Shirpur Education Society's

R. C. Patel Institute of Technology, Shirpur

(An Autonomous Institute)

Course Structure

Third Year B.Tech in Mechanical Engineering

with effect from Year 2024-25

Shahada Road, Near Nimzari Naka, Shirpur, Maharashtra 425405 Ph: 02563 259 802,
Web: www.rcpit.ac.in

Department of Mechanical Engineering
(Autonomous - 22)

Semester – V (w.e.f. 2024-25)

Sr	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)	Best of (TT1 & TT2)			
							[A]			[B]	[C]	[A+B+C]	
1	PC	22PCME5010T	Automotive Prime Movers	3	-	-	20	15	15	15	65	100	3
2	PC	22PCME5010L	Automotive Prime Movers Laboratory	-	-	2	25	-	-	-	-	25	1
3	PC	22PCME5020T	Heat Transfer	3	-	-	20	15	15	15	65	100	3
4	PC	22PCME5020L	Heat Transfer Laboratory	-	-	2	25	-	-	-	-	25	1
5	PC	22PCME5030T	Dynamics of Machinery	3	-	-	20	15	15	15	65	100	3
6	PC	22PCME5030L	Dynamics of Machinery Laboratory	-	-	2	25	-	-	-	-	25	1
7	PC	22PCME5040T	Industrial Electronics	3	-	-	20	15	15	15	65	100	3
8	PC	22PCME5040L	Industrial Electronics Laboratory	-	-	2	25	-	-	-	-	25	1
9	PC	22PCME5050L	Database Management Systems	-	-	2	25	-	-	-	25	50	1
10 #	PE	22PEME506_T	Professional Elective - I	3	-	-	20	15	15	15	65	100	3
11 #	PE	22PEME506_L	Professional Elective - I Laboratory	-	-	2	25	-	-	-	-	25	1
12	MC	22MCME5070T	Environmental Studies	1	-	-	-	-	-	-	-	-	-
12	PJ	22PJME5080L	Semester Project III	-	-	2	25	-	-	-	25	50	1
13	HM	22HMME5090L	Employability Skill Development Program- II	-	-	2	50	-	-	-	-	50	1
			Total	16	0	16	325	75	75	75	375	775	23

PC-Professional Course, PE- Professional Elective, MC-Mandatory Course, HM-Humanity and Management, PJ-Project

Any 1 Department Elective from given list.

Semester – V Professional Elective - I	
Course Code	**Course Title**
22PEME5061T	Advance Materials & Processes
22PEME5062T	Automobile Engineering
22PEME5063T	Reliability Engineering
22PEME5064T	Power Engineering
22PEME5065T	Data Analytics
22PEME5066T	Incubation, Entrepreneurship and Start-ups
22PEME5067T	Design Validation through Prototyping

Semester – V Professional Elective - I Laboratory	
Course Code	**Laboratory Title**
22PEME5061L	Advance Materials & Processes Laboratory
22PEME5062L	Automobile Engineering Laboratory
22PEME5063L	Reliability Engineering Laboratory
22PEME5064L	Power Engineering Laboratory
22PEME5065L	Data Analytics Laboratory
22PEME5066L	Incubation, Entrepreneurship and Start-ups Laboratory
22PEME5067L	Design Validation through Prototyping Laboratory

Prepared by
Prof. R. R. Ozarkar

Checked by
Prof. S. V. Yeole

BOS Chairman
Prof. P. L. Sarode

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

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

Director
Prof. Dr. J. B. Patil

R. C. Patel Institute of Technology, Shirpur
SES
Autonomous

Department of Mechanical Engineering
(Autonomous - 22)

Semester-VI (w.e.f. 2022-23)

Sr	Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme (CA)				ESE	Total	Credit
				L	T	P	TA	Term Test 1 (TT1)	Term Test 2 (TT2)	Best of (TT1 & TT2)			
							[A]			[B]	[C]	[A+B+C]	
1	PC	22PCME6010T	Design of Machine Elements	3	-	-	20	15	15	15	65	100	3
2	PC	22PCME6010L	Design of Machine Elements Laboratory	-	-	2	25	-	-	-	-	25	1
3	PC	22PCME6020T	Finite Element Analysis	3	-	-	20	15	15	15	65	100	3
4	PC	22PCME6020L	Finite Element Analysis Laboratory	-	-	2	25	-	-	-	-	25	1
5	PC	22PCME6030T	Control Systems	3	-	-	20	15	15	15	65	100	3
6	PC	22PCME6030L	Control Systems Laboratory	-	-	2	25	-	-	-	-	25	1
7	PE @	22PEME604_T	Professional Elective - II	3	-	-	20	15	15	15	65	100	3
8	PE @	22PEME604_L	Professional Elective - II Laboratory	-	-	2	25	-	-	-	-	25	1
9	HM $	22HMME6050T	Professional and Business Communication Tutorial	-	2	-	50	-	-	-	-	50	2
11	PC	22PCME6060L	CAD/CAM Laboratory	-	-	2	25	-	-	-	25	50	1
11	PJ	22PJME6070L	Project Stage I	-	-	4	25	-	-	-	25	50	2
			Total	12	2	14	280	60	60	60	310	650	21

PC-Professional Course, PE- Professional Elective, HM-Humanity and Management, PJ-Project

@Any 1 Department Elective from given list

Semester – VI Professional Elective - II	
Course Code	**Course Title**
22PEME6041T	Quality Engineering
22PEME6042T	Vehicle Dynamics and NVH
22PEME6043T	Mechanical Vibrations
22PEME6044T	Refrigeration and Air- conditioning
22PEME6045T	Machine Learning
22PEME6046T	Fundamentals of Business Development
22PEME6047T	Creative Engineering Design
22PEME6048T	Mechatronics

Semester – VI Professional Elective - II Laboratory	
Course Code	**Laboratory Title**
22PEME6041L	Quality Engineering Laboratory
22PEME6042L	Vehicle Dynamics and NVH Laboratory
22PEME6043L	Mechanical Vibrations Laboratory
22PEME6044L	Refrigeration and Air- conditioning Laboratory
22PEME6045L	Machine Learning Laboratory
22PEME6046L	Fundamentals of Business Development Laboratory
22PEME6047L	Creative Engineering Design Laboratory
22PEME6048L	Mechatronics Laboratory

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Prof. S. P. Shukla

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Shirpur Education Society's

R. C. Patel Institute of Technology, Shirpur

(An Autonomous Institute)

Syllabus Booklet

Third Year B.Tech in Mechanical Engineering

with effect from Year 2024-25

Shahada Road, Near Nimzari Naka, Shirpur, Maharashtra 425405 Ph: 02563 259 802,
Web: www.rcpit.ac.in

Automotive Prime Movers
(22PCME5010T)

Teaching Scheme	**Examination Scheme**
Lectures: 03 Hr/week	Term Test : 15 Marks
Tutorial: 00 Hr/week	Teacher Assessment : 20 Marks
Credit : 03	End Sem Exam : 65 Marks

Prerequisites:

Thermodynamics

Course Objectives

1. To study the components of an internal combustion engine and its systems.
2. To familiarize with different systems in SI & CI engines.
3. To analyze engine performance and emissions.
4. To acquaint with modern hybrid and electric powertrains.

Course Outcomes:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Explain the construction and working of internal combustion engines.	L2	Understand
CO2	Demonstrate the working systems of spark ignition & compression ignition engines.	L3	Apply
CO3	Demonstrate the engine cooling, lubrication, and supercharging systems.	L3	Apply
CO4	Analyze various engine performance parameters.	L4	Analy
CO5	Describe the different hybrid and electric powertrain systems.	L2	Understand

Course Contents

Unit-I 07 Hrs.

Introduction

Classification, components and materials of I.C. Engines, Four-stroke, two-stroke engines, Fuel-air cycles and their analysis, Actual working cycle, Valve timing diagram.
Spark Ignition (SI) Engines
Fuel supply system: Air-Fuel mixture requirements for steady state and transient operations.
Fuel Injection Systems: Single-point and Multipoint injection systems, Gasoline Direct Injection. Engine Control Unit (ECU), Important sensors & actuators, Open loop and closed loop modes of operation.
Ignition Systems: Battery ignition system, Magneto ignition system, Electronic ignition systems.
Combustion: Combustion phenomenon in SI Engines, Pressure-crank angle diagram, Abnormal combustion, Factors affecting combustion and detonation, Types of combustion chambers.

Unit-II 07 Hrs.

Compression Ignition (CI) Engines

Fuel Injection Systems: Fuel injection systems, Common rail, individual pump, distributor and unit systems, Types of nozzle, fuel atomization and spray structures, Electronically controlled unit fuel injection system. Load and speed control of CI engines.
Combustion: Combustion phenomenon in CI engines, Stages of combustion, Delay period, Knocking, Pressure-Crank angle diagram, Factors affecting combustion and knocking, Types of combustion chambers.

Unit-III 06 Hrs.

Engine Cooling Systems & Lubrication Systems

Engine Cooling Systems: Necessity of engine cooling, Cooling systems and their comparison: Air cooling, Liquid cooling, Troubleshooting & maintenance.
Engine Lubrication Systems: Types of lubricants and their properties, SAE rating of lubricants, Types of lubrication systems and their applications.
Supercharging/Turbo-charging: Objectives and limitations, Methods, types, and different arrangements of superchargers and turbochargers.

Unit-IV 09 Hrs.

Engine Performance & Emissions

Measurement and analysis of engine performance parameters, Performance characteristics of SI and CI engines, Effect of load and speed on engine performance & heat balance sheet. Emission control systems, Bharat Stage VI emission norms.
Alternative Fuels: Ethanol, Bio-diesel, CNG, LPG, Hydrogen - Merits, demerits, and engine modifications.
Recent Developments: Camless engine, Variable valve timing, Stratification in GDI engines, LHR engine, HCCI engine & six-stroke engine.

Unit-V 05 Hrs.

Hybrid Powertrain

Hybrid Powertrain Architecture, Hybrid Powertrain Performance - Series architecture and Parallel architecture, Hybrid Power System Components, Degree of hybridization, Regenerative Braking, Hybrid Power System Components – Battery, Hybrid Powertrain Energy Management.

Unit-VI 05 Hrs.

Electric Powertrain

Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, Configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, Drive system efficiency.

Books Recommended

Textbooks:

1 V. Ganesan, 'Internal Combustion Engine', 4th Edition, 2017, McGraw Hill

2 Mathur and Sharma, 'Internal Combustion Engine', 2014, Dhanpat Rai Publications

3 H. N. Gupta, 'Internal Combustion Engines', 2nd Edition, 2012, PHI

4 R. K. Rajput, 'Internal Combustion Engines', 3rd Edition, 2016, Laxmi Publications

5 Tom Denton, 'Automotive Electrical and Electronic Systems', 5th Edition, 2017, Routledge

Reference Books:

1 Tom Denton, 'Automotive Electrical and Electronic Systems', 5th Edition, 2017, Routledge

2 Colin Ferguson and Allan Kirkpatrick, 'Internal Combustion Engines', 2nd Edition, Wiley India Pvt. Ltd

3 Willard W. Pulkrabek, 'Internal Combustion Engines', 2nd Edition, 2013, Pearson Education

4 Richard Stone, 'Introduction to Internal Combustion Engines', 4th Edition, 2012, Palgrave Publication

5 Mehrdad, Yimin, Sebastian, Ali, 'Modern Electric, Hybrid Electric, and Fuel Cell Vehicles', 3rd Edition, CRC Press

Evaluation Scheme

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of the semester.

Continuous Assessment (B):

1. Two term tests of 15 marks each will be conducted during the semester.
2. Total duration allotted for writing each of the papers is 1 hour.
3. Best of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper will be based on the entire syllabus summing up to 65 marks.
2. Total duration allotted for writing the paper is 2 hours.

Automotive Prime Movers Laboratory (22PCME5010L)

Teaching Scheme	**Examination Scheme**
Practical : 02 Hrs./week	Teacher Assessment: 25 Marks
Credit : 01	End Sem Exam : 00 Marks

Prerequisites:

Thermodynamics

Objectives

1. To study the components of an internal combustion engine and its systems.
2. To familiarize with different systems in SI & CI engines.
3. To analyze engine performance and emissions.
4. To acquaint with modern hybrid and electric powertrains.

