Soft Computing (22PEME7037T)		
Soft Computing Laboratory (22PEME7037L)		

Prerequisites:

1. Mathematics and Statistics.
2. Programming and Computational Tools.
3. Mechanical Engineering Fundamentals.
4. Control Systems and Automation (Desirable but not mandatory).

Course Objectives:

1. To introduce the fundamental concepts of soft computing and its applications in engineering and optimization problems.
2. To provide a deep understanding of fuzzy logic systems, including fuzzy sets, membership functions, fuzzy inference, and defuzzification techniques.
3. To explore the principles of evolutionary computing, including genetic algorithms (GA), evolutionary strategies, and their applications in problem-solving.
4. To understand artificial neural networks (ANNs), their architectures, training techniques, and applications in predictive modeling and classification.
5. To introduce swarm intelligence algorithms such as Particle Swarm Optimization (PSO) and Ant Colony Optimization (ACO) and their applications in engineering.
6. To develop problem-solving skills using hybrid soft computing techniques, integrating fuzzy logic, neural networks, and evolutionary algorithms for real-world applications.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Explain the fundamental concepts of soft computing and differentiate it from conventional computing techniques.	L2	Understand
CO2	Apply fuzzy logic concepts, including fuzzy inference and defuzzification techniques, to solve decision-making problems in engineering.	L3	Apply
CO3	Implement evolutionary computing techniques, including genetic algorithms, to optimize complex engineering problems.	L3	Apply
CO4	Design and train artificial neural networks for pattern recognition, classification, and predictive analytics.	L6	Create
CO5	Utilize swarm intelligence and probabilistic models to solve multi-objective optimization problems.	L3	Apply
CO6	Integrate multiple soft computing techniques to develop hybrid intelligent systems for practical applications in mechanical and manufacturing engineering.	L6	Create

Soft Computing (22PEME7037T)

Course Contents

Unit-I **07 Hrs.**

Introduction to Soft Computing and Optimization

- Concept of Soft Computing: Definition, characteristics, and advantages over hard computing.
- Applications of Soft Computing: Engineering applications
- Optimization Fundamentals: Global and local optima, Problem formulation; Review of basic calculus concepts (Convex functions, Eigenvalue Decomposition, Singular Value Decomposition); Classification of optimization problems in machine learning.
- Optimization Methods: Linear Programming: Graphical method, Simplex method, Duality; Unconstrained Optimization: Gradient-based methods, Cauchy's steepest descent, Newton's method, Conjugate gradient method; Constrained Optimization: Direct methods, Penalty function methods, Steepest descent method.

Unit-II **06 Hrs.**

Fuzzy Logic and Applications

- Fuzzy Set Theory: Fuzzy sets, Operations, Membership functions; Fuzzy relations, Fuzzy propositions, Fuzzy implications, Fuzzy inference; Defuzzification Techniques: Methods and applications.
- Fuzzy Logic Controller (FLC): Design, Rule base, Inference mechanism;
- Applications in control systems and decision-making.

Unit-III **06 Hrs.**

Artificial Neural Networks (ANNs)

- Introduction to ANN: Biological vs. Artificial neurons, ANN architecture; Types of ANN: Feedforward, Recurrent; Activation functions: Linear, Sigmoid, Tanh.
- Training Techniques: Supervised and unsupervised learning; Backpropagation algorithm.
- Applications of ANN: Pattern recognition, Control systems, Fault detection

Unit-IV **07 Hrs.**

Evolutionary Computing and Genetic Algorithms (GA)

- Evolutionary Computation Concepts: Evolutionary processes, Evolutionary algorithms, Evolutionary programming.
- Genetic Algorithm (GA) Framework: Working principle, Encoding, Fitness function; Selection techniques (Roulette wheel, Tournament selection); Crossover techniques, Mutation techniques.
- Multi-objective Genetic Algorithms (MOEA): Pareto optimization, Crowding distance, Ranking methods.
- Applications of GA: Engineering optimization problems.

Unit-V **07 Hrs.**

Swarm Intelligence and Reinforcement Learning

- Swarm Intelligence Concepts: Features and principles; Algorithms: Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO), Artificial Bee Colony (ABC); Applications in engineering optimization.
- Reinforcement Learning (RL): Basic concepts, Policy, Reward function,
- Value function; RL approaches: Value-based, Policy-based, Model-based; Q- learning algorithm; Comparison between RL and supervised learning.

Unit-VI **06 Hrs.**

Probabilistic Models and Applications in Engineering

- Markov Models: Markov decision process, State transitions; Hidden Markov Models (HMM); Applications in mechanical engineering.
- Probabilistic Design in Mechanical Systems: Stress-strength models, Reliability estimation; Probability distributions in failure modeling
- Applications of Soft Computing in Engineering: Predictive maintenance, Fault detection; Image-based part classification, Process optimization; Tuning of control algorithms.

Soft Computing Laboratory (22PEME7037L)

Suggested Experiments

A Group A : Any five assignments (one from each group) for a data set using a suitable software package/ programming language.

1 Group 1 : Fuzzy Logic Systems

1 Implementation of Fuzzy Membership Functions (Triangular, Trapezoidal, Gaussian)
2 Fuzzy Set Operations (Union, Intersection, Complement)
3 Fuzzy Relation and Composition (Max-Min and Max-Product Composition)
4 Defuzzification Techniques (Centroid, Bisector, Mean of Maximum)
5 Design and Simulation of a Fuzzy Logic Controller (FLC) for Temperature Control

2 Group 2 : Genetic Algorithms (GA) and Evolutionary Computing

1 Implementation of Genetic Algorithm (GA) for Function Optimization
2 Solving the Traveling Salesman Problem (TSP) using Genetic Algorithm
3 Multi-Objective Genetic Algorithm (MOGA) for Pareto Optimization
4 Implementing Crossover and Mutation Techniques in GA
5 Design and Optimization of a Mechanical Component using Genetic Algorithm

3 Group 3 : Artificial Neural Networks (ANN)

1 Implementation of Single-Layer Perceptron for Binary Classification
2 Backpropagation Algorithm for Training a Multi-Layer Perceptron (MLP)
3 Handwritten Digit Recognition using ANN (MNIST Dataset) in Python
4 Design and Training of an ANN-based Predictive Maintenance Model
5 Comparison of Supervised vs. Unsupervised Learning in Neural Networks

4 Group 4 : Swarm Intelligence Techniques

1 Implementation of Particle Swarm Optimization (PSO) for Function Minimization
2 Solving Optimization Problems using Ant Colony Optimization (ACO)
3 Implementation of Artificial Bee Colony (ABC) Algorithm for Optimization
4 Comparison of PSO, ACO, and GA for Engineering Design Problems
5 Hybrid Soft Computing Approach: Integrating Fuzzy Logic and Neural Networks for Control Applications

5 Group 5 : Probabilistic Models & Applications in Engineering

1 Implementation of Markov Decision Process (MDP) for System State Prediction
2 Hidden Markov Model (HMM) for Predictive Maintenance in Mechanical Systems
3 Reliability Estimation of Mechanical Components using Stress-Strength Models
4 Failure Probability Modeling using Monte Carlo Simulation
5 Image-Based Part Classification using Machine Learning

B Group B : A mini project (Mandatory):

One mini project (in a group of 2 students) based on the above contents and using the mechanical engineering application dataset.

Books Recommended

Textbooks

1 Mangey Ram, and Suraj B. Singh, Soft Computing: Techniques om Engineering Sciences, De Gruyter, 2020.

2 S. Chakraverty, Deepti M. Sahoo, and Nisha R. Mahato, Concept of Soft Computing: Fuzzy and ANN Programming, Springer Nature Singapore, 2019.

3 Ashish M. Gujarathi, B. V. Babu," Evolutionary Computation: Techniques and Applications", CRC Press 2016.

4 Tettamanzi Andrea, Tomassini and Marco, Soft Computing Integrating Evolutionary, Neural and Fuzzy Systems, Springer, 2001.

5 Singiresu S Rao, Engineering Optimization Theory and Practice, John Wiley Sons, Inc, 2019

6 Parag Kulkarni and Prachi Joshi, "Artificial Intelligence – Building Intelligent Systems", PHI learning Pvt. Ltd., 2015.

Reference Books

1 Deisenroth, Faisal, Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.

2 X. Yao," Evolutionary Computation: Theory & Applications", World Scientific Publ. Co., 1999.

3 Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image Processing Using MATLAB", Third Edition Tata Mc Graw Hill Pvt. Ltd., 2011.

4 Solanki, Nayyar, Emerging Trends & Applications of Machine Learning, IGI Global, 2018.

5 Mohri, Rostamizdeh, Talwalkar, Foundations of Machine Learning, MIT Press, 2018.

6 Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.

Web References

1 Introduction to Soft Computing https://nptel.ac.in/courses/106105173

2 Soft Computing Techniques hptts://nptel.ac.in/courses/111105614

Program: Mechanical Engineering	Final Y. B.Tech	Semester: VII
Digital Manufacturing (22PEME7041T)		

Prerequisites:

1. Fundamentals of CAD/CAM.

Course Objectives:

1. To focus on equipping the students with the knowledge and skills to leverage digital technologies in the manufacturing process.
2. To gain knowledge about digital procurement, predictive maintenance and predictive quality in digital manufacturing process.
3. To study various cyber threats in digital manufacturing.
4. To gain knowledge about various methods to mitigate the cyber security threats in digital manufacturing.
5. To study usage AI and ML Technology in manufacturing to enhance its performance.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Explain the various steps involved in digital manufacturing and smart factory concepts.	L2	Understand
CO2	Apply the predictive quality and predictive maintenance concepts in manufacturing process.	L3	Apply
CO3	Analyse the benefits of digital procurement in manufacturing process.	L4	Analyze
CO4	Identify and evaluate cyber security issues in digital manufacturing environment.	L5	Evaluate

Digital Manufacturing (22PEME7041T)

Course Contents

Unit-I **10 Hrs.**

Introduction to Digital Manufacturing and Production in Digital Era

- Evolution of conventional to digital Manufacturing (DM), introduction to digital transformation and drivers for digital transformation in manufacturing.
- Planning: Optimization, Rough cut Capacity Planning (RCCP) and Labour planning.
- Execution: Process parameters, Enterprise Data Management (EDM), Run time errors and documentation.
- Technology: Robotic Process automation (RPA) and 3 DP (three dimensional printing).
- Smart factory concepts .
- Digital Twins: Learning about creating digital replicas of physical assets and processes to simulate and optimize performance.