Course Outcomes:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Explain the construction and working of internal combustion engines.	L2	Understand
CO2	Demonstrate the working systems of spark ignition & compression ignition engines.	L3	Apply
CO3	Demonstrate the engine cooling, lubrication, and supercharging systems.	L3	Apply
CO4	Analyze various engine performance parameters.	L4	Analy
CO5	Describe the different hybrid and electric powertrain systems.	L2	Understand

Suggested Experiments

1 Study of components of an internal combustion engine
2 Estimation of valve timing for four SI / CI Engine.
3 Study of ignition system of SI engines.
4 Study of fuel injection system in CI engines
5 Analysis of supercharging and turbocharging of I C engines.
6 Load Test on CI engine.
7 Speed Test on SI engine.
8 Heat Balance test on SI or CI engines
9 Experimental determination of friction power of multi-cylinder SI engine using Morse test method.
10 Experimental determination of Air fuel ratio and volumetric efficiency of the engine.
11 Simulation of electric/hybrid powertrain on MATLAB Simulink software.
12 Study of electric motor test methods.

Minimum eight 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 V. Ganesan, 'Internal Combustion Engine', 4th Edition, 2017, McGraw Hill
2 Mathur and Sharma, 'Internal Combustion Engine', 2014, Dhanpat Rai Publications
3 H. N. Gupta, 'Internal Combustion Engines', 2nd Edition, 2012, PHI
4 R. K. Rajput, 'Internal Combustion Engines', 3rd Edition, 2016, Laxmi Publications
5 Tom Denton, 'Automotive Electrical and Electronic Systems', 5th Edition, 2017, Routledge

Reference Books:

1 Tom Denton, 'Automotive Electrical and Electronic Systems', 5th Edition, 2017, Routledge
2 Colin Ferguson and Allan Kirkpatrick, 'Internal Combustion Engines', 2nd Edition, Wiley India Pvt. Ltd
3 Willard W. Pulkrabek, 'Internal Combustion Engines', 2nd Edition, 2013, Pearson Education
4 Richard Stone, 'Introduction to Internal Combustion Engines', 4th Edition, 2012, Palgrave Publication
5 Mehrdad, Yimin, Sebastian, Ali, 'Modern Electric, Hybrid Electric, and Fuel Cell Vehicles', 3rd Edition, CRC Press

Evaluation Scheme

Continuous Assessment (A): Term work shall consist of minimum 8 experiments.

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks
4. Subject Specific Lab Assignment/Case Study: 10 Marks

The final certification and acceptance of laboratory journal/manual/report will be subject to satisfactory performance of Laboratory work and upon fulfilling minimum passing criteria in the teacher assessment.

Heat Transfer
(22PCME5020T)

Teaching Scheme	**Examination Scheme**
Lectures: 03 Hr/week	Term Test : 15 Marks
Tutorial: 00 Hr/week	Teacher Assessment : 20 Marks
Credit : 03	End Sem Exam : 65 Marks

Prerequisites:

1. Engineering Mathematics
2. Engineering Thermodynamics
3. Fluid Mechanics

Course Objectives

1. To introduce the basic principles of heat transfer and steady state conduction.
2. To determine heat transfer from extended surfaces and unsteady state conduction.
3. To familiarize with the principles of convection and the significance of dimensionless numbers.
4. To introduce different types of heat exchangers and their analysis.
5. To describe the principles of radiation heat transfer.
6. To practice computational techniques used in heat transfer and their applications.

Course Outcomes

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Apply the principles of heat transfer to solve problems related to steady state conduction.	L3	Apply
CO2	Analyze and solve problems involving heat transfer from extended surfaces and unsteady state conduction.	L4	Analyze
CO3	Apply the principles of convection to solve heat transfer problems.	L3	Apply
CO4	Design and analyze heat exchangers for various applications.	L4	Analyze
CO5	Apply the principles of radiation to solve heat transfer problems.	L3	Apply
CO6	Apply various numerical methods to solve heat transfer problems.	L3	Apply

Course Contents

Unit-I 07 Hrs.

Introduction and One-Dimensional Steady State Conduction

Introduction: Thermodynamics and Heat Transfer, Applications of Heat Transfer, Basic Modes of Heat Transfer, Physical Mechanism of Heat Transfer, Fourier's Law of Heat Conduction, Newton's Law of Cooling, Stefan-Boltzmann Law.

One-Dimensional Steady State Conduction: Thermal Conductivity, Variation of Thermal Conductivity in Solids, Liquids, and Gases, Thermal Diffusivity, General Heat Conduction Equation, Electrical Network Analogy, Boundary and Initial Conditions, Steady State Heat Conduction in Walls, Cylinders, and Spheres, Thermal Contact Resistance, Critical Thickness of Insulation.

Unit-II 06 Hrs.

Heat Transfer from Extended Surface and Unsteady State Conduction

Heat transfer from Extended Surface: Types of fins and their applications, Heat transfer from finned surface of uniform cross-sectional area, effectiveness and efficiency of fins, proper length of a fin.

Unsteady State Conduction: Lumped Capacitance method, Biot number, Fourier number and their significance, Heisler charts.

Unit-III 06 Hrs.

Convection

Natural and Forced Convection, Hydrodynamic and Thermal Boundary Layers, Heat Transfer Coefficient, Principle of Dimensional Analysis, Buckingham's Theorem, Application of Buckingham's π Theorem to Forced and Natural Convection, Physical Significance of Dimensionless Numbers, Nusselt Number, Grashof Number, Prandtl Number, Reynolds Number, and Stanton Number, Empirical Relations for Free and Forced Convection for Standard Cases.

Unit-IV 07 Hrs.

Heat Exchangers and Boiling/Condensation

Heat Exchangers: Types of Heat Exchangers, Overall Heat Transfer Coefficient, Fouling Factor, Heat Exchanger Analysis using Log Mean Temperature Difference and Effectiveness- NTU method, Selection of heat exchangers, Compact heat exchangers.

Boiling and Condensation: Boiling heat transfer, Pool boiling, Boiling Regimes and Boiling Curve, Flow boiling, Condensation heat transfer, Film condensation, Dropwise Condensation.

Unit-V 07 Hrs.

Radiation

Emissive power, Emissivity, Irradiation, Radiosity, Absorptivity, Reflectivity and Transmissivity, Black body, Grey body, Opaque body, Kirchhoff's law, Planck's law, Wein's displacement law, Lambert cosine law, Intensity of Radiation, Solid Angle, Radiation heat exchange between two black and gray surfaces, View factor, View Factor relations, Application of Electrical Analogy to thermal radiation heat exchange between two parallel infinite plates, concentric infinitely long cylinders, and two concentric spheres, Radiation shields.

Unit-VI* (NOT INCLUDED IN ESE) 06 Hrs.

Computational Techniques in Heat Transfer

Overview of computational techniques in heat transfer, Importance and applications, Numerical Methods in Heat Transfer: Finite Difference Method, Finite Element Method, and Finite Volume Method, Central, Forward, and Backward difference expressions for a uniform grid, Numerical errors, Finite difference solution for a one-dimensional steady state problem using Gaussian elimination and Gauss-Seidel iterative methods, Finite difference solution for transient one-dimensional problems: Euler, Crank-Nicolson, and pure implicit methods, Accuracy, stability of transient heat transfer problems.

((*) This module is not included in the End Semester Examination. Instead, students are required to submit two assignments. The first assignment involves modeling a steady state heat transfer problem, while the second one involves an unsteady state heat transfer problem. Students must validate their results with analytical calculations. These assignments will serve as a practical evaluation of the students' ability to apply computational techniques in heat transfer problems.)

Books Recommended

Textbooks:

1. Yunus Cengel and Afshin Ghajar, 'Heat and Mass Transfer: Fundamentals and Applications', 6th Edition, McGraw Hill, 2020.
2. P. S. Ghoshdastidar, 'Heat Transfer', Second Edition, Oxford University Press, 2012.
3. R.K. Rajput, 'A Textbook of Heat and Mass Transfer (SI Units)', S. Chand, 2018.

Reference Books:

1. Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt, 'Fundamentals of Heat and Mass Transfer', 8th Edition, Wiley, 2018.
2. S.P. Sukhatme, 'Textbook of Heat Transfer', Fourth Edition, Universities Press, 2005.
3. C.P. Kothandaraman, 'Fundamentals of Heat and Mass Transfer', 4th Edition, New Age International Press, 2012.
4. Dr. D.S. Kumar, S.K. Kataria, 'Basics of Heat and Mass Transfer', 2018.

Evaluation Scheme

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of the semester.

Continuous Assessment (B):

1. Two term tests of 15 marks each will be conducted during the semester.
2. Total duration allotted for writing each of the papers is 1 hour.
3. Best of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper will be based on the entire syllabus summing up to 65 marks.
2. Total duration allotted for writing the paper is 2 hours.

Heat Transfer Laboratory

(22PCME5020L)

Teaching Scheme	**Examination Scheme**
Practical : 02 Hrs./week	Teacher Assessment: 25 Marks
Credit : 01	End Sem Exam : 00 Marks

Prerequisites:

1. Engineering Mathematics
2. Engineering Thermodynamics
3. Fluid Mechanics

Course Objectives

1. To introduce the basic principles of heat transfer and steady state conduction.
2. To determine heat transfer from extended surfaces and unsteady state conduction.
3. To familiarize with the principles of convection and the significance of dimensionless numbers.
4. To introduce different types of heat exchangers and their analysis.
5. To describe the principles of radiation heat transfer.
6. To practice computational techniques used in heat transfer and their applications.

Course Outcomes

CO	**Course Outcomes**	**Bloom's Level**	**Bloom's Description**
CO1	Apply the principles of heat transfer to solve problems related to steady state conduction.	L3	Apply
CO2	Analyze and solve problems involving heat transfer from extended surfaces and unsteady state conduction.	L4	Analyze
CO3	Apply the principles of convection to solve heat transfer problems.	L3	Apply
CO4	Design and analyze heat exchangers for various applications.	L4	Analyze
CO5	Apply the principles of radiation to solve heat transfer problems.	L3	Apply
CO6	Apply various numerical methods to solve heat transfer problems.	L3	Apply

Suggested Experiments

1 Thermal conductivity of solid/liquid

2 Heat transfer coefficient in natural convection heat transfer

3 Heat transfer coefficient in forced convection heat transfer

4 Unsteady state heat transfer in cylinder/rod/wall

5 Fin efficiency and fin effectiveness

6 Critical heat flux

7 Overall heat transfer coefficient and effectiveness of heat exchanger

8 Stefan-Boltzmann apparatus

9 Emissivity of Grey surface

10 Numerical modelling of any heat transfer problem using FDM

Minimum seven 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. Yunus Cengel and Afshin Ghajar, 'Heat and Mass Transfer: Fundamentals and Applications', 6th Edition, McGraw Hill, 2020.
2. P. S. Ghoshdastidar, 'Heat Transfer', Second Edition, Oxford University Press, 2012.
3. R.K. Rajput, 'A Textbook of Heat and Mass Transfer (SI Units)', S. Chand, 2018.

Reference Books:

1. Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt, 'Fundamentals of Heat and Mass Transfer', 8th Edition, Wiley, 2018.
2. S.P. Sukhatme, 'Textbook of Heat Transfer', Fourth Edition, Universities Press, 2005.
3. C.P. Kothandaraman, 'Fundamentals of Heat and Mass Transfer', 4th Edition, New Age International Press, 2012.
4. Dr. D.S. Kumar, S.K. Kataria, 'Basics of Heat and Mass Transfer', 2018.

Evaluation Scheme

The distribution of marks shall be as follows:

Continuous Assessment (A):

Term work shall consist of minimum 7 experiments.

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks
4. Subject Specific Lab Assignment/Case Study: 10 Marks

The final certification and acceptance of laboratory journal/manual/report will be subject to satisfactory performance of Laboratory work and upon fulfilling minimum passing criteria in the teacher assessment.

Dynamics of Machinery

(22PCME5030T)

Teaching Scheme	**Examination Scheme**
Lectures: 03 Hr/week	Term Test : 15 Marks
Tutorial: 00 Hr/week	Teacher Assessment : 20 Marks
Credit : 03	End Sem Exam : 65 Marks

Pre-requisites:

1. Engineering Mechanics
2. Strength of Materials
3. Kinematics of Machinery

Course Objectives

1. To acquaint with working principles and applications of Gyroscope.
2. To study static and dynamic force analysis in mechanisms.
3. To familiarize with basics of mechanical vibrations.
4. To study the balancing of mechanical systems.

Course Outcomes:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Analyze the effect of gyroscopic couple on various applications.	L4	Analyze
CO2	Analyze forces and torques that act on mechanisms.	L4	Analyze
CO3	Determine vibration response of free undamped systems.	L3	Apply
CO4	Determine vibration response of free damped systems.	L3	Apply
CO5	Determine vibration response of systems subjected to forced vibrations.	L3	Apply
CO6	Apply the principles of force and couple balancing to solve engineering problems.	L3	Apply

Course Contents

Unit-I 06 Hrs.

Static and Dynamic Force Analysis

Analysis of slider crank mechanism (neglecting mass of connecting rod and crank), Turning moment on crank shaft, fluctuation of energy, flywheel analysis - fluctuation of speed, energy stored, dimensions of flywheel rims, dynamically equivalent systems to convert rigid body into two masses with and without correction couple.

Unit-II 05 Hrs.

Gyroscope

Gyroscopic couple and its effect on spinning bodies, naval ships during steering, pitching, rolling and their stabilization, Effect of gyroscopic and centrifugal couples on vehicles moving along a curved path, permissible speeds on curved paths.

Unit-III 06 Hrs.

Rotor Dynamics and Balancing

Unbalance in machines, Critical speed of shaft with single rotor, Static and dynamic balancing of multi rotor system (up to four rotors), Balancing of reciprocating masses in In-line engines (up to four cylinders), Balancing machines.

Unit-IV 07 Hrs.

Basic Concepts of Vibration

Vibration and oscillation, causes and effects of vibrations, Vibration parameters - springs, mass, damper, Motion- periodic, non-periodic, degree of freedom, static equilibrium position, vibration classification, steps involved in vibration analysis.

Free Undamped Single Degree of Freedom Vibration System

Longitudinal, transverse, torsional vibration system, Methods for formulation of differential equations by Newton, Energy, Lagrangian and Rayleigh's method.

Unit-V 07 Hrs.

Free Damped Single Degree of Freedom Vibration System

Introduction to different methods of damping, Study and analysis of viscous damped system (under damped, critically damped, over damped; logarithmic decrement), Coulomb's damping.

Unit-VI 08 Hrs.

Forced Single Degree of Freedom Vibratory System

Analysis of linear and torsional systems subjected to harmonic force excitation and harmonic motion excitation (excluding elastic damper).

Vibration Isolation and Transmissibility

Force Transmissibility and isolation, Typical isolators & mounts.

Vibration Measuring Instruments

Principle of seismic instruments, Vibrometer, Accelerometer - undamped and damped, Case studies on diagnostics maintenance and condition-based monitoring approach.

Books Recommended

Textbooks:

1. S. S. Ratan, 'Theory of Machines', Tata McGraw Hill
2. J. K. Gupta and R. S. Khurmi, 'Theory of Machines', S. Chand Publishing

Reference Books:

1. Thomas Bevan, 'Theory of Machines', CSB Publishers Distributors
2. Jagdishlal, 'Theory of Machines', Metropolitan Book New Delhi
3. P. L. Bellaney, 'Theory of Machines', Khanna publication
4. John J. Uicker, Gordon R. Pennock and Joseph E. Shigley, 'Theory of Machines and Mechanisms', Oxford University Press
5. W. Thomson, 'Theory of Vibration with Applications', Pearson Education
6. S. S. Rao, 'Mechanical Vibrations', Pearson Education
7. S. Graham Kelly, 'Fundamentals of Mechanical Vibration', Tata McGraw Hill
8. Benson H Tongue, 'Principles of Vibration', 2nd Edition, Oxford University Press
9. William W. Seto, 'Mechanical Vibrations- Schaum's outline series', McGraw Hill
10. J. S. Rao and K. Gupta, 'Theory and Practice of Mechanical Vibrations', New Age International

Evaluation Scheme

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of the semester.

Continuous Assessment (B):

1 Two term tests of 15 marks each will be conducted during the semester.

2 Total duration allotted for writing each of the papers is 1 hour.

3 Best of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1 Question paper will be based on the entire syllabus summing up to 65 marks.

2 Total duration allotted for writing the paper is 2 hours.

Dynamics of Machinery Laboratory (22PCME5030L)

Teaching Scheme	**Examination Scheme**
Practical : 02 Hrs./week	Teacher Assessment: 25 Marks
Credit : 01	End Sem Exam : 00 Marks

Pre-requisites:

1. Engineering Mechanics
2. Strength of Materials
3. Kinematics of Machinery

Course Objectives

1. To acquaint with working principles and applications of Gyroscope.
2. To study static and dynamic force analysis in mechanisms.
3. To familiarize with basics of mechanical vibrations.
4. To study the balancing of mechanical systems.

Course Outcomes:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Analyze the effect of gyroscopic couple on various applications.	L4	Analyze
CO2	Analyze forces and torques that act on mechanisms.	L4	Analyze
CO3	Determine vibration response of free undamped systems.	L3	Apply
CO4	Determine vibration response of free damped systems.	L3	Apply
CO5	Determine vibration response of systems subjected to forced vibrations.	L3	Apply
CO6	Apply the principles of force and couple balancing to solve engineering problems.	L3	Apply

Suggested Experiments

1 Experiments on Governors- Porter Governor, Hartnell Governor

2 Experimental verification of principle of Gyroscopic couple

3 Determine natural frequency of compound pendulum, equivalent simple pendulum system

4 Determine natural frequency for longitudinal vibrations of helical springs

5 Determine natural frequency and nodal points for single rotor and two-rotor vibratory system

6 Experiment on whirling of shaft

7 Determination of damping coefficient of any system/media

8 Experimental balancing of single and multi-rotor system

9 Measurement of vibration response of a system

10 Condition monitoring using FFT analyzer

11 Vibration analysis of mechanical system using MATLAB/SCILAB/Python

Minimum eight 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.
Mini project/Assignments relevant to the subject may be included, which would help the learner to apply the concept learnt.

Books Recommended

Textbooks:

1. S. S. Ratan, 'Theory of Machines', Tata McGraw Hill
2. J. K. Gupta and R. S. Khurmi, 'Theory of Machines', S. Chand Publishing

Reference Books:

1. Thomas Bevan, 'Theory of Machines', CSB Publishers Distributors
2. Jagdishlal, 'Theory of Machines', Metropolitan Book New Delhi
3. P. L. Bellaney, 'Theory of Machines', Khanna publication
4. John J. Uicker, Gordon R. Pennock and Joseph E. Shigley, 'Theory of Machines and Mechanisms', Oxford University Press
5. W. Thomson, 'Theory of Vibration with Applications', Pearson Education
6. S. S. Rao, 'Mechanical Vibrations', Pearson Education
7. S. Graham Kelly, 'Fundamentals of Mechanical Vibration', Tata McGraw Hill
8. Benson H Tongue, 'Principles of Vibration', 2nd Edition, Oxford University Press
9. William W. Seto, 'Mechanical Vibrations- Schaum's outline series', McGraw Hill
10. J. S. Rao and K. Gupta, 'Theory and Practice of Mechanical Vibrations', New Age International

Evaluation Scheme

Continuous Assessment (A):

Term work shall consist of minimum 8 experiments.

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks
4. Subject Specific Lab Assignment/Case Study: 10 Marks

The final certification and acceptance of laboratory journal/manual/report will be subject to satisfactory performance of Laboratory work and upon fulfilling minimum passing criteria in the teacher assessment.

Industrial Electronics
(22PCME5040T)

Teaching Scheme	**Examination Scheme**
Lectures: 03 Hr/week	Term Test : 15 Marks
Tutorial: 00 Hr/week	Teacher Assessment : 20 Marks
Credit : 03	End Sem Exam : 65 Marks

Prerequisite:

Knowledge of basic electronic devices like Semiconductor Diodes

Course Objectives

1. To study power electronic switches and circuits and their applications.
2. To familiarize with Op-amp and digital circuits and their applications.
3. To acquaint with the basics of microcontrollers.
4. To study the working of Sensors and Motors.

Course Outcomes

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Illustrate construction, working principles and applications of power electronic switches.	L2	Understand
CO2	Identify rectifiers and inverters for DC and AC motor speed control.	L3	Apply
CO3	Identify digital circuits for industrial applications.	L3	Apply
CO4	Develop circuits using OPAMP and timer IC555.	L5	Create
CO5	Analyze and suggest application-specific sensors and motors.	L4	Analyze

Course Contents

Unit-I 08 Hrs.

Semiconductor Devices

Review of diodes, V-I characteristics and Applications of: rectifier diode, zener diode, LED, photodiode; SCR V-I characteristics, UJT triggering circuit, turning-off of a SCR (preliminary discussion), basics of Gate Turn Off (GTO), Structure and V-I characteristics of Triac (modes of operation not needed) and Diac, Applications of Triac-Diac circuit; Characteristics of Power BJT, power MOSFET, IGBT; Comparison of SCR, Triac, Power BJT, power MOSFET, IGBT

Unit-II 08 Hrs.

Phase-Controlled Rectifiers and Bridge Inverters

Half and Full wave controlled rectifiers using SCRs with R load only, H-Bridge for DC Motor, Block diagram of closed-loop speed control of DC motors, Basic principle of single phase and three phase bridge inverters, block diagrams including rectifier and inverter for speed control of AC motors (frequency control only)

Unit-III 08 Hrs.

Elements of Signal Conditioning

Amplifiers, Attenuators, Filter Circuits

Operational amplifier: Ideal and Practical OPAMP Characteristics, Basic OPAMP circuits- Inverting amplifier, Non-inverting amplifier, Voltage follower (Buffer), Comparator, Instrumentation Amplifier, Active filters; Power Op Amps, IC-555 timer-Operating modes: monostable, astable multivibrator

Unit-IV 08 Hrs.

Digital Logic and Microcontrollers

Boolean algebra and logic gates. TTL and CMOS logic families, Multiplexer and Demultiplexer applications, Flip flops: Set Reset (SR), Trigger (T), clocked F/Fs; Overview of generic microprocessor and Microcontrollers, Comparison of microprocessor and microcontroller, Features of Microcontroller General purpose i/o toggle and its applications, Interrupts and ISR, Analog to digital converter, Serial communications - UART, SPI and I2C, Timer module, precise delay generation, timer waveforms, counting applications, Interrupt and polling mode of control.

Basics of interfacing with external input/output devices (like reading external analog voltages, digital input-output)

Applications of the microcontroller: Temperature measurement, Speed Measurement, Solenoid, Relay, Motor Control, etc.

Unit-V 07 Hrs.

Sensors and Motors

Industrial Sensors: Displacement, temperature, acceleration, force/pressure and optical sensors, static and dynamic characteristics.

Motors: Review and comparison of DC motors and AC induction motors, Basic principles of speed control of DC motor, microcontroller-based speed control for DC Motor. Basic principles of speed control of AC induction motor, Basics of BLDC motor, Linear Actuators, Servo Motor; Motor Specifications, suitability of each motor for various industrial applications, Selection and sizing of motors for different applications.

Applications for pumps, conveyors, machine tools

Books Recommended

Textbooks:

1 Power Electronics by M.H. Rashid, Prentice-Hall of India

2 Power Electronics by P. S. Bhimbra

3 Power Electronics by Vedam Subramanyam, New Age International

4 Power Electronics by Ned Mohan, Undeland, Robbins, John Wiley Publication

5 Electronic Devices and Circuits by Robert Boylestad and Louis Nashelsky, Prentice-Hall

6 Industrial Electronics and Control by S.K. Bhattacharya, S. Chatterjee, TTTI Chandigarh

7 Modern Digital Electronics by Jain R. P., Tata McGraw Hill

8 Digital Principles and Applications by Malvino and Leach, Tata McGraw Hill

9 Fundamentals of Microcontrollers and Embedded Systems by Ramesh Gaonkar, PENRAM

10 MSP430 Microcontroller Basics by John H. Davies, Newnes

11 Modern Control Engineering by Ogata, Prentice Hall

12 Control Systems by Dhanes Manik, Cengage Learning

13 Engineering Metrology and Measurements by N.V. Raghavendra and L. Krishnamurthy, Oxford University Press

14 Instrumentation and Control Systems by W. Bolton, Elsevier

Evaluation Scheme Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of the semester.