Unit-II **10 Hrs.**

Predictive Quality

- Classification of predictive analysis. Steps involved in implementing of predictive analytics in the organization. Data collection and integration of the data. Real time data monitoring, Analysis and modelling of the data using Emerging tools (Industrial IoT, ML, statistical modelling, neural networks and AI). Use of models to predict quality issues and setting up the alert.
- Benefits of predictive quality analysis in manufacturing.
- Case study discussion on implementation of Predictive Quality in an industry.

Unit-III **07 Hrs.**

Predictive Maintenance (PdM)

- Definition of PdM. Types of PdM. Difference between predictive and preventive maintenance. Steps used in PdM.
- Collection of the data on parameters like vibration, temperature, humidity, pressure and noise using and transmission of the real time data for analysis using IOT.
- Analysis of the data using AI and ML tools and creation of models to predict the life span of the machines. Setting up the alert for maintenance issues.
- Benefits of PdM in manufacturing.
- Discussion on case study.

Unit-IV **06 Hrs.**

Digital Procurement

- Definition of digital procurement. Types of procurement. 5 R's in procurement. Digital procurement strategy and steps. Procurement to pay cycle (P2P).
- Use of online platforms for supplier selection, bidding and contract management.

- Analysis of procurement data to identify trends, optimize spending and improve decision-making using ML.
- Use of AI for price prediction, supplier selection and risk assessment.
- Use of digital tools for managing contracts, tracking compliance and mitigating risks.
- Benefits of digital procurement.

Unit-V **06 Hrs.**

Cybersecurity/ Big Data Security in Digital Manufacturing

- Introduction, basic cybersecurity concepts, threats, vulnerabilities and attacks relevant to digital manufacturing.
- Network and System Security: Security of networks i.e. wireless security, firewalls, intrusion detection systems (IDS) and intrusion prevention systems (IPS) in relevance to the digital factory environment.
- Industrial Control Systems (ICS) Security: SCADA (Supervisory Control and Data Acquisition) systems, PLC (Programmable Logic Controller) networks and other critical ICS components.
- Data Security: Protection of sensitive data i.e. intellectual property, customer data and operational data, through data encryption, access control, and data loss prevention (DLP) techniques in digital manufacturing.
- Mitigation of cyber security risks.

Books Recommended

Textbooks

1 Sunil Mudumala, Leading Digital Transformation in Manufacturing Industry 4.0.

2 J. Paulo Davim , Kaushik Kumar, Divya Zindani , J. Paulo Davim, Digital Manufacturing and Assembly Systems in Industry 4.0, Taylor and Francis, 2021.

3 Dipti Bandi, Digital Procurement unlocked, Notion press, 2023.

4 Mark J. Barrenechea, Tom Jenkins, Digital Manufacturing, Waterloo, 2018

5 Florian Schupp, Heiko Wöhner, Digitalization in Procurement, Springer, 2024.

6 Chandrakant D. Patel, Chun-Hsien Chen, Digital Manufacturing, Elsevier, 2024.

Reference Books

1 Andries Feikema, Digital Transformation in Procurement, Koganpage, 2025.

2 Lane Thames, Dirk Schaefer, Cybersecurity for Industry 4.0, Springer, 2017.

3 R Sujatha, G Prakash, Noor Zaman Jhanjhi, Cyber Security Applications for Industry 4.0, Chapman & Hall, 2024

Program: Mechanical Engineering	Final Y. B.Tech	Semester: VII
Automotive Materials and Manufacturing (22PEME7042T)		

Prerequisites:

Nil

Course Objectives:

1. To provide an understanding of advanced materials, including composites and specialty materials in automotive applications.
2. To introduce the mechanical behavior, constitutive models, and applications of polymers and composite materials in automotive design.
3. To explore smart materials, sensors, and actuators, and their integration into automotive structures.
4. To study the criteria for material selection in automotive design based on strength, cost, formability, and machinability.
5. To understand the impact of globalization on automotive manufacturing and supply chain management.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Explain the significance of advanced materials in vehicle design and performance.	L2	Understand
CO2	Understand the viscoelastic behavior of polymers under different loading conditions.	L2	Understand
CO3	Evaluate design and manufacturing challenges in integrating smart materials.	L5	Evaluate
CO4	Identify suitable materials for automotive components based on mechanical and economic factors.	L3	Apply
CO5	Analyze strategies for product-process-business integration in a globalized economy.	L4	Analyze

Automotive Materials and Manufacturing (22PEME7042T))

Course Contents

Unit-I **06 Hrs.**

Overview of materials used in automotive systems

Traditional vs. advanced materials, Metallic and non-metallic composites: Properties, applications in structural and non-structural components, Specialty materials: High-strength steels, lightweight alloys (Al, Mg, Ti), shape memory alloys, and ceramics, Nanotechnology in automotive systems: Nano-coatings, nanocomposites, nano- lubricants, energy storage and thermal management, Environmental and sustainability considerations in advanced material selection

Unit-II **06 Hrs.**

Composite Materials

Composite materials, including naturally occurring substances such as wood and bone, and engineered materials from concrete to carbon fiber reinforced epoxies. Design and analysis of composite components in automotive applications. Natural composites (e.g., wood, bamboo) and bio-based composites in green automotive design.

Unit-III **07 Hrs.**

Smart Materials and Structures

Theoretical aspects of smart materials, sensors and actuator technologies. It will also cover design, modeling and manufacturing issues involved in integrating smart materials and components with control capabilities to engineering smart structures.

Unit-IV **06 Hrs.**

Materials in Manufacturing and Design

Material selection based on cost, strength, formability and machinability. Advanced strength analysis of heat-treated and cold-formed parts including axial, bending, shear and cyclic deformation. Correlations of functional specifications and process capabilities

Unit-V **08 Hrs.**

Laser Materials Processing

Application of lasers in materials processing and manufacturing. Laser principles and optics. Fundamental concepts of laser/material interaction. Laser welding, cutting, surface modification, forming, and rapid prototyping.

Unit-VI **06 Hrs.**

Assembly Modeling for Design and Manufacturing

Assembly on product and process, Assembly representation, Assembly sequence, Datum flow chain, Geometric Dimensioning and Tolerance, Tolerance analysis, Tolerance synthesis, Robust design, Joint design and joining methods, Stream of variation, Auto body assembly case studies.

Books Recommended

Textbooks

1 S. Kalpakjian and S. R. Schmid, Manufacturing Engineering and Technology, Pearson Education South Asia Pte Limited, 2013.Education.

2 William D. Callister, William D. Callister, Jr., and David G. Rethwisch, Materials Science and Engineering: An Introduction, Wiley, 2008.

3 M. P. Groover, Fundamentals of Modern Manufacturing: Processes, and Systems, Wiley, 1996.

4 W. F. Smith, J. Hashemi, and F. Presuel-Moreno, Foundations of Materials Science and Engineering, McGraw-Hill, 2018.

Reference Books

1 David R. H. Author Jones and M. A. Asbhy, Engineering Materials, Butterworth-Heinemann, 1996.

2 C. K. Chawla Composite Materials: Science and Engineering, Springer, 2012.

3 R. F. Gibson, Principles of Composite Material Mechanics, CRC Press, 2016.

4 F. C. Campbell (Jr.), and F. C. Campbell, Manufacturing Processes for Advanced Composites," Elsevier, 2003.

5 A. B. Strong, Plastics: Materials and Processing, Pearson Prentice Hall, 2006.

6 W. M. Steen, Laser Material Processing, Springer, 2013.

Program: Mechanical Engineering	Final Y. B.Tech	Semester: VII
Design for X (22PEME7043T)		

Prerequisites:

1. Fundamentals of Mechanical Engineering.
2. Fundamentals of Design, Manufacturing, Assembly.

Course Objectives:

1. To Understand the fundamental principles of Design for X (DfX) and its role in product development.
2. To gain knowledge about DfX methodologies to optimize designs for manufacturability, cost, reliability, sustainability, safety, and maintainability.
3. To Develop analytical skills to assess trade-offs between different DfX factors and make informed design decisions.
4. To Gain knowledge of industry best practices, tools, and techniques used in DfX.
5. To Explore emerging trends and future advancements in DfX, including additive manufacturing, IoT integration, and sustainability-driven designs.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Explain the fundamental principles of DfX and its role in optimizing product design for various factors such as manufacturability, reliability, cost, and sustainability.	L2	Understand
CO2	Apply Design for Manufacturability (DfM) principles to optimize material selection, process constraints, and design simplification for efficient manufacturing.	L3	Apply
CO3	Analyze product designs to minimize assembly complexity, reduce part count, and optimize cost through effective DfA and DfC strategies.	L4	Analyze
CO4	Evaluate reliability and sustainability factors in product design using techniques such as Failure Modes and Effects Analysis (FMEA) and Life Cycle Assessment (LCA).	L5	Evaluate
CO5	Integrate safety, maintainability, and serviceability considerations into product design to enhance usability, longevity, and compliance with industry standards.	L5	Evaluate
CO6	Develop an optimized product design by integrating multiple DfX principles and using digital tools such as CAD, simulation, and AI-driven optimization.	L6	Create

Design for X (22PEME7043T)

Course Contents

Unit-I **08 Hrs.**

Introduction to Design for X

Definition and Philosophy of DfX: Understanding "X" as a variable representing key design considerations, Holistic and proactive approach to engineering design, Emphasis on life-cycle thinking.
Importance of DfX in Product Development: Enhancing product quality, usability, and competitiveness, Reducing time-to-market and development cost, Supporting innovation while mitigating risks.
Role of DfX in the Product Development Cycle: Integrating DfX early in the concept and design stages. Cross-functional collaboration (design, manufacturing, supply chain, sustainability, etc.). Aligning with customer requirements and business goals.
Overview of Key DfX Disciplines: Design for Manufacturability (DfM), Design for Assembly (DfA), Design for Cost (DfC), Design for Reliability (DfR), Design for Sustainability (DfS) , Design for Safety (DfSa), Design for Maintainability & Serviceability (DfMS).
Case studies on successful DfX applications: Real-world examples of successful DfX applications from industries like automotive, aerospace, electronics, and consumer goods. Analysis of the impact of DfX on cost, quality, time, and environmental performance.