Continuous Assessment (B):

1 Two term tests of 15 marks each will be conducted during the semester.

2 Total duration allotted for writing each of the papers is 1 hour.

3 Best of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1 Question paper will be based on the entire syllabus summing up to 65 marks.

2 Total duration allotted for writing the paper is 2 hours.

Industrial Electronics Laboratory

(22PCME5040T)

Teaching Scheme	**Examination Scheme**
Practical : 02 Hrs./week	Teacher Assessment: 25 Marks
Credit : 01	End Sem Exam : 00 Marks

Prerequisite:

Knowledge of basic electronic devices like Semiconductor Diodes

Course Objectives

1. To study power electronic switches and circuits and their applications.
2. To familiarize with Op-amp and digital circuits and their applications.
3. To acquaint with the basics of microcontrollers.
4. To study the working of Sensors and Motors.

Course Outcomes

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Illustrate construction, working principles and applications of power electronic switches.	L2	Understand
CO2	Identify rectifiers and inverters for DC and AC motor speed control.	L3	Apply
CO3	Identify digital circuits for industrial applications.	L3	Apply
CO4	Develop circuits using OPAMP and timer IC555.	L5	Create
CO5	Analyze and suggest application-specific sensors and motors.	L4	Analyze

Suggested Experiments

1 Study on MOSFET / IGBT as a switch
2 Study on Single phase Bridge inverter with rectifier load
3 Study on OPAMP as integrator
4 Implementing study of gates and Logic Operations like, NOT, AND, OR
5 Realization of basic gates using universal gates
6 Light dimmer circuit using Diac-Triac
7 Speed control of DC motor
8 Simple microcontroller-based applications like Temp Measurement/ Speed Measurement using Proximity
9 Speed control of induction motor
10 Speed control of BLDC motor
11 Study of Sensors kit

Minimum of eight 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 Power Electronics by M.H. Rashid, Prentice-Hall of India
2 Power Electronics by P. S. Bhimbra
3 Power Electronics by Vedam Subramanyam, New Age International
4 Power Electronics by Ned Mohan, Undeland, Robbins, John Wiley Publication
5 Electronic Devices and Circuits by Robert Boylestad and Louis Nashelsky, Prentice-Hall
6 Industrial Electronics and Control by S.K. Bhattacharya, S. Chatterjee, TTTI Chandigarh
7 Modern Digital Electronics by Jain R. P., Tata McGraw Hill
8 Digital Principles and Applications by Malvino and Leach, Tata McGraw Hill
9 Fundamentals of Microcontrollers and Embedded Systems by Ramesh Gaonkar, PENRAM
10 MSP430 Microcontroller Basics by John H. Davies, Newnes
11 Modern Control Engineering by Ogata, Prentice Hall
12 Control Systems by Dhanes Manik, Cengage Learning
13 Engineering Metrology and Measurements by N.V. Raghavendra and L. Krishnamurthy, Oxford University Press
14 Instrumentation and Control Systems by W. Bolton, Elsevier

Evaluation Scheme

Continuous Assessment (A):

Term work shall consist of minimum 8 experiments.

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks
4. Subject Specific Lab Assignment/Case Study: 10 Marks

The final certification and acceptance of laboratory journal/report will be subject to satisfactory performance of Laboratory work and upon fulfilling minimum passing criteria in the teacher assessment.

Database Management System Laboratory (22PCME5050L)

Teaching Scheme	**Examination Scheme**
Practical : 02 Hrs./week	Teacher Assessment: 25 Marks
Credit : 01	End Sem Exam : 25 Marks

Prerequisite:

Computer Basics

Course Objectives

1. To introduce students to the management of database systems.
2. To emphasize the design, organization, maintenance, and retrieval of information from a database.

Course Outcomes

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Design an optimized database.	L6	Create
CO2	Construct SQL queries to perform operations on the database.	L6	Create
CO3	Demonstrate the concept of transaction, concurrency, and recovery.	L2	Understand

Course Content

Unit-I 03 Hrs.

Introduction to Database Concepts

Introduction, Characteristics of databases, File system vs Database system, Users of Database system, Schema and Instance, Data Independence, DBMS system architecture, Database Administrator.

Unit-II 05 Hrs.

Entity–Relationship Model

Introduction, Entity types, Entity sets, weak and strong entity, types of attributes, keys, and relationships, Relationship constraints: cardinality and participation, Generalization and specialization, Mapping the ER Model to the Relational Model.

Unit-III 10 Hrs.

Structured Query Language (SQL)

Overview of SQL, Data Definition Commands, Data Manipulation commands, Integrity constraints - key constraints, Domain Constraints, Referential integrity, check constraints, Data Control commands, Transaction Control Commands, Set and String operations, aggregate function - group by, having, Views in SQL, joins, Nested and complex queries, Triggers.

Unit-IV 04 Hrs.

Relational–Database Design

Pitfalls in Relational-Database designs, Concept of normalization, Function Dependencies, Normal Forms- 1NF, 2NF, 3NF, BCNF.

Unit-V 04 Hrs.

Transaction Management and Recovery

Transaction Concept, ACID properties, Transaction States, Implementation of atomicity and durability, Concurrent Executions, Serializability, Concurrency Control Protocols: Lock-based, Timestamp based, Log based recovery.

Experimental Suggested Experiments

1. To draw an ER diagram for a problem statement and map the ER diagram to relations.
2. To implement DDL and DML queries.
3. Write queries using aggregate functions.
4. Write queries using Joins.
5. Write queries using sub-queries.
6. To implement Integrity Constraints.
7. To implement triggers.
8. To Study and Implement TCL Commands.
9. Examine the consistency of database using concurrency control technique (Locks).
10. Case Study for a specific product/process:
    1. Schema Design
    2. Database instance on cloud.
       Build visualizations using SQL Queries.

Minimum eight 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. Korth, Silberschatz, Sudarshan, "Database System Concepts", 7th Edition, McGraw-Hill, 2019.
2. Elmasri and Navathe, "Fundamentals of Database Systems", 7th Edition, Pearson Education, 2021.
3. G. Peter Rob and Carlos Coronel, "Database Systems Design, Implementation and Management", 5th Revised Edition, Thomson, 2002.
4. G. K. Gupta, "Database Management Systems", 3rd Edition, McGraw-Hill, 2018.

Reference Books:

1. Dr. P.S. Deshpande, "SQL and PL/SQL for Oracle 10g, Black Book", Dreamtech Press, 2012.
2. Sharanam Shah, Vaishali Shah, "Oracle for Professional", 1st Edition, Shroff Publishers Distributors Private Limited, 2008.
3. Raghu Ramakrishnan and Johannes Gehrke, "Database Management Systems", 3rd Edition, McGraw-Hill, 2014.
4. Patrick Dalton, "Microsoft SQL Server Black Book", 11th Edition, Coriolis Group, U.S., 1997.
5. Lynn Beighley, "Head First SQL", 1st Edition, O'Reilly Media, 2007.

Evaluation Scheme

Continuous Assessment (A):

Term work shall consist of minimum 8 experiments

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks

End Semester Examination (C):

Oral & Practical examination will be based on the entire syllabus including, the practicals performed during Laboratory sessions.

The final certification and acceptance of laboratory journal/report will be subject to satisfactory performance of Laboratory work and upon fulfilling minimum passing criteria in the teacher assessment.

Advanced Materials and Processes (22PEME5061T)

Teaching Scheme	**Examination Scheme**
Lectures: 03 Hr/week	Term Test : 15 Marks
Tutorial: 00 Hr/week	Teacher Assessment : 20 Marks
Credit : 03	End Sem Exam : 65 Marks

Prerequisites:

1. Engineering Materials
2. Manufacturing Processes

Course Objectives

1. To provide comprehensive exposure to new and advanced materials such as smart materials, high temperature materials, nanomaterials, energy storage materials, etc.
2. To familiarize students with the development of new materials and processes to meet real-world application requirements of real world.

Course Outcomes:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Understand the stimuliresponse behavior of various smart materials along with their properties and processing.	L2	Understand
CO2	Select an appropriate smart material and analyze it for applications such as sensors, actuators, self-healing, and health monitoring of structures.	L3	Apply
CO3	Understand the behavior of material at elevated temperatures and select an appropriate material for high temperature applications.	L2	Understand
CO4	Correlate structure, properties, and synthesis of nanostructured materials and biomaterials, and appreciate their engineering importance.	L4	Analyze
CO5	Demonstrate various materials and methods for energy storage and harvesting.	L3	Apply

Course Contents

Unit-I 09 Hrs.

Smart Materials – Part I

Introduction: Concept of smart and intelligent materials, Overview and classification, Active and passive smart materials, HBLS and LBHS materials, Applications for sensors and actuators (mechatronic aspect).
Shape Memory Alloys: Brief history, Shape memory materials and their properties, One-way and two-way shape memory effect, Pseudo elasticity and pseudo plasticity effect, Examples, Applications and related manufacturing processes.
Piezoelectric Materials: Piezoelectricity, Materials- processing properties, piezoelectric effects, Constituent equations and Applications.
Structural Health Monitoring: Integration of smart materials into structures.

Unit-II 09 Hrs.

Smart Materials – Part II

Brief overview, Related materials – composition, properties processing, Effects, Constituting or governing equations and Industrial applications associated with the following smart materials:
Magnetorheological Electrorheological fluids, Magnetostrictive Electrostrictive materials, Electroactive polymers (EAP's): IPMC's, Dielectric polymers, Conductive polymers etc., Soft matter, Smart composites: Active fiber composites/smart polymer matrix composites.

Unit-III 07 Hrs.

High Temperature Materials & Super Alloys

Introduction, Materials behavior at high temperature, Characteristics of high temperature materials, their composition, properties and applications (Steels, intermetallic, ceramics and composites).
Super Alloys: Common features, synthesis and applications of Ni and Co based super alloys.

Unit-IV 09 Hrs.

Nanomaterials and Biomaterials

Nanomaterials: Concept, classification, Size effect on structural and functional properties, Synthesis of nanomaterials – Top down and bottom up approaches, Issues and applications of nanomaterials in various industries, Special nanostructures (Fullerene, Graphene, Carbon nanotubes etc) and their application, Nanocomposites and Nanotechnology.
Biomaterials: Need for biomaterials, biocompatibility, types of biomaterials and applications in orthopedic, dental, cardiovascular and biomedical devices.

Unit-V 07 Hrs.

Materials for Energy Storage and Harvesting

Materials used for storage and conversion of various sources of energy such as electrical, electrochemical, photo-electrochemical, thermal, and mechanical energy.
Smart materials for energy harvesting.
Hydrogen storage materials.

Unit-VI 06 Hrs.

Processes Applied for Advanced Materials

Manufacturing of smart and new materials by additive manufacturing, powder metallurgy, vacuum

arc melting, mechanical alloying, single crystal growth, rapid solidification processing, sol-gel, physical and chemical vapor deposition techniques, etc.

Books Recommended

Textbooks:

1 Chander Prakash, Sunpreet Singh, and J. Paulo Davim, *Functional and Smart Materials*, CRC Press, 2021.

2 Rachid Bouhfid Abou el Kacem Qaiss Mohammad Jawaid, *Polymer Nanocomposite-Based Smart Materials*, Elsevier Science, 2020.

3 Masoud Mozafari, *Handbook of Biomaterials Biocompatibility*, Woodhead Publishing, 2020.

4 Aguilar, Maria Rosa, Roman, Julio San, *Smart Polymers and their Applications*, Woodhead Publishing, 2019.

5 Anca Filimon, *Smart Materials- Integrated Design, Engineering Approaches, and Potential Applications*, Apple Academic Press, 2019.

6 Cheong K.Y., Impellizzeri, G., and Fraga, M.A., *Emerging Materials for Energy Conversion and Storage*, 1st Edition, Elsevier, 2018.

7 Ying-Pin Chen, Sajid Bashir, Jingbo Louise Liu, *Nanostructured Materials for Next-Generation Energy Storage and Conversion*, Springer, 2017.

8 Li, Qing; Mai, Yiu-Wing, *Biomaterials for Implants and Scaffolds*, Springer, 2017.

9 Epaarachchi, Jayantha Ananda; Kahandawa, Gayan Chanaka, *Structural Health Monitoring Technologies and Next-Generation Smart Composite Structures*, CRC Press, 2016.

10 Hou, Xu, *Design, Fabrication, Properties, and Applications of Smart and Advanced Materials*, CRC Press, 2016.

11 Yoseph Bar-Cohen, *High Temperature Materials and Mechanisms*, CRC Press, 2014.

12 William G. Fahrenholtz; Eric J. Wuchina; William E. Lee; Yanchun Zhou, *Ultra-High Temperature Ceramics: Materials for Extreme Environment Applications*, Wiley, 2014.

13 Rani Elhajjar; Valeria La Saponara; Anastasia Muliana, *Smart Composites: Mechanics and Design*, CRC Press, 2013.

14 C. Mauli Agrawal, Joo L. Ong, Mark R. Appleford, Gopinath Mani, *Introduction to Biomaterials: Basic Theory with Engineering Applications*, Cambridge University Press, 2013.

15 J. L. Zhong, *Smart Materials and Nanotechnology in Engineering*, Trans Tech Pubn, 2012.

16 Mel Schwartz, *Smart Materials*, CRC Press, 2008.

Other Resources:

1 Prof. Jayanta Das, *Advanced Materials and Processes*, NPTEL Course, IIT Kharagpur, 2019.

2 Prof. Kaushik Pal, *Selection of Nanomaterials for Energy Harvesting and Storage Application*, NPTEL Course, IIT Roorkee, 2019.

3 Bhattacharya B, *Smart Materials and Intelligent System Design*, NPTEL, IIT Kanpur, 2018.

Evaluation Scheme

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of the semester.

Continuous Assessment (B):

1. Two term tests of 15 marks each will be conducted during the semester.
2. Total duration allotted for writing each of the papers is 1 hour.
3. Best of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper will be based on the entire syllabus summing up to 65 marks.
2. Total duration allotted for writing the paper is 2 hours.

Advanced Materials and Processes Laboratory (22PEME5061L)

Teaching Scheme	**Examination Scheme**
Practical : 02 Hrs./week	Teacher Assessment: 25 Marks
Credit : 01	End Sem Exam : 00 Marks

Prerequisites:

1. Engineering Materials
2. Manufacturing Processes

Course Objectives

1. To provide comprehensive exposure to new and advanced materials such as smart materials, high temperature materials, nanomaterials, energy storage materials, etc.
2. To familiarize students with the development of new materials and processes to meet real-world application requirements of real world.

Course Outcomes:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Understand the stimuliresponse behavior of various smart materials along with their properties and processing.	L2	Understand
CO2	Select an appropriate smart material and analyze it for applications such as sensors, actuators, self-healing, and health monitoring of structures.	L3	Apply
CO3	Understand the behavior of material at elevated temperatures and select an appropriate material for high temperature applications.	L2	Understand
CO4	Correlate structure, properties, and synthesis of nanostructured materials and biomaterials, and appreciate their engineering importance.	L4	Analyze
CO5	Demonstrate various materials and methods for energy storage and harvesting.	L3	Apply

Assignment / Case study / Mathematical modelling

1. Assignments based on syllabus
2. Case study or literature based presentation/seminar.
3. Mathematical modelling and simulation of smart and new materials based systems and devices

Books Recommended

Textbooks:

1 Chander Prakash, Sunpreet Singh, and J. Paulo Davim, *Functional and Smart Materials*, CRC Press, 2021.

2 Rachid Bouhfid Abou el Kacem Qaiss Mohammad Jawaid, *Polymer Nanocomposite-Based Smart Materials*, Elsevier Science, 2020.

3 Masoud Mozafari, *Handbook of Biomaterials Biocompatibility*, Woodhead Publishing, 2020.

4 Aguilar, Maria Rosa, Roman, Julio San, *Smart Polymers and their Applications*, Woodhead Publishing, 2019.

5 Anca Filimon, *Smart Materials- Integrated Design, Engineering Approaches, and Potential Applications*, Apple Academic Press, 2019.

6 Cheong K.Y., Impellizzeri, G., and Fraga, M.A., *Emerging Materials for Energy Conversion and Storage*, 1st Edition, Elsevier, 2018.

7 Ying-Pin Chen, Sajid Bashir, Jingbo Louise Liu, *Nanostructured Materials for Next-Generation Energy Storage and Conversion*, Springer, 2017.

8 Li, Qing; Mai, Yiu-Wing, *Biomaterials for Implants and Scaffolds*, Springer, 2017.

9 Epaarachchi, Jayantha Ananda; Kahandawa, Gayan Chanaka, *Structural Health Monitoring Technologies and Next-Generation Smart Composite Structures*, CRC Press, 2016.

10 Hou, Xu, *Design, Fabrication, Properties, and Applications of Smart and Advanced Materials*, CRC Press, 2016.

11 Yoseph Bar-Cohen, *High Temperature Materials and Mechanisms*, CRC Press, 2014.

12 William G. Fahrenholtz; Eric J. Wuchina; William E. Lee; Yanchun Zhou, *Ultra-High Temperature Ceramics: Materials for Extreme Environment Applications*, Wiley, 2014.

13 Rani Elhajjar; Valeria La Saponara; Anastasia Muliana, *Smart Composites: Mechanics and Design*, CRC Press, 2013.

14 C. Mauli Agrawal, Joo L. Ong, Mark R. Appleford, Gopinath Mani, *Introduction to Biomaterials: Basic Theory with Engineering Applications*, Cambridge University Press, 2013.

15 J. L. Zhong, *Smart Materials and Nanotechnology in Engineering*, Trans Tech Pubn, 2012.

16 Mel Schwartz, *Smart Materials*, CRC Press, 2008.

Other Resources:

1 Prof. Jayanta Das, *Advanced Materials and Processes*, NPTEL Course, IIT Kharagpur, 2019.

2 Prof. Kaushik Pal, *Selection of Nanomaterials for Energy Harvesting and Storage Application*, NPTEL Course, IIT Roorkee, 2019.

3 Bhattacharya B, *Smart Materials and Intelligent System Design*, NPTEL Course, IIT Kanpur, 2018.

Evaluation Scheme

The distribution of marks shall be as follows:

Continuous Assessment (A):

Term work shall consist of minimum 8 experiments.

1. Assignments based on syllabus : 10 Marks
2. Case study or literature based presentation/seminar: 05 Marks
3. Viva-voce: 05 Marks
4. Mathematical modelling and simulation of smart and new materials based systems and devices : 10 Marks

The final certification and acceptance of laboratory journal/manual/report will be subject to satisfactory performance of Laboratory work and upon fulfilling minimum passing criteria in the teacher assessment.

Automobile Engineering
(22PEME5062T)

Teaching Scheme	**Examination Scheme**
Lectures: 03 Hr/week	Term Test : 15 Marks
Tutorial: 00 Hr/week	Teacher Assessment : 20 Marks
Credit : 03	End Sem Exam : 65 Marks

Pre-requisites:

1. Manufacturing Processes, Mechanics of Materials
2. Fluid Mechanics
3. Basic Electronics

Course Objectives

1. To impart an understanding of important mechanical systems of an automobile.
2. To impart an understanding of the electrical and electronic systems of an automobile.
3. To familiarize with the latest technological developments in automotive technology.

Course Outcomes:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Describe the types and working of clutch and transmission systems.	L2	Understand
CO2	Illustrate the working of steering and braking systems.	L2	Understand
CO3	Describe the role of vehicle suspension systems and vehicle body.	L2	Understand
CO4	Describe the different automotive electrical and electronic systems.	L2	Understand
CO5	Acquaint with recent developments in automobiles.	L2	Understand

Course Contents

Unit-I 08 Hrs.

Introduction, Clutch, Transmission, Final Drive, and Differential

Introduction: Classification of automobiles, Importance of various sub-systems of an automobile, development of an automobile, aspects of automotive engineering.
Clutch: Performance characteristics of a prime mover, requirements & types of clutches, single plate, multi-plate, wet clutch, centrifugal clutch. Clutch materials. Clutch operating Mechanisms - Mechanical, Electric, Hydraulic, and Vacuum. Trouble shooting and remedies. Clutch-by-wire.
Transmission: Requirements of gear box. Sliding mesh, Constant mesh, and Synchromesh Gearbox. Gear selector mechanisms. Overdrives, under-gearing, over-gearing, tractive effort and hydrodynamic torque converter, Epicyclic gear train and automatic transmissions. Trouble shooting and remedies. Automated Manual Transmission (AMT), Continuously Variable Transmission (CVT), Dual Clutch Transmission (DCT).
Final Drive and Differential: Types of Final drive; spiral, bevel, Hypoid and worm drives. Necessity of differential, Working of differential, Conventional and limited-slip differential, Trouble shooting and remedies.

Unit-II 07 Hrs.

Propeller Shaft, Axle, Steering System, and Braking System

Propeller Shaft and Axle: Propeller shafts and universal joints: Types and construction, Different types of universal joints and constant velocity joints. Classification of axles, Loads on axles, Semi, Three quarter and Full floating axles. Trouble shooting and remedies.
Steering System: Steering requirements, steering linkages and steering gears. Steering geometry, Analysis of steering geometry, Over-steer and Under-steer, Reversibility of steering gears. Trouble shooting and remedies.
Braking System: Requirement of brakes, Classification of brakes, Brake Actuation Methods: Mechanical, Hydraulic, Pneumatic, Electro and vacuum brakes. Types of Disc brakes and Drum Brakes, Brake trouble shooting, Antilock braking system (ABS).

Unit-III 07 Hrs.

Suspension System, Wheels, and Tyres

Suspension System: Objects of suspension, Basic requirements, Sprung and un-sprung mass, Types of Independent, semi-independent and rigid axle suspension. Air suspension and its features. Pitching, rolling and bouncing. Shock absorbers and its types, Trouble shooting and remedies. Electronically controlled active suspension system.
Wheels and Tyres: Requirements of wheels and tyres. Types of wheels, types of tyres and types of carcass. Tyre and wheel manufacturing processes. Trouble shooting and remedies. Airless tyres & run flat tyres.

Unit-IV 07 Hrs.

Body Engineering

Importance of vehicle body and its types. Loads on vehicle body, materials for body construction. Layouts of passenger cars, Bus and truck bodies.
Chassis types and structure types: Open, Semi integral and integral structures. Frames: Types of

frames and their functions, Loads on frames, Load distribution of structure. Importance of crumple zone in vehicles, Crash safety ratings in India.

Unit-V 06 Hrs.

Automotive Electronics

Storage Systems: Lead-Acid Battery; construction, working, ratings, types of charging methods, Alkaline battery, ZEBRA and Sodium Sulphur battery. Lithium ion battery, battery pack for electric vehicles, Battery management system. Solid state battery.
Vehicle Sensors: Vehicle speed sensor, Mass air flow sensor, temperature sensor, MAP sensor, Lambda sensor, TP sensor, Steering angle sensor, Acceleration sensor, Yaw rate sensor, Airbag sensor, Radar, LiDAR sensor.

Unit-VI 05 Hrs.

Recent Developments in Automobiles

Active and Passive Safety systems in an automobile. Cruise Control, Adaptive Cruise Control (ACC), Predictive Cruise Control, Electronic Stability Program (ESP), Electronic Brake Distribution System (EBD), Traction Control System (TCS). Integrated Starter Alternator (ISA), Hill assist, Launch control, Connected cars with V2V communication & pre-collision technology.

Books Recommended

Textbooks:

1 *Automobile Engineering*, Dr. Kirpal Singh, Vol I & II, 13th Edition, Standard Publishers

2 *Automobile Engineering*, S. K. Gupta, S Chand Publications

3 *Automobile Engineering*, R. K. Rajput, 2nd Edition, Laxmi Publications

Reference Books:

1 *Automotive Engineering Fundamentals*, Jeffrey Ball, Richard Stone, SAE International.

2 *Encyclopedia of Automotive Engineering*, David Crolla, Wiley Publication

3 *Automotive Electrical and Electronic Systems*, Tom Denton, 5th Edition, Routledge

4 *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles*, Mehrdad, Yimin, Sebastian, Ali, 3rd Edition, CRC Press

Evaluation Scheme

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of the semester.