Unit-II **07 Hrs.**

Design for Manufacturability (DfM)

Principles of Manufacturability: Designing products for ease, efficiency, and cost-effectiveness in manufacturing, Avoiding overly complex geometry and unnecessary features,
Material Selection and Process Constraints: Matching materials to manufacturing processes and product requirements, Consideration of formability, machinability, weldability, etc.
Tolerance Analysis and Design Simplification: Importance of tolerancing in manufacturability and quality, GDT basics and statistical tolerance stacking, Simplifying part geometry to reduce processing steps.
Design Guidelines for Key Manufacturing Processes: Casting: Uniform wall thickness, draft angles, and riser design. Machining: Tool access, fixturing, and reducing setup changes. Injection Molding: Parting lines, flow paths, undercuts, and sink marks. Sheet Metal: Bend radii, material usage, and nesting. Additive Manufacturing: Layer orientation, support structures, and topology optimization.
Tools and Techniques: DFM/DFA software tools (DFMPro, DesignSpark, etc.), Case examples of design changes that improved manufacturability.

Unit-III **08 Hrs.**

DfA and DfC

Design for Assembly (DfA)
Principles of Assembly Efficiency: Minimizing assembly time, tools, and labor, Reducing orientation sensitivity.
Minimizing Part Count and Fasteners: Use of multifunctional and self-locating parts, Snap-fits, interlocking components, and integrated designs.
Modular Design and Standardization: Plug-and-play components, Reusability across product lines and platforms.
Automated Assembly Considerations: Robotics and automation-friendly design, Avoiding small, fragile, or asymmetrical parts.
Design for Cost (DfC):

Cost Modelling Techniques: Parametric costing, activity-based costing. Material and Process Cost Trade-offs: Evaluating performance vs. cost.
Design Simplifications for Cost Reduction: Standard components, simplified assemblies.
Life Cycle Cost Analysis: CAPEX, OPEX, maintenance, and end-of-life.

Unit-IV 08 Hrs.

DfR and DfS

Design for Reliability (DfR)
Failure Modes and Effects Analysis (FMEA): Systematic identification and ranking of potential failure modes, Risk Priority Number (RPN) and mitigation strategies.
Reliability Prediction and Testing Methods: MTBF (Mean Time Between Failures), Weibull analysis, Accelerated life testing, environmental testing.
Fatigue, Wear, and Durability: Stress-life and strain-life approaches, Material selection and design against degradation.
Redundancy and Fault-Tolerant Design: Backup systems, graceful degradation, Criticality analysis and design for safe failure.
Design for Sustainability (DfS):
Environmental Impact: Energy consumption, emissions, waste, Life Cycle Assessment (LCA): Cradle-to- grave and cradle-to-cradle models, Sustainable Materials and Processes: Bio-based materials, green manufacturing,
Circular Economy: Reuse, remanufacturing, recycling, and take-back systems.

Unit-V 08 Hrs.

DfM&S and Integrated DfX Approach

Design for Safety (DfS) Compliance with Safety Standards (ISO, OSHA, CE marking, etc.), Human Factors Ergonomics (User interaction, comfort, and errors), Hazard Analysis Techniques (HAZOP, FTA (Fault Tree Analysis), ETA (Event Tree)), Fail-Safe and Foolproof Design (Interlocks, alarms, and error-proofing (Poka-yoke)).
Design for Maintainability Serviceability (DfMS): Ease of Inspection and Diagnostics (Access to critical components, onboard diagnostics), Modularity and Repairability (Plug-and-play modules, standardized connectors), Spare Parts and Accessibility Considerations (Common fasteners, open-able enclosures), Predictive Maintenance and IoT Integration (Real-time monitoring, analytics-driven alerts).
Integrated DfX Approach: Cross-functional Optimization (Balancing manufacturability, cost, reliability, and sustainability), Trade-off and Decision-Making Techniques (Pareto analysis, QFD, TRIZ, multicriteria decision analysis).
Digital Tools and Software: CAD/CAM/CAE integration for DfX analysis, PLM (Product Lifecycle Management) platforms, AI and machine learning in design optimization.
Industry Trends and Future Directions: Smart manufacturing, Industry 4.0, digital twins, DfX in circular economy and net- zero goals, Role of generative design and design automation.

Books Recommended

Reference Books

1 George Q. Huang, Design for X: Concurrent Engineering Imperatives, Springer London, 1996.

2 Geoffrey Boothroyd, Peter Dewhurst, and Winston Knight, Product Design for Manufacture and Assembly, CRC Press, 2010.

3 Gerhard Pahl and Wolfgang Beitz, Engineering Design: A Systematic Approach, Springer London, 2007.

4 David M. Anderson, Design for Manufacturability: How to Use Concurrent Engineering to Rapidly Develop Low-Cost, High-Quality Products for Lean Production, CRC Press, 2014.

5 Bryan R. Fischer, Mechanical Tolerance Stackup and Analysis, CRC Press, 2011.

6 Peter Sandborn, Cost Analysis of Electronic Systems, World Scientific Publishing, 2013.

7 E. E. Lewis, Reliability Engineering, Dover Publications, 1996.

8 Patrick D. T. O'Connor and Andre Kleyner, Practical Reliability Engineering, Wiley, 2012.

9 David T. Allen and David R. Shonnard, Sustainable Engineering: Principles and Practice, Pearson Education, 2011.

10 Louis J. Gullo and Jack Dixon, Design for Safety, Wiley, 2018.

11 Mark S. Sanders and Ernest J. McCormick, Human Factors in Engineering and Design, McGraw-Hill, 1993.

12 B. S. Dhillon, Maintainability, Maintenance, and Reliability for Engineers, CRC Press, 2006.

13 Kusiak, Concurrent Engineering: Contemporary Issues and Modern Design Tools, Wiley, 1993.

Web References

1 Dassault Systèmes
https://www.3ds.com/store/cad/design-for-x

2 ANSYS
https://www.ansys.com/en-in/blog/what-is-dfx

Program: Mechanical Engineering	Final Y. B.Tech	Semester: VII
Renewable Energy Systems (22PEME7044T)		

Prerequisites:

1. Knowledge of Energy science, Energy sources.
2. Fundamentals of Thermodynamics, Heat Transfer and Fluid mechanics.

Course Objectives:

1. To study working principles of various renewable energy sources and their utilities.
2. To study economics of harnessing energy from renewable energy sources.
3. To gain the knowledge of renewable energy conversion systems design.
4. To develop skills to analyse industry and domestic applications of RES.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Explain the need of different renewable energy sources.	L2	Understand
CO2	Discuss importance of renewable energy sources.	L2	Understand
CO3	Discuss various renewable energy sources in Indian context.	L2	Understand
CO4	Calculate and analyse utilization of solar and wind energy.	L4	Analyze
CO5	Illustrate design of biogas plant.	L3	Apply
CO6	Explain basics of hydrogen energy.	L2	Understand

Renewable Energy Systems (22PEME7044T)

Course Contents

Unit-I **04 Hrs.**

Introduction to Energy Sources

Renewable and non-renewable energy sources, Energy policy and sustainability, Energy Consumption as a measure of Nation's development; Strategy for meeting the future energy requirements, Global and National scenarios, Prospects of renewable energy sources, Present status and current installations, Emerging and future energy technologies, various MNRE programmes.

Unit-II **09 Hrs.**

Solar Energy

Merits and demerits, Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solar radiation, local solar time, derived solar Angles, sunrise, sunset and day length, Principle of solar energy conversion. Types of Solar Energy Technologies. Components of a Solar Power System. Solar Energy collection devices and Classification: Flat plate collectors, concentrating collectors, Solar air heaters-types, solar driers, storage of solar energy-thermal storage, solar pond, solar water heaters, solar distillation, solar still, solar cooker, solar heating & cooling of buildings, Solar Photovoltaic systems & applications. Solar Energy in the Global Context. Future of Solar Energy.

Unit-III **08 Hrs.**

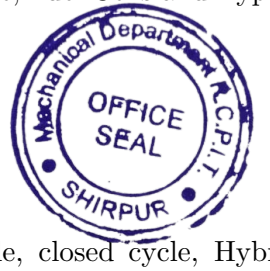
Wind Energy

Principle of wind energy conversion; Basic components of wind energy conversion systems; Wind turbine technologies, wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of Aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection Considerations. Global Wind Energy Development. Future Trends in Wind Energy.

Unit-IV **07 Hrs.**

Energy from Biomass & Hydrogen Energy

Energy from Biomass: Biomass conversion technologies, Biogas generation plants, classification, advantages and disadvantages, constructional details, site selection, digester design consideration, filling a digester for starting, maintaining biogas production, Fuel properties of biogas, utilization of biogas. Hydrogen Energy: Methods of Hydrogen production, Hydrogen Storage, Fuel Cells and Types of Fuel Cells.



Unit-V **06 Hrs.**

Energy from the Ocean

Ocean Thermal Electric Conversion (OTEC) systems like open cycle, closed cycle, Hybrid cycle, prospects of OTEC in India. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy.

Unit-VI **05 Hrs.**

Geothermal Energy

Estimation and nature of geothermal energy, geothermal sources and Resources like hydrothermal, geo-pressured hot dry rock, magma. Advantages, disadvantages and Application of geothermal energy, prospects of geothermal energy in India.

Books Recommended

Textbooks

1 G. D. Rai, Non-conventional energy sources, 6th edition, Khanna Publishers, 1988.

2 S. P. Sukhatme, and J. K. Nayak, Solar Energy: Principles of Thermal Collection and Storage, 4th edition, TMH, 2017.

3 H. P. Garg, and Jai Prakash, Solar Energy: Fundamentals and Applications, 1st revised edition, TMH, 1997.

4 Joshua Earnest, Wind Power Technology, PHI Learning, 2014.

5 J. W. Twidell, and Anthony D. Weir, Renewable Energy Sources, ELBS Publication, 1986.

6 D. Begamudre, Energy Conversion Systems, R. New Age International (P) Ltd., Publishers, 1998.

7 C. S. Solanki, Solar Photovoltaics: Fundamentals, Technologies and Applications, 3rd Edition, PHI Learning, 2013.

Reference Books

1 D. D. Hall and R. P. Grover, Biomass Regenerable Energy, John Wiley, New York, 1987.

2 Mukund R. Patel, Wind and Solar Power Systems, 2nd edition, CRC Press, 2005.

3 J. F. Manwell, J. G. McGowan, and A. L. Rogers, Wind Energy Explained: Theory, Design and Application, John Wiley and Sons, 2009.