Continuous Assessment (B):

1. Two term tests of 15 marks each will be conducted during the semester.
2. Total duration allotted for writing each of the papers is 1 hour.
3. Best of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper will be based on the entire syllabus summing up to 65 marks.
2. Total duration allotted for writing the paper is 2 hours.

Automobile Engineering Laboratory
(22PEME5062L)

Teaching Scheme	**Examination Scheme**
Practical : 02 Hrs./week	Teacher Assessment: 25 Marks
Credit : 01	End Sem Exam : 00 Marks

Pre-requisites:

1. Manufacturing Processes, Mechanics of Materials
2. Fluid Mechanics
3. Basic Electronics

Course Objectives

1. To impart an understanding of important mechanical systems of an automobile.
2. To impart an understanding of the electrical and electronic systems of an automobile.
3. To familiarize with the latest technological developments in automotive technology.

Course Outcomes:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Describe the types and working of clutch and transmission systems.	L2	Understand
CO2	Illustrate the working of steering and braking systems.	L2	Understand
CO3	Describe the role of vehicle suspension systems and vehicle body.	L2	Understand
CO4	Describe the different automotive electrical and electronic systems.	L2	Understand
CO5	Acquaint with recent developments in automobiles.	L2	Understand

Suggested Experiments

1 Identify and illustrate various components in a clutch assembly.

2 Simulation of powertrain systems on Lotus Engineering Software

3 Simulation of powertrain systems on MATLAB Simulink software.

4 Simulation and analysis of transmission system gear ratio using MATLAB Simulink software

5 Modeling and FEA analysis of vehicle frame designs and materials on ANSYS / Solidworks

6 Characterization and visualization of output of various sensors such as TPS, MAP, ECT sensor.

7 Simulation of cruise control system using MATLAB Simulink software

8 Case study presentations on upcoming vehicle technologies

Minimum seven 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 *Automobile Engineering*, Dr. Kirpal Singh, Vol I & II, 13th Edition, Standard Publishers

2 *Automobile Engineering*, S. K. Gupta, S Chand Publications

3 *Automobile Engineering*, R. K. Rajput, 2nd Edition, Laxmi Publications

Reference Books:

1 *Automotive Engineering Fundamentals*, Jeffrey Ball, Richard Stone, SAE International.

2 *Encyclopedia of Automotive Engineering*, David Crolla, Wiley Publication

3 *Automotive Electrical and Electronic Systems*, Tom Denton, 5th Edition, Routledge

4 *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles*, Mehrdad, Yimin, Sebastian, Ali, 3rd Edition, CRC Press

Evaluation Scheme

The distribution of marks shall be as follows:

Continuous Assessment (A):

Term work shall consist of minimum 8 experiments.

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks
4. Subject Specific Lab Assignment/Case Study: 10 Marks

The final certification and acceptance of laboratory journal/manual/report will be subject to satisfactory performance of Laboratory work and upon fulfilling minimum passing criteria in the teacher assessment.

Reliability Engineering
(22PEME5063T)

Teaching Scheme	**Examination Scheme**
Lectures: 03 Hr/week	Term Test : 15 Marks
Tutorial: 00 Hr/week	Teacher Assessment : 20 Marks
Credit : 03	End Sem Exam : 65 Marks

Pre-requisites:

Basics of Probability and Statistics

Course Objectives

1. To impart a basic understanding of probability and statistical techniques used in reliability engineering.
2. To inculcate basic knowledge on the applications of probability distributions in modeling and analyzing failure data.
3. To be familiar with the techniques used in system reliability modeling and analyze warranty data.
4. To provide a basic understanding of the use of probabilistic approaches to design components and predict reliability.
5. To acquaint with the concepts of reliability testing.

Course Outcomes:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Apply the basics of reliability and its measures for analyzing components and systems.	L3	Apply
CO2	Apply probability distributions to estimate reliability functions such as reliability, CDF, PDF, hazard rate, etc.	L3	Apply
CO3	Develop the system reliability models to solve system reliability problems and analyze warranty data.	L4	Analyze
CO4	Apply probabilistic approaches for component design and reliability prediction.	L3	Apply
CO5	Select a suitable reliability testing method for testing of components.	L3	Apply

Course Contents

Unit-I 07 Hrs.

Basic Reliability Mathematics

Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem.
Reliability Concepts: Reliability Engineering in the 21st Century, Reliability definitions, Importance of Reliability, Reliability objectives.
Failure Data Analysis: PDF, Reliability function, CDF, Moments of time to failure - MTTF, MTBF, the median time to failure, mode, skewness, kurtosis, variance and standard deviation, Hazard rate function, Bathtub curve.

Unit-II 07 Hrs.

Probability Distributions

Discrete Probability Distribution: Binomial distribution, Poisson distribution.
Continuous Probability Distributions: Weibull, exponential, normal (Gaussian), and lognormal. Concept of confidence interval.

Unit-III 07 Hrs.

System Reliability

System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems. Successful Path method, Decomposition method. Tie-set and Cut-set methods. Logic diagrams.
Reliability Improvement: Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies.

Unit-IV 06 Hrs.

System Reliability Modelling and Warranty Analysis

Failure Modes and Effects Analysis (FMEA), and Fault Tree Analysis (FTA). Product warranty and reliability.

Unit-V 06 Hrs.

Probabilistic Design

Design for Reliability: Reliability models for probabilistic design, Relationship between reliability, the factor of safety and variability.
Maintainability: Types of maintenance, models for maintenance data.
Availability: Types, Markov chains.

Unit-VI 06 Hrs.

Reliability Testing

Introduction to reliability testing, Stress strength interaction, Accelerated Life Testing and Highly Accelerated Life Testing (HALT), and highly accelerated stress Screening (HASS). Handbook-based reliability predictions.

Books Recommended

Textbooks:

1 *An Introduction to Reliability and Maintainability Engineering*, C. E. Ebeling, Waveland Press Inc., 2019.

2 *Reliability Engineering*, K. C. Kapur, and M. Pecht, John Wiley and Sons, 2014.

3 *Design Reliability: Fundamentals and Application*, B. S. Dhillon, CRC Press, 1999.

4 *Reliability Engineering and Life Testing*, V. N. A. Naikan, PHI Learning, 2008.

5 *Reliability Engineering*, L.S. Srinath, Affiliated East-West Press (P) Ltd., 2016.

Reference Books:

1 *Reliability Engineering*, E. Balagurusamy, Tata McGraw Hill, 2017.

2 *Reliability Engineering and Risk Analysis – A Practical Guide*, M. Modarres, K. Kaminsky, and V. Krivstov, CRC Press, Taylor and Francis Group, 2017.

3 *Practical Reliability Engineering*, P. D. T. O'Conner, John Wiley and Sons, 2012.

4 *Life Cycle Reliability Engineering*, G. Yang, John Wiley and Sons, 2007.

5 *Engineering Maintainability*, B. S. Dhillon, Prentice Hall of India, 1999.

Web References:

1. *Statistical Learning in Reliability Analysis.*
   https://onlinecourses.nptel.ac.in/noc22_cs120/preview
2. *Introduction to Reliability Engineering.*
   https://onlinecourses.nptel.ac.in/noc23_ge20/preview

Evaluation Scheme

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of the semester.

Continuous Assessment (B):

1. Two term tests of 15 marks each will be conducted during the semester.
2. Total duration allotted for writing each of the papers is 1 hour.
3. Best of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper will be based on the entire syllabus summing up to 65 marks.
2. Total duration allotted for writing the paper is 2 hours.

Reliability Engineering Laboratory (22PEME5063L)

Teaching Scheme	**Examination Scheme**
Practical : 02 Hrs./week	Teacher Assessment: 25 Marks
Credit : 01	End Sem Exam : 00 Marks

Pre-requisites:

Basics of Probability and Statistics

Course Objectives

1. To impart a basic understanding of probability and statistical techniques used in reliability engineering.
2. To inculcate basic knowledge on the applications of probability distributions in modeling and analyzing failure data.
3. To be familiar with the techniques used in system reliability modeling and analyze warranty data.
4. To provide a basic understanding of the use of probabilistic approaches to design components and predict reliability.
5. To acquaint with the concepts of reliability testing.

Course Outcomes:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Apply the basics of reliability and its measures for analyzing components and systems.	L3	Apply
CO2	Apply probability distributions to estimate reliability functions such as reliability, CDF, PDF, hazard rate, etc.	L3	Apply
CO3	Develop the system reliability models to solve system reliability problems and analyze warranty data.	L4	Analyze
CO4	Apply probabilistic approaches for component design and reliability prediction.	L3	Apply
CO5	Select a suitable reliability testing method for testing of components.	L3	Apply

Suggested Experiments / Exercises

1. Reliability data collection, sorting, classification, Pareto analysis/ bar chart plotting (paper clips experiments). Plotting reliability characteristics for a given data set.
2. Select best-fit probability distributions for reliability modelling using a suitable approach (Use data from paper clips experiments).
3. A case study on reliability block diagrams.
4. A case study on fault tree analysis.
5. A case study FMEA analysis using MIL-STD-1629.
6. A case study on Markov chains/ Monte Carlo simulation
7. Physics of failure models/ Warranty data analysis
8. A case study on reliability allocation (ARINC/ AGREE/ Feasibility of objectives/ Aggarwal's method/ and Integrated factor).
9. Handbook based reliability predictions - FIDES, 217+, Bellcore/ Telcordia SR-332, ANSI/ VITA51.1, NSWC-11, or GJB/z 299 (any one)
10. Analyse life testing data for the following cases:
    - Life testing with censoring
    - Life testing with replacement
    - Life testing without replacement

The above Experiments/ Exercises should be performed using a suitable software package/ programming language whenever required. The first 6 experiments are mandatory. Any two from experiment no. 7 to 10 can be performed.

Books Recommended

Textbooks:

1 *An Introduction to Reliability and Maintainability Engineering*, C. E. Ebeling, Waveland Press Inc., 2019.

2 *Reliability Engineering*, K. C. Kapur, and M. Pecht, John Wiley and Sons, 2014.

3 *Design Reliability: Fundamentals and Application*, B. S. Dhillon, CRC Press, 1999.

4 *Reliability Engineering and Life Testing*, V. N. A. Naikan, PHI Learning, 2008.

5 *Reliability Engineering*, L.S. Srinath, Affiliated East-West Press (P) Ltd., 2016.

Reference Books:

1 *Reliability Engineering*, E. Balagurusamy, Tata McGraw Hill, 2017.

2 *Reliability Engineering and Risk Analysis – A Practical Guide*, M. Modarres, K. Kaminsky, and V. Krivstov, CRC Press, Taylor and Francis Group, 2017.

3 *Practical Reliability Engineering*, P. D. T. O'Conner, John Wiley and Sons, 2012.

4 *Life Cycle Reliability Engineering*, G. Yang, John Wiley and Sons, 2007.

5 *Engineering Maintainability*, B. S. Dhillon, Prentice Hall of India, 1999.

Web References:

1. *Statistical Learning in Reliability Analysis.*
   https://onlinecourses.nptel.ac.in/noc22_cs120/preview
2. *Introduction to Reliability Engineering.*
   https://onlinecourses.nptel.ac.in/noc23_ge20/preview

Evaluation Scheme

The distribution of marks shall be as follows:

Continuous Assessment (A):

Term work shall consist of minimum 8 experiments.

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks
4. Subject Specific Lab Assignment/Case Study: 10 Marks

The final certification and acceptance of laboratory journal/manual/report will be subject to satisfactory performance of Laboratory work and upon fulfilling minimum passing criteria in the teacher assessment.

Power Engineering
(22PEME5064T)

Teaching Scheme	**Examination Scheme**
Lectures: 03 Hr/week	Term Test : 15 Marks
Tutorial: 00 Hr/week	Teacher Assessment : 20 Marks
Credit : 03	End Sem Exam : 65 Marks

Prerequisites:

Thermodynamics

Course Objectives

1. To study boilers, boiler mountings and accessories.
2. To study steam turbines, hydraulic turbines and their utilities.
3. To study pumps, compressors and their utilities.

Course Outcomes

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Recognize different types of boilers and evaluate steam generator, steam turbine performance.	L2	Understand
CO2	Identify basic concepts in the case of centrifugal compressors and evaluate their performance.	L3	Apply
CO3	Demonstrate working of axial flow compressors and evaluate their performance.	L3	Apply
CO4	Identify basic difference between impulse and reaction water turbines, investigate various parameters and design turbine runners.	L3	Apply
CO5	Define operating principles of reciprocating and centrifugal pumps and evaluate their performance.	L2	Understand

Course Contents

Unit-I 04 Hrs.

Steam Generators

Fire tube and Water tube boiler, Low pressure and high-pressure boilers, once through boiler, examples, and important features of HP boilers, Mountings and accessories, Equivalent evaporation of boilers, Boiler performance and Boiler efficiency.

Unit-II 06 Hrs.

Steam Nozzle & Steam Turbine

Flow through steam nozzle-velocity at exit and condition for maximum discharge, nozzle efficiency. Basics of steam turbine, Classification, compounding of turbine, Impulse turbine – velocity diagram, Condition for max efficiency, Reaction turbine - velocity diagram, degree of reaction, Parson's turbine, Condition for maximum efficiency.

Unit-III 05 Hrs.

Rotary Compressors & Centrifugal Compressors

Vane type compressors, Scroll & Screw compressors etc.
Work required, polytropic efficiency, pressure rise, slip, effect of blade shape, two-dimensional flow through impeller; Vaned diffuser and volute casing; Surging and choking of compressors; Compressor performance and characteristic curves.

Unit-IV 04 Hrs.

Axial Flow Compressors

Work required, polytropic efficiency, pressure rise, degree of reaction; Simple design calculations; Surging and stalling of compressors; Compressor performance and characteristic curves.

Unit-V 10 Hrs.

Hydraulic Turbines

Introduction to hydrodynamic thrust of jet on a fixed and moving surface (flat & curve), Types of hydro turbines - impulse and reaction, definition of various turbine parameters like gross head, discharge, work done, input power, output power, efficiencies etc., Eulers' equation applied to a turbine, turbine velocities and velocity triangles, expression for work done.
Impulse Turbine: Components of Pelton turbine, definition of design parameters like speed ratio, jet ratio, and estimation of various parameters like head, discharge, and efficiency etc., determination of number of buckets.
Reaction Turbines: Types of reaction turbines - inward and outward flow, Francis turbine, Kaplan turbine; elements of the turbine, estimation of various parameters. Unit quantities in turbines.

Unit-VI 10 Hrs.

Pumps

Classification of pumps: positive displacement and non-positive displacement.
Positive Displacement pumps: Types and applications, general features of rotary pumps, general feature of reciprocating pumps, definition of head, discharge, work done and efficiency, types of reciprocating pumps, indicator diagram, use of air vessel.

Centrifugal Pumps: Types - radial flow, mixed flow and axial flow, priming of pumps, components of the pump, Euler's equation and velocity triangles, correction factors for the head, design constant e.g., head constant, flow constant etc. self-priming pumps, series and parallel operation of pumps, system curve, determination of operating point, Cavitation in pumps, Determination of available and required NPSH, Model testing, Dimensional analysis.
Submersible Pumps: Types and applications, general features of submersible pumps, work done and efficiency.

Books Recommended

Reference Books:

1 Thermal Engineering, R. K. Rajput, 10th edition, Laxmi Publication

2 Thermal Engineering, Kothandraman, Domkundwar, Khajuria, Arora, 5th edition, 2002, Dhanpatrai & Sons

3 Thermal Engineering, Ballaney P.L., 25th edition, 2015, Khanna Publishers.

4 Steam & Gas Turbines and Power Plant Engineering, R. Yadav, 7th edition, 2000, Central Publishing house Allahabad

5 Fluid Mechanics and Fluid Machines, D.S. Kumar, 2013, S.K. Kataria & Sons

6 Fluid Mechanics and Machinery, C. S. P. Ojha, P. N. Chandramouli, R. Berndtsson, 2010, Oxford University Press

7 Fluid Mechanics and Hydraulic Machinery, P. N. Modi and S. M. Seth, 17th edition, 2011, Standard Book House.

8 Hydraulic Machines, R. K. Rajput, S. Chand Publication.

9 Fluid Mechanics and Fluid Machines, Bansal R.K, 9th edition, 2015, Laxmi Publications.

10 Turbines, Fans and Compressors, Yahya S.M, 4th edition, 2011, Tata McGraw Hill.

Evaluation Scheme

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of the semester.

Continuous Assessment (B):

1. Two term tests of 15 marks each will be conducted during the semester.
2. Total duration allotted for writing each of the papers is 1 hour.
3. Best of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper will be based on the entire syllabus summing up to 65 marks.
2. Total duration allotted for writing the paper is 2 hours.

Power Engineering Laboratory
(22PEME5064L)

Teaching Scheme	**Examination Scheme**
Practical : 02 Hrs./week	Teacher Assessment: 25 Marks
Credit : 01	End Sem Exam : 00 Marks

Prerequisites:

Thermodynamics

Course Objectives

1. To study boilers, boiler mountings and accessories.
2. To study steam turbines, hydraulic turbines and their utilities.
3. To study pumps, compressors and their utilities.

Course Outcomes

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Recognize different types of boilers and evaluate steam generator, steam turbine performance.	L2	Understand
CO2	Identify basic concepts in the case of centrifugal compressors and evaluate their performance.	L3	Apply
CO3	Demonstrate working of axial flow compressors and evaluate their performance.	L3	Apply
CO4	Identify basic difference between impulse and reaction water turbines, investigate various parameters and design turbine runners.	L3	Apply
CO5	Define operating principles of reciprocating and centrifugal pumps and evaluate their performance.	L2	Understand

Suggested Experiments

1. Study/Demonstration of Boilers
2. Study/Demonstration of Boiler mountings and accessories
3. Study of Steam Turbine
4. Trial on Impulse turbine (Pelton Wheel)
5. Trial on Reaction water turbine (Francis / Kaplan turbine)
6. Study of Rotary compressors
7. Trial on Positive displacement pump
8. Trial on Single stage centrifugal pump
9. Trial on Multistage centrifugal pump
10. Demonstration of different components of Centrifugal pump by dismantling the pump system.

Minimum eight 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.

Assignments:

Minimum five assignments based on syllabus (covering numerical). A Mini project relevant to the subject may be included, which would help the learner to apply the concept learnt.

Books Recommended

Reference Books:

1 Thermal Engineering, R. K. Rajput, 10th edition, Laxmi Publication

2 Thermal Engineering, Kothandraman, Domkundwar, Khajuria, Arora, 5th edition, 2002, Dhanpatrai & Sons

3 Thermal Engineering, Ballaney P.L., 25th edition, 2015, Khanna Publishers.

4 Steam & Gas Turbines and Power Plant Engineering, R. Yadav, 7th edition, 2000, Central Publishing house Allahabad

5 Fluid Mechanics and Fluid Machines, D.S. Kumar, 2013, S.K. Kataria & Sons

6 Fluid Mechanics and Machinery, C. S. P. Ojha, P. N. Chandramouli, R. Berndtsson, 2010, Oxford University Press

7 Fluid Mechanics and Hydraulic Machinery, P. N. Modi and S. M. Seth, 17th edition, 2011, Standard Book House.

8 Hydraulic Machines, R. K. Rajput, S. Chand Publication.

9 Fluid Mechanics and Fluid Machines, Bansal R.K, 9th edition, 2015, Laxmi Publications.

10 Turbines, Fans and Compressors, Yahya S.M, 4th edition, 2011, Tata McGraw Hill.

Evaluation Scheme

Continuous Assessment (A):

Term work shall consist of minimum 8 experiments.

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks
4. Subject Specific Lab Assignment/Case Study: 10 Marks

The final certification and acceptance of laboratory journal/manual/report will be subject to satisfactory performance of Laboratory work and upon fulfilling minimum passing criteria in the teacher assessment.

Data Analytics

(22PEME5065T)

Teaching Scheme	**Examination Scheme**
Lectures: 03 Hr/week	Term Test : 15 Marks
Tutorial: 00 Hr/week	Teacher Assessment : 20 Marks
Credit : 03	End Sem Exam : 65 Marks

Prerequisites:

1. Fundamentals of Mechanical Engineering
2. Engineering Mathematics and Statistics
3. Basics of Probability and Statistics

Course Objectives

1. To explore the fundamental concept of data analytics and its relationship with AI-ML-DL.
2. To apply descriptive and inferential statistics to solve mechanical engineering problems.
3. To understand the various data analytics approaches and visualization techniques.
4. To apply various machine learning techniques for data analysis.

Course Outcomes:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Explain the fundamentals of data analytics and select a suitable approach for data analytics.	L2	Understand
CO2	Apply descriptive analytics to describe and analyze the data.	L3	Apply
CO3	Apply descriptive, diagnostic, predictive, and prescriptive analytics techniques to withdraw useful conclusions from the acquired data set.	L4	Analyze
CO4	Use inferential analytics to draw critical inferences from the given data.	L3	Apply
CO5	Select suitable plots for the given data and draw practical interpretations.	L3	Apply
CO6	Apply data science concepts and methods to solve problems in a real-world context.	L4	Analyze

Course Contents

Unit-I 05 Hrs.

Introduction

Data science and data analytics, Types of data, Data recording/collecting, Data storing, Data pre-processing, Data describing/visualization, Statistical modelling, Algorithmic modelling, Missing data treatment, Relationship between AI, ML, DL, and Data Science, Big data, Database system.

Unit-II 05 Hrs.

Descriptive Statistics

Universe, population, and sample, Measures of central tendency and their characteristics, Outlier detection, Histogram and central tendency, Measures of spread, variance, and percentiles, Effect of transformation of measure of spread.

Unit-III 09 Hrs.

Inferential Statistics

Sampling distribution, Hypothesis testing, Types of errors, Level of significance, p-test, Chi-Square test, z-test, t-test, ANOVA, K-S test, Correlation analysis, Maximum likelihood test.

Unit-IV 06 Hrs.

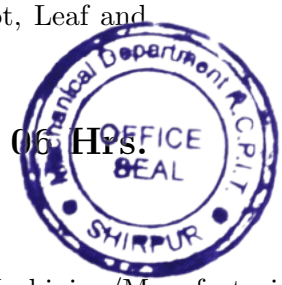
Data Analytics Approaches

Predictive analytics predictions using statistical modeling and machine learning techniques, Demand forecasting, Anomaly detection.
Prescriptive analytics process improvement decisions, Supplier reviewing, maintenance scheduling.
Descriptive analytics trends and patterns in the data, data visualization tools.
Diagnostic analytics root cause analysis, data mining, correlation, product quality analysis.

Unit-V 08 Hrs.

Data Visualization using Python/R/Tableau/Power BI

Histogram, Bar/line chart, Box plots, Swarm plot, Violin plot, Faceted plot, Boxen plot, Leaf and stem plots, Scatter plots, Heat map, Bubble chart, Pie chart, Line plot.



Unit-VI 06 Hrs.

Applications

Thermal/Heat Transfer/HVAC/Fluid Mechanics/Fluid Power, Solid Mechanics/Design, Machining/Manufacturing Automation and Robotics, Maintenance/reliability/condition monitoring, Quality Control, Materials and metallurgy, Energy Conservation and Management, Industrial Engineering, Estimation and Management, Automotive Technology.

Books Recommended

Textbooks:

1 Brunton, S. L., & Kutz, J. N. (2022). Data-driven science and engineering: Machine learning, dynamical systems, and control. Cambridge University Press.

2 Dunn, P. F., & Davis, M. P. (2017). Measurement and data analysis for engineering and science. CRC press.

3 Roy, S. S., Samui, P., Deo, R., & Ntalampiras, S. (Eds.). (2018). Big data in engineering applications (Vol. 44). Berlin/Heidelberg, Germany: Springer.

4 Middleton, J. A. (2021). Experimental Statistics and Data Analysis for Mechanical and Aerospace Engineers. Chapman and Hall/CRC.

5 Brandt, S. (1970). Statistical and computational methods in data analysis.

6 Robinson, E. L. (2017). Data analysis for scientists and engineers. In Data Analysis for Scientists and Engineers. Princeton University Press.