Program: Mechanical Engineering	Final Y. B.Tech	Semester: VII
Startup Registration and Development (22PEME7045T)		

Prerequisites:

Nil

Course Objectives:

1. To Understand the startup registration process, legal structures, and compliance requirements.
2. To analyze government incentives, policies, and funding opportunities for startups.
3. To develop key business registration documents and compliance reports.
4. To assess intellectual property protection and its impact on startups.
5. To evaluate financial planning, fundraising, and investment strategies.
6. To ensure taxation, auditing, and regulatory compliance for startups.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Differentiate between various startup legal structures and their compliance requirements.	L4	Analyze
CO2	Evaluate government schemes, startup incentives, and funding policies.	L5	Evaluate
CO3	Prepare and assess essential business registration documents.	L3	Apply
CO4	Apply intellectual property protection strategies for business innovation.	L3	Apply
CO5	Develop financial models and fundraising strategies for startup sustainability.	L6	Create
CO6	Ensure compliance with taxation, auditing, and corporate legal frameworks.	L3	Apply

Startup Registration and Development (22PEME7045T))

Course Contents

Unit-I **08 Hrs.**

Introduction to Startup Registration

Definition, Types, and Importance of Startups
Legal Structures: Proprietorship, LLP, Pvt. Ltd., Public Ltd.
Steps for Business Registration
Case Studies on Startup Registrations.

Unit-II **08 Hrs.**

Government Policies and Incentives for Startups

Overview of Startup India, MSME, and Other Government Schemes
Tax Benefits, Grants, and Financial Incentives
Public and Private Funding Support
Case Studies on Startups Using Government Incentives.

Unit-III **06 Hrs.**

Business Compliance and Documentation

Important Documents: MoA, AoA, GST Registration, UDYAM Certification
Business Licenses, Permits, and Compliance Reports
Understanding Business Ethics and Legal Challenges.

Unit-IV **06 Hrs.**

Intellectual Property Rights (IPR) for Startups

Types of Intellectual Property: Patents, Trademarks, Copyrights, Trade Secrets
Legal Framework and Filing Procedures (Startup India/IP India Portals)
Strategic Use of IP in Startup Growth and Fundraising
Licensing, Commercialization, and IP Monetization Techniques
Legal Aspects and Compliance for Engineering Startups
Case Studies on Startup IP Protection.

Unit-V **06 Hrs.**

Fundraising and Investment Strategies

Seed Funding, Angel Investors, Venture Capital, Crowdfunding
Investor Relations and Pitching Techniques
Understanding Term Sheets and Equity Dilution
Case Studies on Startup Fundraising.

Unit-VI **05 Hrs.**

Taxation, Compliance, and Business Growth

GST, Corporate Tax, and Financial Reporting
Auditing and Legal Risk Management
Business Growth and Exit Strategies (Mergers, Acquisitions, IPOs)
Final Startup Business Plan Development

Books Recommended

1 Purohit, Prachi. Startup India: The Complete Guide to Launching and Managing a Business. Notion Press, Chennai, 2021.

2 Joshi, M.V. Entrepreneurship Development and Startup India. Himalaya Publishing House, Mumbai, 2020.

3 Pathak, Akhileshwar. Legal Aspects of Business. McGraw Hill, New Delhi, 2018.

4 Hegde, Dinesh S. Indian Startups and their Funding Journey. Springer, New Delhi, 2021.

5 Sharma, Rajat. Business Laws for Entrepreneurs. Pearson, New Delhi, 2019.

6 Blank, Steve, and Bob Dorf. The Startup Owner's Manual. K&S Ranch Publishing, Pescadero, 2012.

7 Feld, Brad, and Jason Mendelson. Venture Deals: Be Smarter Than Your Lawyer and Venture Capitalist. Wiley, New Jersey, 2019.

8 Desai, Vasant. Entrepreneurship Development in India. Himalaya Publishing House, Mumbai, 2019.

Program: Mechanical Engineering	Final Y. B.Tech	Semester: VII
Big Data Analytics (22PEME7046T)		

Prerequisites:

1. Mathematics and Statistics.
2. Programming Fundamentals.
3. Fundamentals of Data Science and Machine Learning.
4. Mechanical Engineering Knowledge.

Course Objectives:

1. To study the fundamentals of big data analytics and its significance in mechanical engineering applications.
2. To explain various data acquisition, storage, and pre-processing techniques used in mechanical systems.
3. To explore statistical and machine learning techniques to analyze mechanical engineering data.
4. To impart the fundamentals of large datasets from mechanical systems using big data tools and frameworks such as Hadoop and Spark.
5. To evaluate the effectiveness of predictive maintenance and fault diagnosis models in mechanical engineering.
6. To be able to develop data-driven solutions for mechanical engineering problems using big data analytics techniques.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Explain big data concepts and their applications in mechanical engineering.	L2	Understand
CO2	Use data collection, storage, and pre-processing techniques for handling mechanical engineering data.	L3	Apply
CO3	Apply machine learning models to predict failures and optimize mechanical system performance.	L3	Apply
CO4	Analyze large-scale mechanical engineering datasets using big data tools like Apache Spark and Hadoop.	L4	Analyze
CO5	Evaluate different predictive analytics techniques for reliability assessment and fault detection in mechanical systems.	L5	Evaluate
CO6	Design a data-driven project related to mechanical engineering problems using big data analytics techniques.	L6	Create

Big Data Analytics (22PEME7046T)

Course Contents

Unit-I **06 Hrs.**

Introduction to Big Data and Analytics

- Definition and Characteristics of Big Data (Volume, Velocity, Variety, Veracity, and Value)
- Importance of Big Data in Mechanical Engineering
- Data Sources in Mechanical Engineering: IoT sensors, CAD/CAE simulations, Manufacturing, Maintenance logs
- Big Data vs. Traditional Data Processing
- Data security, risk mitigation, and life cycle assessment
- Case Studies: Predictive Maintenance in Industrial Machines.

Unit-II **06 Hrs.**

Data Acquisition, Storage, and Preprocessing

- Data Collection Methods: Sensors, IoT, SCADA, PLM Systems
- Data Storage Technologies: SQL vs NoSQL, Hadoop, HDFS, Apache Spark
- Data Preprocessing: Cleaning, Transformation, Feature Engineering
- Handling Missing Data and Outliers
- Introduction to Time-Series Data Processing in Mechanical Systems.

Unit-III **09 Hrs.**

Statistical Analysis and Machine Learning

- Descriptive Statistics: Mean, Median, Standard Deviation, Correlation
- Regression Models: Linear, and Multiple, Regression for Mechanical Data
- Classification Algorithms: Decision Trees, Support Vector Machines (SVM), k-NN
- Clustering Techniques: k-Means, DBSCAN, Hierarchical Clustering.

Unit-IV **06 Hrs.**

Big Data Tools and Frameworks

- Introduction to Hadoop and MapReduce
- Apache Spark for Real-time Data Processing
- Python Libraries for Big Data: Pandas, NumPy, SciPy, Scikit-learn
- Cloud Computing and Big Data: AWS, Google Cloud, Microsoft Azure
- Hands-on Session: Processing Mechanical Sensor Data using Spark.

Unit-V **06 Hrs.**

Applications in Mechanical Engineering

- Big Data in Manufacturing: Smart Factories, Industry 4.0, Digital Twins
- Condition Monitoring and Predictive Maintenance using IoT Data
- Fault Detection and Diagnosis in Mechanical Systems
- Big Data in CFD and FEA Simulations: Data-driven Optimization
- Hands-on Project: Analyzing Vibration Data for Predictive Maintenance.

Unit-VI **06 Hrs.**

Case Studies and Emerging Trends

- AI-Driven Predictive Analytics in Mechanical Engineering
- Applications in Autonomous Vehicles and Robotics
- Supply Chain Optimization in Manufacturing
- Ethical and Security Concerns in Big Data Applications
- Future Trends: Quantum Computing, Edge Computing, and Big Data

Books Recommended

Textbooks

1 M.Thangaraj, S. Suguna, G. Sudha, Big Data Analytics: Concepts, Techniques, Tools and Technologies, PHI Learning Pvt. Ltd., 2022.

2 B. L. S. Prakasa Rao, S. B. Rao, and Saumyadipta Pyne, Big Data Analytics: Methods and Applications, Springer India, 2016.

3 EMC Education Services, Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, Wiley, 2014.

4 David Loshin, Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph, Morgan Kaufmann, 2013.

Reference Books

1 Edward L. Robinson, Data Analysis for Scientists and Engineers, Princeton University Press, 2016.

2 Parikshit N. Mahalle, Pravin P. Hujare, and Gitanjali Rahul Shinde, Predictive Analytics for Mechanical Engineering: A Beginners Guide, Springer Nature Singapore, 2023.

3 Venkat Ankam, Big Data Analytics, Packt Publishing, 2016.

4 Dina Darwish, Big Data Analytics Techniques for Market Intelligence, IGI Global, 2023.

5 Francesco Corea, Big Data Analytics: A Management Perspective, Springer International Publishing, 2016.

6 Mohammed Guller, Big Data Analytics with Spark: A Practitioner's Guide to Using Spark for Large Scale Data Analysis, Apress, 2015.

Web References

1 Algorithms for Big Data
https://nptel.ac.in/courses/106106142

2 Big Data Computing
https://nptel.ac.in/courses/106104189

Program: Mechanical Engineering	Final Y. B.Tech	Semester: VII
Product Life Cycle Management (22OEME7051T)		

Prerequisites:

1. Knowledge of basic concepts of Management.

Course Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.	L2	Understand
CO2	Illustrate various approaches and techniques for designing and developing products.	L3	Apply
CO3	Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.	L3	Apply
CO4	Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant.	L3	Apply

Product Life Cycle Management (22OEME7051T)

Course Contents

Unit-I **09 Hrs.**

Introduction to PLM

Introduction to Product Lifecycle Management (PLM): Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications.
PLM Strategies:Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy, Change management for PLM.

Unit-II **08 Hrs.**

Product Design

Product Design: Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process.

Unit-III **08 Hrs.**

PDM & Virtual Product Development

Product Data Management (PDM): Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation.
Virtual Product Development Tools: For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modelling and simulations in Product Design, Examples/Case Studies.

Unit-IV **07 Hrs.**

Integration of Environmental Aspects in Product Design

Integration of Environmental Aspects in Product Design: Sustainable Development Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design.

Unit-V **07 Hrs.**

Life Cycle Assessment and Life Cycle Cost Analysis

Life Cycle Assessment and Life Cycle Cost Analysis: Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle

Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis.

Books Recommended

Textbooks

1 Product Lifecycle Management: Paradigm for 21st Century Product Realization, John Stark, Springer-Verlag, 2004.

2 Product Design for the environment-A life cycle approach, Fabio Giudice, Guido La Rosa, Antonino Risitano, Taylor & Francis 2006.

Reference Books

1 Product Life Cycle Management‖, Saaksvuori Antti, Immonen Anselmie, Springer, Dreamtech.

2 Product Lifecycle Management: Driving the next generation of lean thinking, Michael Grieve, Tata McGraw Hill, 2006.

3 Product Life-Cycle Management: Geometric Variations, François Villeneuve, Luc Mathieu, Max Giordano, Wiley, 2010.

Program: Mechanical Engineering	Final Y. B.Tech	Semester: VII
Management Information System (22OEME7052T)		

Prerequisites:

Nil

Course Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today‘s business and define various technology architectures on which information systems are built.
3. Define and analyze typical functional information systems and identify how they meet the needsof the firm to deliver efficiency and competitive advantage.
4. Identify the basic steps in systems development.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Explain how information systems Transform Business	L2	Understand
CO2	Identify the impact information systems have on an organization	L1	Remember
CO3	Describe IT infrastructure and its components and its current trends	L2	Understand
CO4	Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making	L2	Understand
CO5	Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses.	L1	Remember

Management Information System (22OEME7052T)

Course Contents

Unit-I **03 Hrs.**

Foundation Concepts

Foundation Concepts: Information Systems in Business, Functional Area Information System, The Components of Information Systems, Impact of IT on organizations and society, Organizational Strategy, Information systems for strategic advantage.

Unit-II **07 Hrs.**

Information Technologies

Information Technologies: Hardware and Software.
Computer Systems: End User and Enterprise Computing.
Computer Peripherals: Input, Output, and Storage Technologies.
Application Software: End User Applications.
System Software: Computer System Management.
Data Resource Management: Technical Foundations of Database Management, Managing Data Resources, Big data, Data warehouse and Data Marts, Knowledge Management.
Networks: The Networked Enterprise (Wired and wireless), Pervasive computing, Cloud Computing models.

Unit-III **08 Hrs.**

MIS Tools and applications

MIS Tools and applications for Decision making: ERP and ERP support of Business Process Reengineering.
Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Visualization.
Artificial Intelligence Technologies in Business.

Unit-IV **06 Hrs.**

Security and Ethical Challenges

Security and Ethical Challenges: Security, Ethical, and Societal Challenges of IT Security Management of Information Technology.

Unit-V **07 Hrs.**

Social Computing (SC)

Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C, Mobile commerce.

Unit-VI **08 Hrs.**

IT in Organizaion, Enterprise and Global Management

Information System within Organization: Acquiring Information Systems and Applications: Various System development life cycle models.
Enterprise and Global Management of Information Technology: Managing Information Technology, Managing Global IT.

Books Recommended

Reference Books

1 Management Information Systems, 11th edition by James A O'Brien, George M., Ramesh Behl.

2 Kelly Rainer, Brad Prince, Management Information Systems, Wiley.

3 K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.

4 D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008.

Program: Mechanical Engineering	Final Y. B.Tech	Semester: VII
Operations Research (22OEME7053T)		

Prerequisites:

1. Basic Knowledge of Algebra, Probability and Statistics.

Course Objectives:

1. To formulate a real-world decision problem as a mathematical programming model.
2. To learn the mathematical tools that are employed to solve mathematical programming models.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Convert a real-world problem in to a Linear Programming Problem and analyse the solution obtained using Simplex method or other algorithms.	L4	Analyze
CO2	Identify real-world problems as Transportation Problem and Assignment Problem and Solve the decision problem by choosing appropriate algorithm.	L3	Apply
CO3	Identify the decision situations which vary with time and analyse them using principle of dynamic programming to real life situations.	L4	Analyze
CO4	Explain reasons of formation of queues, classify various queuing systems and apply parameters defined for various queuing systems for decision making in real life situations.	L3	Apply
CO5	Understand the concept of decision making in situation of competition and recommend strategies in case of two-person zero sum games.	L2	Undserstand
CO6	Describe concept of simulation and apply Monte Carlo Simulation technique to systems such as inventory, queuing and recommend solutions for them.	L3	Apply
CO7	Understand need for right replacement policy and determine optimal replacement age.	L2	Understand

Operations Research (22OEME7053T)

Course Contents

Unit-I **10 Hrs.**

Introduction & LPP

Introduction to Operations Research: Concept of decision making. Definition of OR. Formulation of decision problem as OR model, Concept of Optimization.
Linear Programming Problem: Mathematical Formulation. Finding optimal solution - Graphical method, Simplex Method, Big M-method, Two Phase Method. Duality, Primal – Dual construction, Symmetric and Asymmetric Dual. Dual Simplex Method.

Unit-II **08 Hrs.**

Assignment & Transportation Problems

Assignment Problems: Mathematical Formulation, Finding optimal solution - Hungarian Method.
Transportation problem: Mathematical Formulation, Finding initial basic feasible solution – North-west corner rule, row minima, column minima, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. Improving the solution.

Unit-III **05 Hrs.**

Dynamic Programming

Dynamic Programming: Bellman's Principle of optimality - Applications of dynamic programming- Employment smoothening problem, capital budgeting problem, shortest path problem, cargo loading problem.

Unit-IV **10 Hrs.**

Queuing Models & Game Theory

Queuing Models: Characteristics of queuing models.
Single Channel – Single and multi phase servers, Poisson arrivals, exponential service time - with infinite population and finite population models – with infinite and finite capacity.
Multichannel – Single phase server - Poisson arrivals, exponential service time with infinite population.
Game Theory: Introduction. Minimax Maximin Criterion and optimal strategy. Solution of games with saddle points, rectangular games without saddle points - 2 x 2 games, dominance principle.
Approximate methods - Iterative method, m x 2 2 x n games -Graphical method and method of sub-games.
Expressing game as LPP.

Unit-V **06 Hrs.**

Simulation & Replacement Models

Simulation: Definition. Types of simulation models. Monte Carlo simulation technique. Applications of simulation - Inventory and Queuing problems. Simulation Languages.
Replacement Models: Replacement of items that deteriorate with time - when money value is not counted and counted, Replacement of items that fail suddenly – individual and group replacement

policy.

Books Recommended

Textbooks

1 Operations Research, Sharma J. K., Trinity Press

2 Operations Research, Gupta P. K., Hira D. S., S. Chand Limited

Reference Books

1 Operations Research - An Introduction; Taha, H.A.; Prentice Hall.

2 Operations Research: Principles and Practice; Ravindran, A, Phillips, D. T and Solberg, J. J.; John Willey and Sons.

3 Introduction to Operations Research; Hiller, F. S. and Liebermann, G. J.; Tata McGraw Hill.

4 Operations Research Principles and Practice; Pradeep Prabhakar Pai; Oxford University Press.

5 Operations Research, R. Panneerselvam, PHI Publications.

6 Operations Research, A. M. Natarajan, P. Balasubramani, A. Tamilarasi, Pearson Education.

7 Operations Research; Kanti Swarup, P. K. Gupta and Man Mohan; Sultan Chand Sons.

Program: Mechanical Engineering	Final Y. B.Tech	Semester: VII
Cyber Security and Laws (22OEME7054T)		

Prerequisites:

Nil

Course Objectives:

1. To understand and identify different types cybercrime and cyber offences.
2. To recognized Indian IT Act 2008 and its latest amendments.
3. To learn various types of security standards compliances.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Understand the different types of cybercrime and security issues E Business.	L2	Understand
CO2	Analyses different types of cyber threats and techniques for security management.	L4	Analyze
CO3	Explore the legal requirements and standards for cyber security in various countries to regulate cyberspace.	L3	Apply
CO4	Impart the knowledge of Information Technology Act and legal frame work of right to privacy, data security and data protection.	L2	Understand

Cyber Security and Laws (22OEME7054T)

Course Contents

Unit-I **10 Hrs.**

Introduction to Cybercrime

Cyber Crime, Cyber Law, Cyber Security, History of Cyber Crime, Hacking, Data Theft, Cyber Terrorism, Virus Worm's, Email Bombing, Pornography, online gambling, Forgery, Web Defacements, Web Jacking, Illegal online Selling, Cyber Defamation, Software Piracy, Electronics/ Digital Signature, Phishing, Password Cracking, Key loggers and Spywares, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Over Flow„ Phishing Identity Theft (ID Theft) ,How criminal plan the attacks, Social Engineering, Cyber stalking.

Unit-II **06 Hrs.**

Cyber Threats Analysis

Knowledge of Dynamic and Deliberate Targeting .
Knowledge of Indications and Warning.
Knowledge of Internal Tactics to Anticipate and/or, Emulate Threat Capabilities and Actions.
Knowledge of Key Cyber Threat Actors and their Equities.
Knowledge of Specific Target Identifiers and Their Usage.

Unit-III **06 Hrs.**

Electronic Business and legal issues

Evolution and development in Ecommerce, Policy Frameworks for Secure Electronic Business, paper vs paper less contracts, E-Commerce models- B2B, B2C, E security. E- Payment Mechanism; Payment through card system, E-Cheque, E-Cash, E-Payment Threats & Protections, Security for E-Commerce.

Unit-IV **08 Hrs.**

Indian IT Act

Indian IT Act: Cyber Crime and Criminal Justice, Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments
Security aspect in cyber Law: The Contract Aspects in Cyber Law , The Security Aspect of Cyber Law, The Intellectual Property Aspect in Cyber Law ,The Evidence Aspect in Cyber Law ,The Criminal Aspect in Cyber Law.

Unit-V **09 Hrs.**

Security Industries Standard Compliances

IT Security v/s IT Compliance, Cyber Security Standards, critical security controls for cyber security, GRC (Governance, Risk Management, and Compliance), SOX, GLBA, HIPAA, ISO/IEC 27001, NIST Cyber Security Framework (CSF), PCI-DSS.
OWASP Top Ten Project, GDPR (General Data Protection Regulation), NIST (National Institute of Standards and Technology), CIS Controls (Center for Internet Security Controls).

Books Recommended

Reference Books

1 Nina Godbole, Sunit Belapure, Cyber Security, Wiley India, New Delhi.

2 The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi.

3 The Information Technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.

4 E-Commerce Security and Privacy", Anup K. Ghosh, Springer Science and Business Media, 2012.

5 Izzat Alsmadi , The NICE Cyber Security Framework Cyber Security Intelligence and Analytics, Springer.

6 Cyber Law & Cyber Crimes, Advocate Prashant Mali; Snow White Publications, Mumbai.

7 Nina Godbole, Information Systems Security, Wiley India, New Delhi.

8 Kennetch J. Knapp, Cyber Security & Global Information Assurance Information Science Publishing.

9 William Stallings, Cryptography and Network Security, Pearson Publication

Web References

1 The Information Technology ACT, 2008- TIFR
https://www.tifrh.res.in

2 A Compliance Primer for IT professional
https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Program: Mechanical Engineering	Final Y. B.Tech	Semester: VII
Personal Finance Management (22OEME7055T)		

Prerequisites:

1. Basic Knowledge of Algebra, Probability and Statistics.

Course Objectives:

1. To create awareness and educate consumers on access to financial services.
2. To make the students understand the basic concepts, definitions and terms related to direct taxation.
3. To help the students compute the Goods and Service Tax (GST) payable by a supplier after considering the eligible input tax credit.
4. To familarise the students with microfinance for accelerating the expansion of local microbusinesses.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Use a framework for financial planning to understand the overall role finances play in his/her personal life.	L3	Apply
CO2	Compute income from salaries, house property, business/profession, capital gains and income from other sources.	L3	Apply
CO3	Compute the amount of CGST, SGST and IGST payable after considering the eligible input tax credit.	L3	Apply
CO4	Understand how Microfinance can help in financial inclusion.	L2	Understand

Personal Finance Management (22OEME7055T)

Course Contents

Unit-I **07 Hrs.**

Overview of Indian Financial System

Overview of Indian Financial System: Characteristics, Components and Functions of Financial System. Financial Instruments and Financial Markets, Financial inclusion.
Introduction to Personal Finance : Person Financial Planning in Action, Money Management Skills, Taxes in Your Financial Plan, Savings and Payment Services. Consumer Credit: Advantages, Disadvantages, Sources and Costs.

Unit-II **07 Hrs.**

Personal Financial Management

Loans: Home, Car, Education, Personal, Loan against property and Jewel loan.
Insurance: Types of Insurance – ULIP and Term; Health and Disability Income Insurance, Life Insurance.
Investment: Investing Basics and Evaluating Bonds, Investing in Stocks and Investing in Mutual Funds, Planning for the Future.

Unit-III **07 Hrs.**

Income Tax

Income Tax Act Basics- Introduction to Income Tax Act, 1961.
Heads of Income and Computation of Total Income and Tax Liability- Heads of Income and Computation of Total Income under various heads, Clubbing Provisions, Set off and Carry forward of Losses, Deductions, Assessment of Income and tax liability of different persons.
Tax Management, Administrative Procedures and ICDS - TDS, TCS and Advance Tax Administrative Procedures, ICDS.

Unit-IV **09 Hrs.**

Goods and Services Tax

Goods and Services Tax: GST Constitutional framework of Indirect Taxes before GST (Taxation Powers of Union State Government); Concept of VAT: Meaning, Variants and Methods; Major Defects in the structure of Indirect Taxes prior to GST; Rationale for GST; Structure of GST (SGST, CGST, UTGST IGST); GST Council, GST Network, State Compensation Mechanism, Registration. Levy and Collection of GST : Taxable event- "Supply" of Goods and Services; Place of Supply: Within state, Interstate, Import and Export; Time of supply: Valuation for GST- Valuation rules, taxability of reimbursement of expenses; Exemption from GST: Small supplies and Composition Scheme: Classification of Goods and Services.

Unit-V **09 Hrs.**

Introduction to Micro – finance

Micro-Finance: Definitions, Scope Assumptions, Types of Microfinance, Customers of Micro-finance, Credit Delivery Methodologies, SHG concept, origin, Formation Operation of Self Help Groups

(SHGs).
Models in Microfinance - Joint Liability Groups (JLG), SHG Bank Linkage Model and GRAMEEN Model: Achievements Challenges,
Institutional Mechanism: Current Challenges for Microfinance, Microfinance Institutions (MFIs): Constraints Governance Issues, Institutional Structure of Microfinance in India :NGO-MFIs, NBFC-MFIs, Co-operatives, Banks, Microfinance Networks and Associations; Demand Supply of Microfinance Services in India, Impact assessment and social assessments of MFIs.

Books Recommended

Reference Books

1 Banking and Financial Sector Reforms in India , by Asha Singh, M.S. Gupta, Serials Publication.

2 Indian Banking Sector: Essays and Issues (1st) , by M.S. Gupta & J.B. Singh, Serials Publication.

3 Basics Of Banking & Finance , by K.M. Bhattacharya O.P. Agarwal , Himalaya Publishing House.

4 Agricultural Finance And Management, by S. Subba Reddy , P. Raghu Ram .

5 The Indian Financial System And Development , by Dr.Vasant Desai, Himalaya Publishing House; Fourth Edition.

6 Income Tax Management , Simple Way of Tax Management, Tax Planning and Tax Saving , By Sanjay Kumar Satapathy.

7 Direct Tax System Income Tax by Dr. R. K. Jain, SBPD Publications.

8 Simplified Approach to GST Goods and Services Tax, By S K Mishra , Educreation Publishing.

9 Introduction To Microfinance , By Todd A Watkins , World Scientific Publishing Company.

Program: Mechanical Engineering	Final Y. B.Tech	Semester: VII
Energy Audit and Management (22OEME7056T)		

Prerequisites:

Nil

Course Objectives:

1. To understand the importance of energy security for sustainable development and the fundamentals of energy conservation.
2. To identify and describe the basic principles and methodologies adopted in energy audit of a utility
3. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management.
4. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	To identify and describe present state of energy security and its importance.	L2	Understand
CO2	To identify and describe the basic principles and methodologies adopted in energy audit of a utility.	L2	Understand
CO3	To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.	L3	Apply
CO4	To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities.	L3	Apply
CO5	To analyze the data collected during performance evaluation and recommend energy saving measures.	L4	Analyze

Energy Audit and Management (22OEME7056T)

Course Contents

Unit-I **05 Hrs.**

Energy Scenario

Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act- 2001 and its Features. Basics of Energy and its various forms, Material and Energy balance.

Unit-II **09 Hrs.**

Energy Audit

Energy Audit: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring & targeting, Energy audit instruments. Technical and economic feasibility, Classification of energy conservation measures. Safety considerations during energy audit.
Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI) Internal rate of return (IRR).

Unit-III **10 Hrs.**

Energy Management & Energy Conservation in Electrical System

Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. Energy efficiency measures in lighting system, lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in water pumps, compressor, fan and blower. industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.

Unit-IV **09 Hrs.**

Energy Management & Energy Conservation in Thermal Systems

Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Steam leakages, Steam trapping, Condensate and flash steam recovery system. Waste heat recovery, use of insulation- types and application. Energy conservation opportunities in: Boiler system. Refrigeration system and HVAC system.

Unit-V **06 Hrs.**

Energy conservation in Buildings

Energy Conservation Building Codes (ECBC):Green Building, LEED rating,
Application of Non-Conventional and Renewable Energy Sources, Energy sources and energy management in electric vehicles.

Books Recommended

Reference Books

1 Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science.

2 Designing with light: Lighting Handbook, By Anil Valia, Lighting System.

3 Energy Management Handbook, By W.C. Turner, John Wiley and Sons.

4 Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).

5 Energy Management Principles, C.B. Smith, Pergamon Press.

6 Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press.

7 Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press.

Web References

1 www.energymanagertraining.com

2 www.bee-india.nic.in

Program: Mechanical Engineering	Final Y. B.Tech	Semester: VII
Disaster Management and Mitigation Measures (22OEME7057T)		

Prerequisites:

Nil

Course Objectives:

1. To provide basic understanding hazards, disaster and various types and categories of disaster occurring around the world.
2. To identify extent and damaging capacity of a disaster.
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand roles and responsibilities of individual and various organization during and after disaster.
5. To appreciate the significance of GIS, GPS in the field of disaster management.
6. To understand the emergency government response structures before, during and after disaster.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Know natural as well as man made disaster and their extent and possible effects on the economy.	L1	Remember
CO2	Know the institutional framework and organization structure in India for disaster management and get acquainted with government policies, acts and various emergency laws.	L1	Remember
CO3	Get to know the simple dos and don'ts in such extreme events and build skills to respond accordingly.	L3	Apply
CO4	Understand the importance of disaster prevention and various mitigation measures with the exposure to disaster hotspots across the globe.	L2	Understand

Disaster Management and Mitigation Measures (22OEME7057T)

Course Contents

Unit-I **09 Hrs.**

General Information about Disaster

Brief concept of Hazards, definition and types of Disasters – Natural, Man-made, and hybrid, Groups of Disasters- Natural and Technological, global Scenario, Significance of studying various aspects of disasters, effects of disasters, India's vulnerability to disasters, Impact of disaster on National development.
Study of Natural disasters: Flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion etc.
Study of Human/Technology Induced Disasters: Chemical, Industrial and Nuclear disasters, Internally displaced persons, road and train accidents Fire Hazards, terrorism, militancy, Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.

Unit-II **08 Hrs.**

Disaster Management

Brief Introduction, Disaster management cycle, Evolution of Disaster and Disaster management in India, Disaster management acts, policies and guidelines, laws of emergencies etc.
Prior, During and Post disaster management activities:
(Preparedness, strengthening emergency centers, Logistics, optimum resource management, emergency response and relief, Training, Public awareness, Research, Reconstruction of essential services and livelihood restoration.

Unit-III **07 Hrs.**

Institutional framework & Mechanism for disaster management in India:

Institutions in India for dealing with various disasters, Organizational structure, functions and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India, roles and responsibilities of central and state government during and after disaster, NGO's involved in disasters and their task, Jobs carried out by armed forces.
Financial Relief During disaster (State, National and International Disaster Assistance).

Unit-IV **08 Hrs.**

Disaster risk reduction and Mitigation Measures

Need of disaster prevention and mitigation, mitigation guiding principles, challenging areas, structural and non-structural measures for disaster risk reduction.
Mitigation measures for flood, earthquake, cyclone monitoring, air quality, water quality, climate change, land use, winter storms and aquatic biology etc.
Use of information management, GIS, GPS and remote sensing Mitigation measure. Do's and don'ts in case of disasters and effective implementation of relief aids.

Unit-V **07 Hrs.**

Case studies on disaster (National /International)

Case study discussion of Hiroshima – Nagasaki (Japan), India – Tsunami (2004) , Bhopal gas tragedy, Kerala and Uttarakhand flood disaster, Cyclone Phailin (2013), Fukushima Daiichi nuclear disaster (2011), 26th July 2005 Mumbai flood, Chernobyl meltdown and so on.
(Discuss case studies on disaster with respect to reason for the disaster, incidents, effects of disaster, present scenario and safety measures taken)

Books Recommended

Reference Books and Reports

1 Disaster Management, by Harsh K.Gupta, Universities Press Publications (2003).

2 Disaster Management: An Appraisal of Institutional Mechanisms in India, by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.

3 Introduction to International Disaster Management, by Damon Copolla, Butterworth Heinemann Elsevier Publications (2015).

4 Disaster Management Handbook, by Jack Pinkowski, CRC Press, Taylor and Francis group (2008).

5 Disaster management & rehabilitation, by Rajdeep Dasgupta, Mittal Publications, New Delhi (2007).

6 Natural Hazards and Disaster Management, Vulnerability and Mitigation, by R B Singh, Rawat Publications (2006).

7 Concepts and Techniques of GIS, by C.P.Lo Albert, K.W. Yonng, Prentice Hall (India) Publications (2006).

8 Risk management of natural disasters, by Claudia G. Flores Gonzales, KIT Scientific Publishing (2010).

9 Disaster Management – a disaster manger's handbook, by W. Nick Carter, Asian Development Bank (2008).

10 Disaster Management in India, by R. K. Srivastava, Ministry of Home Affairs, GoI, New Delhi (2011)

11 The Chernobyl Disaster: Legacy and Impact on the Future of Nuclear Energy, by Wil Mara, Marshall Cavendish Corporation, New York, 2011.

12 The Fukushima 2011 Disaster, by Ronald Eisler, Taylor & Francis, Florida, 2013.

(Learners are expected to refer reports published at national and international level and updated information available on authentic web sites)

Program: Mechanical Engineering	Final Y. B.Tech	Semester: VII
Science of Well-being (22OEME7058T)		

Prerequisites:

Nil

Course Objectives:

1. To create consciousness about importance of holistic health and physical as well as mental well-being.
2. To make learners aware of the concepts of Happiness, Gratitude, Self-Compassion, Empathy etc.
3. To introduce the learners to the means of mental and physical well-being, ill effects of mal-practices like alcoholism, smoking etc.
4. To equip the learners to manage and cope up with stress in their daily living.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Describe concepts of holistic health and well-being, differentiate between its true meaning and misconceptions and understand the benefits of well-being.	L2	Understand
CO2	Recognize meaning of happiness, practice gratitude and self-compassion and analyze incidents from one's own life.	L4	Analyze
CO3	Understand the causes and effects of stress, identify reasons for stress in one's own surrounding and self.	L2	Understand
CO4	Recognize the importance of physical health and fitness, assess their lifestyle and come up with limitations or effectiveness.	L4	Analyze
CO5	Inspect one's own coping mechanism, assess its effectiveness, develop and strategize for betterment and execute it.	L6	Create

Science of Well-being (22OEME7058T)

Course Contents

Unit-I **06 Hrs.**

Health and well-being

The concept of health, dimensions of health, the notion of well- being, various facets of well-being, relation between health and well-being.
Concept of holistic health, its principles and importance, concept and benefits of holistic care, misconceptions about holistic health approach, the application of a true holistic approach to our well-being.

Unit-II **08 Hrs.**

Concepts of happiness

Happiness: what is it and how do we measure it? Philosophical perspectives on happiness, Happiness: Nature or Nurture? Happiness in the modern world: impediments and accelerators, Narrow vs. Broad Band Approaches to Happiness, Benefits of Happiness, Self-Compassion and Gratitude. Misconceptions of happiness.

Unit-III **09 Hrs.**

Stress and mental health/well-being

Nature and concept of stress, meaning and definitions of stress, types of stress, meaning of stressors, types of stressors, symptoms of stress, effects of stress, different models of stress.
Sources of stress and how does stress cause illness, various sources of stress, delineate between external and internal sources of stress, differentiate between continuous and discrete stressors, the effects of these stressors on health and well-being, diversity of stressors and their health consequences, relation between stress and illness from different perspectives association between stress related physiological mechanisms and different illnesses.

Unit-IV **08 Hrs.**

Physical Well-being / Health management

Concept of health behaviours, dimensions of health behaviours. Health enhancing behaviors: Exercise and Weight control, application and importance of these health enhancing behaviours. Health protective behaviors and illness management: concept of illness management, effectiveness of illness management. Concept of Nutrition, Role of Nutrition, Components of Nutrition, concept of Malnutrition, Health compromising behaviours: Alcoholism, Smoking and its effects on health.

Unit-V **08 Hrs.**

Dealing with Difficult Times / Coping mechanisms

The concept of chronic stress, Health and safety risks of chronic stress, Forms and Treatment of chronic stress, Coping with Acute and Chronic stress, theories of the stress-illness link, role of stress in mental disorders.
Concept of coping, Ways of coping and stress management, basic knowledge about stress management, various techniques of stress management, stress management programs.

Mental strengths and virtues, Hope, Optimism, Resilience – concept, pathways and models, Meditation and Self-introspection.

Books Recommended

Textbooks

1 The Science of well-being by Felicia Huppert, Nick Baylis, Barry Keverne; Oxford University Press

2 Health and Well-Being: Emerging Trends by S. Ojha, U. Rani Srivastava, Shobhna Joshi, Global Vision Publishing House

3 Positive psychology: The scientific and practical explorations of human strengths by Shane. J. Lopez, Jennifer Teramoto Pedrotti, Charles Richard Snyder; Sage Publications.

Reference Books

1 The pursuit of happiness and the realization of sympathy: Cultural patterns of self, social relations, and well-being by Kitayama, S., & Markus, H. R, Culture and subjective well-being, The MIT Press.

2 Man Adapting by Dubos, R; New Haven: Yale University Press.

3 Happiness a history by McMahon D. M., Atlantic Monthly Press.

4 Well-being: The foundations of hedonic psychology by D. Kahneman & E. Diener & N. Schwarz, New York: Russell Sage

5 Selye H. The Stress of Life. New York; McGraw-Hill; 1984.

Program: Mechanical Engineering	Final Y. B.Tech.	Semester: VII
Research Methodology (22OEME7059T)		

Prerequisites:

1. Basic Knowledge of Probability and Statistics.

Course Objectives:

1. To understand Research and Research Process.
2. To acquaint learners with identifying problems for research and develop research strategies.
3. To familiarize learners with the techniques of data collection, analysis of data and interpretation.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Prepare a preliminary research design for projects in their subject matter areas	L6	Create
CO2	Accurately collect, analyze and report data	L4	Analyze
CO3	Present complex data or situations clearly	L3	Apply
CO4	Review and analyze research findings	L4	Analyze
CO5	Write report about findings of research carried out.	L6	Create

Research Methodology (22OEME7059T)

Course Contents

Unit-I **07 Hrs.**

Basic Research Concepts

Meaning of research, Objectives of research, Types of research, Significance of research, Research process.

Unit-II **09 Hrs.**

Research Methodology

Identification of research problem, Literature review, Formulation of hypothesis, Formulation of Research design.

Unit-III **09 Hrs.**

Research and Sample Design

Meaning of research and sample design, Need of research design, Features of good research design, Important concepts, Different research designs, Types of sampling designs.

Unit-IV **09 Hrs.**

Data Collection and Data Analysis

Types of data, Methods for collecting data: Experiments and surveys, Collection of primary and secondary data, Hypothesis testing and interpretation of Data.

Unit-V **05 Hrs.**

Interpretation and Report Writing

Interpretation and drawing conclusions on the research, Preparation of the report, Ethical Issues.

Books Recommended

Reference Books

1 Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.

2 Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.

3 Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd Edition), Singapore, Pearson Education.

Program: Mechanical Engineering	Final Y. B.Tech.	Semester: VII
Public Systems and Policies (22OEME70510T)		

Prerequisites:

1. Basic Knowledge of Social science and Current affairs.

Course Objectives:

1. To analyze the transformations in public systems with emphasis on current initiatives and emerging challenges in the field.
2. To understand public systems in a fast-changing environment in the global context.
3. To provide an in-depth understanding of the ills prevailing in the society and aids to identify the solutions for them.
4. To explain public policy and its operations with special focus on policy relating to Government finance.
5. To analyze and evaluate the impact of the public policy on firms and economy at large.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Understand the importance of public systems in a fast-changing environment in the global context.	L2	Understand
CO2	Analyze the transformations in public systems with emphasis on current initiatives and emerging challenges in the field.	L4	Analyze
CO3	Explain public policy and its operations with special focus on policy relating to Government finance.	L2	Understand
CO4	Make policies and know about the happenings in the world, in the nation and those in their locality.	L6	Create
CO5	Analyze and evaluate the impact of the public policy on firms and economy at large and work under various fields as policy-makers.	L5	Evaluate

Public Systems and Policies (22OEME70510T)

Course Contents

Unit-I **09 Hrs.**

Introduction and Overview of Public Systems

Ideology of Public Systems; Mechanistic and Organic view of Society and Individuals, The Legal Framework; Federal Government; State and Local Governments, Government growth; The size of Government.

Unit-II **06 Hrs.**

Public Sector in the Economics Accounts

Public Sector in the circular flow; Public Sector in the National Income Accounts.

Unit-III **07 Hrs.**

Public Choice and Fiscal Politics

Direct Democracy; Representative Democracy; The Allocation Function; The Distribution Function; The Stabilization Function; Coordination of Budget Functions; The Leviathan Hypothesis.

Unit-IV **11 Hrs.**

Introduction and Overview of Public Policy

Markets and Government; Social goods and Market failure, Public expenditure and its evaluation; Cost Benefit Analysis, Public policy and Externalities, Taxation Policy and its impact, Income distribution, redistribution and social security issues Fiscal Budgetary Policy, Fiscal Federalism in India.

Unit-V **06 Hrs.**

Case Studies in Expenditure Policy: Public Services

A) National Defense, B) Highways, C) Outdoor Recreation, D) Education

Books Recommended

Reference Books

1 Introduction to Public Policy by Charles Wheelan, W.W. Norton & Company.
2 Understanding Public Policy by Thomas R. Dye, Prentice Hall.
3 Public Policy-Making: An Introduction by Anderson J.E., Boston, Houghton.
4 Public Administration by Avasthi & Maheshwari, Lakshminarayan Agarwal, Agra.
5 New Horizons of Public Administration by Bhattacharya, Jawahar Publishers, New Delhi.
6 Public Administration and Public Affairs by Henry, Nicholas, Prentice Hall of India, New Delhi.
7 Public Finance 10th Edition by Harvey S Rosen and Ted Gayer, McGraw-Hill Education, 2013.
8 Public Finance in Theory and Practice by Musgrave and Musgrave.

Program: Mechanical Engineering	Final Y. B.Tech.	Semester: VII
Project Stage-II (22PJME7060L)		

Prerequisites:

Course Objectives:

1. To implement the solution as per the problem statement
2. To develop the team building, writing, logical reasoning and management skills.
3. To provide the connections between the designs and concepts across different disciplinary boundaries.
4. To encourage students to become independent personnel, critical thinkers and lifelong learners.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Apply engineering knowledge to produce solution of a problem considering cultural, social, environmental, and economic factors using appropriate tool and method.	L4	Analyze
CO2	Demonstrate project based learning that allows students to transfer existing ideas into new applications.	L2	Understand
CO3	Develop an ability to work in teams and manage the conduct of the research study	L3	Apply
CO4	Integrate different perspectives from relevant disciplines which help them to get internships, jobs and admission for higher studies	L3	Apply
CO5	Present the research in the form of technical writing, understand what constitutes to plagiarism and how to use proper referencing styles.	L2	Understand

Project Stage-II (22PJME7060L)

Syllabus

Domain knowledge (any beyond) is needed from the areas of Mechanical Engineering for the effective implementation of the project.
The areas can be updated on the basis of the technological innovations and development needed for a specific project.
Each student shall work on a project approved by the departmental committee approved by the Head of the Department. A group of 3 to 5 students (maximum allowed: 5 students in extraordinary cases, subject to the approval of the department committee and the Head of the department) shall be allotted for each Project. Each group shall submit at least 3 topics for the Semester Project. The departmental committee shall finalize one topic for every group. The Project Title or Theme should be based on the knowledge acquired during the all semesters. The project work shall involve sufficient work so that students get acquainted with different aspects of knowledge acquired from subjects.

Guidelines

The main purpose of this activity is to improve the students technical skills, communication skills by integrating writing, presentation and teamwork opportunities.

- Each group will be reviewed twice in a semester and marks will be allotted based on the various points mentioned in the evaluation scheme.
- In the first review of this semester, each group is expected to complete 30% of project.
- In the second review of this semester, each group is expected to complete 50% of project.
- Interaction with alumni mentor will also be appreciated for the improvement of project.

Student is expected to :

- Select an appropriate project title based on acquired knowledge from subjects.
- Maintain a Log Book of weekly work done (Log Book Format will be as per Table 1).
- Report weekly to the project guide along with the log book.

Table 1: Log Book Format

Sr	Week (Start Date:End Date)	Work Done	Sign of Guide	Sign of Coordinator
1				

Assessment Criteria

- At the end of the semester, after confirmation by the project guide, each project group will submit a project completion report in the prescribed format for assessment to the departmental committee (including project guide).
- Assessment of the Project Stage-II (at the end of the semester) will be done by the departmental committee (including project guide).
- Oral examination should be conducted by Internal and External examiners. Students have to give presentation and demonstration based on their project.

Prescribed project report guidelines

The size of the report shall be a minimum of 25 pages. The Project Report should include appropriate content for:

- Introduction
- Literature Survey
- Related Theory
- Implementation details
- Project Stage-II Outcomes
- Conclusion
- References

Assessment criteria for departmental committee (including project guide) for Continuous Assessment:

Guide will monitor weekly progress, and marks allocation will be as per Table 2.

Table 2: Continuous Assessment table

Sr	PRN	Name of Student	Student Attendance	Log Book Maintain	Literature Review	Depth of Understanding	Report	Total
			5	5	5	5	5	25

Each group will be reviewed twice in a semester by faculty guide and faculty coordinator based on the following criteria;

- Project progress
- Documentation/Technical paper writing
- Key findings
- Validation of results

Each review consists of 50 marks. Average of the marks scored in both the two reviews will be considered for final grading. The final certification and acceptance of TA ensures the satisfactory performance on the above aspects.

Assessment criteria for departmental committee (including project guide) for End Semester Exam:

evaluate the project as per Table 3.

Table 3: Evalution Table

Sr	PRN	Name of Student	Project Selection	Design/ Simulation	model/ programming	Result Verification	Presentation	Total
			5	5	5	5	5	25

Each group shall present/publish a paper based on the project in reputed/peer-reviewed Conference/Journal/TechFest/Magazine before the end of the semester.

Program: Mechanical Engineering	Final Y. B.Tech.	Semester: VII
Full Stack Development Laboratory (22ESME7070L)		

Prerequisites:

1. Basic understanding of computers and web browsers
2. Familiarity with basic programming concepts (variables, loops, functions, etc.)

Course Objectives:

1. To introduce students to the fundamentals of web development using HTML, CSS, and JavaScript.
2. To provide in-depth knowledge of modern JavaScript (ES6+) features used in frontend development.
3. To enable students to build interactive user interfaces using React and its component-based architecture.
4. To develop skills in managing state, handling events, and using React Hooks for building dynamic applications.
5. To empower learners to build and deploy real-world React projects including a personal portfolio.

Course Outcomes:

On completion of the course, the learner will be able to:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Design responsive web pages using HTML5, CSS, and modern layout techniques.	L3	Apply
CO2	Apply core JavaScript and ES6+ features to build interactive web functionalities.	L3	Apply
CO3	Develop dynamic user interfaces using React components, props, state, and event handling.	L6	Create
CO4	Manage application state and side effects using React Hooks and advanced patterns.	L4	Analyze
CO5	Build and deploy real-world React projects and a personal portfolio showcasing frontend skills.	L6	Create

Full Stack Development Laboratory (22ESME7070L)

Course Content

Unit-I **08 Hrs.**

Learn React JS for Front-end development

ES6+ Features: Let and Const (Replacing var), Arrow functions, Promises (async /await), Spread / Rest operators, Destructuring.
Javascript Functions: Array Map Method, JavaScript for Each Method, JavaScript Filter() Method, JavaScript Reduce Method.
React Fundamentals: About React, About JSX in React, Components in React, Iteration in React, Conditional Rendering, Range Utility & styling in React.
Working With State in React: Event Handlers, The use State Hook, Forms in React, Props Vs. State.
React Hooks: About Hooks, Immutability Revisited & Refs, Side Effects, Custom hooks & Data Fetching, Memoization.
Project - Interactive Forms with Dynamic Tabs
Project - The Job Application Form.
Component API Design : The Spectrum of Components, Polymorphism & Compound Components, React Context, Understanding Modals
Portfolio Project - Portfolio Website
Project - 2048 Game
Advanced Patterns and Smarter State in React : React State and Visual Updates, Smarter Component Design in React, Managing Complex State with use Reducer, Advanced UI and Safe State Updates in React.

Unit-II **06 Hrs.**

Learn HTML / CSS

Introduction to HTML : Introduction to HTML tags and structure, List / Images / Links / Table using HTML, Semantic HTML, Project: HTML.
Introduction to CSS : Ways to style using CSS, CSS selectors and properties, CSS layout and positioning - Box model,Project: CSS.

Unit-III **14 Hrs.**

Learn Javascript

Output / Print in JavaScript : Introducing output/printing, Printing on multiple lines, Print text and numbers using single print
Variables & datatypes : Introduction to variables & datatypes, Boolean data type & negative numbers.
Strings :Introduction to strings, Functions in JavaScript.
Functions, Use functions in problems
Conditional statements: Intro to if / else, Combining conditions - And / or
Debug your code : Learn to debug common errors, Practice debugging.
Arrays : Introduction to arrays, Loops : While loops, For loops, Break / continue.
ES6+ Features in JavaScript :Introduction to let and const, Arrow Functions, Spread and Rest Operators, Destructuring in JavaScript.
User Inputs : take user input
Algorithmic problems : test cases, custom inputs

Full Stack Development Laboratory (22ESME7070L)

Suggested Experiments

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1. Creation of HTML Skeleton
2. Creation of a Paragraph in HTML
3. Add the elements in HTML - images and videos. Links to external websites, Create lists, Add tables
4. Use semantic HTML
5. Do inline styling in CSS
6. Create a style sheet in CSS - internal and external
7. Use class / ID selector in CSS
8. Do font stying in CSS
9. Do layout and positioning in CSS
10. Printing a number/text in JS
11. Arithmetic Operations in JS
12. Inserting text Between Outputs in JS
13. Create and Declare Variables in JS
14. Use of String datatype/Float Datatype
15. Create a boolean variable
16. Use a function in JS
17. Call a function within a function
18. Render Dynamic Data in JSX
19. Do Inline Styles in JSX
20. Update the given React component to display dynamic values and additional information inside the in React
21. Create a basic react component in React
22. Create flexible and reusable components in React
23. Create a component with an input field and two buttons in React
24. Interact with DOM elements and handle side effects in React using useRef and useEffect
25. Handle Form Submissions with Fetch in React

Minimum 25 experiments from the above suggested list or any other experiment based on syllabus will be included, which would help the learner to apply the concept learnt.

Books Recommended

Textbooks

1. A. Banks and E. Porcello, Learning React: Modern Patterns for Developing React Apps, 3rd ed. Sebastopol, CA, USA: O'Reilly Media, 2020.

Reference Books

1 S. Stefanov, React – Up & Running: Building Web Applications, Sebastopol, CA, USA: O'Reilly Media, 2016.

2 A. Accomazzo, N. Murray, A. Lerner, C. Blank, and D. Gallo, Fullstack React: The Complete Guide to ReactJS and Friends, San Francisco, CA, USA: Fullstack.io, 2017.

3 D. Crockford, JavaScript: The Good Parts, Sebastopol, CA, USA: O'Reilly Media, 2008.

4 M. Haverbeke, Eloquent JavaScript: A Modern Introduction to Programming, 3rd ed. San Francisco, CA, USA: No Starch Press, 2018.

5 J. Duckett, HTML and CSS: Design and Build Websites, Indianapolis, IN, USA: Wiley, 2011.