7 Araghinejad, S. (2013). Data-driven modeling: using MATLAB® in water resources and environmental engineering (Vol. 67). Springer Science Business Media.

8 Niu, G. (2017). Data-driven technology for engineering systems health management. Beijing, China: Springer.

Reference Books:

1 Zsolt Nagy, "Artificial Intelligence and Machine Learning Fundamentals", Packt Publishing, 2018, ISBN: 978-1-78980-165-1

2 Hastie, Trevor, Robert Tibshirani, Jerome H. Friedman, and Jerome H. Friedman. The elements of statistical learning: data mining, inference, and prediction. Vol. 2. New York: Springer, 2009.

3 Zaki, Mohammed J., Wagner Meira Jr, and Wagner Meira. Data mining and analysis: fundamental concepts and algorithms. Cambridge University Press, 2014.

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

Web References:

1 Foundations of Data Science `https://padhai.onefourthlabs.in/courses/data-science`)

2 Data Analytics with Python `https://nptel.ac.in/courses/106107220`)

3 Introduction to Data Analytics `https://nptel.ac.in/courses/110106072`

Evaluation Scheme

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of the semester.

Continuous Assessment (B):

1 Two term tests of 15 marks each will be conducted during the semester.

2 Total duration allotted for writing each of the papers is 1 hour.

3 Best of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1 Question paper will be based on the entire syllabus summing up to 65 marks.

2 Total duration allotted for writing the paper is 2 hours.

Data Analytics Laboratory
(22PEME5065L)

Teaching Scheme	**Examination Scheme**
Practical : 02 Hrs./week	Teacher Assessment: 25 Marks
Credit : 01	End Sem Exam : 00 Marks

Prerequisites:

1. Fundamentals of Mechanical Engineering
2. Engineering Mathematics and Statistics
3. Basics of Probability and Statistics

Course Objectives

1. To explore the fundamental concept of data analytics and its relationship with AI-ML-DL.
2. To apply descriptive and inferential statistics to solve mechanical engineering problems.
3. To understand the various data analytics approaches and visualization techniques.
4. To apply various machine learning techniques for data analysis.

Course Outcomes:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Explain the fundamentals of data analytics and select a suitable approach for data analytics.	L2	Understand
CO2	Apply descriptive analytics to describe and analyze the data.	L3	Apply
CO3	Apply descriptive, diagnostic, predictive, and prescriptive analytics techniques to withdraw useful conclusions from the acquired data set.	L4	Analyze
CO4	Use inferential analytics to draw critical inferences from the given data.	L3	Apply
CO5	Select suitable plots for the given data and draw practical interpretations.	L3	Apply
CO6	Apply data science concepts and methods to solve problems in a real-world context.	L4	Analyze

Suggested Experiments

Group A :

1 To study data science, data analytics, and AI-ML-DL.

2 To perform descriptive statistical analysis by using the data from the literature or mechanical laboratory. Data can be generated by performing bending tests on the paper clips. The minimum number of data points should be 30.

3 To develop a regression model and evaluate its performance (any one algorithm).

4 To develop a classification model and evaluate its performance (any one algorithm).

5 To conduct hypothesis tests using p-test/ Chi-Square test/ z-test/ t-test/ ANOVA/ K-S test.

6 To visualize a given data set (paperclip tests/ literature/ laboratory) - scattered diagram, Bar/ line chart, histogram, Box plots, and pie charts.

7 To visualize a given data set (paperclip tests/ literature/ laboratory) - swarm plot, Violin plot, faceted plot, boxen plot, leaf and stem plots, Heat map, Bubble chart, line plot.

8 To estimate the best-fit probability distribution for a given data set - Weibull, Exponential, Normal, and Lognormal.

Many five experiments from the following list should be performed for a data set using a suitable software package/ programming language.

Group B (Mandatory):

One mini project (in a group of 3-4 students)
based on the above contents and using the mechanical engineering application dataset.

Books Recommended

Textbooks:

1 Brunton, S. L., & Kutz, J. N. (2022). Data-driven science and engineering: Machine learning, dynamical systems, and control. Cambridge University Press.

2 Dunn, P. F., & Davis, M. P. (2017). Measurement and data analysis for engineering and science. CRC press.

3 Roy, S. S., Samui, P., Deo, R., & Ntalampiras, S. (Eds.). (2018). Big data in engineering applications (Vol. 44). Berlin/Heidelberg, Germany: Springer.

4 Middleton, J. A. (2021). Experimental Statistics and Data Analysis for Mechanical and Aerospace Engineers. Chapman and Hall/CRC.

5 Brandt, S. (1970). Statistical and computational methods in data analysis.

6 Robinson, E. L. (2017). Data analysis for scientists and engineers. In Data Analysis for Scientists and Engineers. Princeton University Press.

7 Araghinejad, S. (2013). Data-driven modeling: using MATLAB® in water resources and environmental engineering (Vol. 67). Springer Science Business Media.

8 Niu, G. (2017). Data-driven technology for engineering systems health management. Beijing, China: Springer.

Reference Books:

1 Zsolt Nagy, “Artificial Intelligence and Machine Learning Fundamentals”, Packt Publishing, 2018, ISBN: 978-1-78980-165-1

2 Hastie, Trevor, Robert Tibshirani, Jerome H. Friedman, and Jerome H. Friedman. The elements of statistical learning: data mining, inference, and prediction. Vol. 2. New York: Springer, 2009.

3 Zaki, Mohammed J., Wagner Meira Jr, and Wagner Meira. Data mining and analysis: fundamental concepts and algorithms. Cambridge University Press, 2014.

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

Web References:

1 Foundations of Data Science
https://padhai.onefourthlabs.in/courses/data-science)

2 Data Analytics with Python
https://nptel.ac.in/courses/106107220)

3 Introduction to Data Analytics
https://nptel.ac.in/courses/110106072

Evaluation Scheme

The distribution of marks shall be as follows:

Continuous Assessment (A):

Term work shall consist of minimum 8 experiments.

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks
4. Mini Project: 10 Marks

The final certification and acceptance of laboratory journal/manual/report will be subject to satisfactory performance of Laboratory work and upon fulfilling minimum passing criteria in the teacher assessment.

Incubation, Entrepreneurship and Startups (22PEME5066T)

Teaching Scheme	**Examination Scheme**
Lectures: 03 Hr/week	Term Test : 15 Marks
Tutorial: 00 Hr/week	Teacher Assessment : 20 Marks
Credit : 03	End Sem Exam : 65 Marks

Prerequisites:

Nil

Course Objectives

1 To enable participants in exploring the Startup World: Investigate global startup stories and the role of incubators in fostering growth.

2 To foster an entrepreneurial mindset in participants: Develop creative problem-solving skills applicable to diverse challenges.

3 To guide participants in building effective Business Models: Learn the art of creating versatile business plans and understanding customer needs.

4 To assist participants in understanding Tech and Innovation: Explore the intersection of technology and entrepreneurship, and basics of idea protection.

5 To educate participants on Fundraising for Innovative Ventures: Explore diverse fundraising avenues and strategies to impress potential investors.

6 To equip participants for Execution and Growth: Develop skills for turning plans into action and strategies for sustained startup growth.

Course Outcomes:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Effectively Navigate the Global Startup Landscape: Understand and navigate the global startup ecosystem, recognizing the role of incubators.	L2	Understand
CO2	Cultivate an Entrepreneurial Mindset: Develop creative problem-solving skills applicable to diverse challenges.	L3	Apply
CO3	Create Effective Business Models: Develop versatile business plans, applying lean startup methodologies and addressing customer needs.	L6	Create
CO4	Navigate Technology and Innovation: Understand the intersection of technology and entrepreneurship, including the protection of intellectual property.	L2	Understand
CO5	Master Fundraising Strategies: Evaluate diverse fundraising avenues and impress potential investors with innovative ideas.	L5	Evaluate
CO6	Execute and Foster Growth: Apply skills for effective startup execution and explore strategies for sustained growth.	L3	Apply

Course Contents

Unit-I — 08 Hrs.

Understanding the Entrepreneurial Ecosystem

- Introduction to Entrepreneurship and Startups
- Global and Local Entrepreneurial Landscapes
- Role of Incubators and Accelerators
- Case Studies of Successful Startups
- Guest Lectures from Entrepreneurs and Incubator Managers

Unit-II — 08 Hrs.

Developing a Startup Mindset

- Cultivating an Entrepreneurial Mindset
- Design Thinking and Creativity in Mechanical Engineering
- Innovation and Idea Generation
- Practical Exercises and Workshops on Creative Problem Solving
- Group Projects: Ideation and Concept Development

Unit-III — 06 Hrs.

Business Model Development

- Introduction to Business Models
- Lean Startup Methodology
- Customer Validation and Market Research
- Prototyping and Minimum Viable Product (MVP)
- Business Model Canvas Workshop
- Pitching Practice: Presenting Business Models

Unit-IV — 06 Hrs.

Technological Innovation and Intellectual Property

- Technology Readiness Levels (TRLs)
- Technology and Entrepreneurship
- Intellectual Property Basics (Patents, Trademarks, Copyrights)
- Patent Search and Analysis
- Strategies for Protecting Intellectual Property
- Ethical Considerations in Technology and Innovation

Unit-V — 06 Hrs.

Fundraising and Investment Strategies

- Fundraising Options for Start-ups
- Indian Government Schemes for Start-ups and Entrepreneurs
- Angel Investors and Venture Capital
- Crowdfunding Platforms
- Financial Modelling for Startups

- Crafting an Effective Pitch
- Mock Pitch Sessions and Feedback

Unit-VI 05 Hrs.

Execution and Scaling

- Challenges in Startup Execution
- Operations and Logistics for Startups
- Scaling Strategies for Mechanical Engineering Startups
- Case Studies of Startup Success and Failure
- Final Project: Develop and Present a Comprehensive Startup Plan
- Course Review and Reflection

Books Recommended

Text Books:

1 "Technology Entrepreneurship", Taking Innovation to the Marketplace by Thomas N. Duening.

2 "Entrepreneurship Trajectories", by Diego Matricano

3 "Entrepreneurship Development in India" by Vasant Desai

Reference Books:

1 "The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses" by Eric Ries

2 "Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers" by Alexander Osterwalder and Yves Pigneur

3 "Zero to One: Notes on Startups, or How to Build the Future" by Peter Thiel and Blake Masters

4 "The Art of Startup Fundraising: Pitching Investors, Negotiating the Deal, and Everything Else Entrepreneurs Need to Know" by Alejandro Cremades

5 "The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail" by Clayton M. Christensen

6 "Venture Deals: Be Smarter Than Your Lawyer and Venture Capitalist" by Brad Feld and Jason Mendelson

7 "Disciplined Entrepreneurship: 24 Steps to a Successful Startup" by Bill Aulet

8 "The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company" by Steve Blank and Bob Dorf

9 "Crossing the Chasm: Marketing and Selling Disruptive Products to Mainstream Customers" by Geoffrey A. Moore

10 "The Founder's Dilemmas: Anticipating and Avoiding the Pitfalls That Can Sink a Startup" by Noam Wasserman

11 "Entrepreneurship Development in India" by S. Anil Kumar

12 "Entrepreneurship: Theory and Practice" by Dr. S. Ramesh Kumar

13 "Indian Entrepreneurship: Analysis of Business Practices" by Rajat K Baisya

14 "Start-up Sutra: What the Angels Won't Tell You About Business and Life" by Rohit Prasad

15 "Entrepreneurship Development in India" by Vasant Desai

16 "Startup Capitals: Discovering the Global Hotspots of Innovation" by Zafar Anjum

17 "From Start-Up to Global Success: The Zensar Story" by Ganesh Natarajan

18 "India's Intellectual Property Landscape: Lessons from the Biotechnology and Pharmaceutical Industries" by Kshama V. Kaushik

19 "The Making of India: Gamechanging Transitions" by Akhilesh Tilotia

20 "The Mouse Charmers: Digital Pioneers of India" by Anuradha Goyal

Evaluation Scheme

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of the semester.

Continuous Assessment (B):

1. Two term tests of 15 marks each will be conducted during the semester.
2. Total duration allotted for writing each of the papers is 1 hour.
3. Best of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper will be based on the entire syllabus summing up to 65 marks.
2. Total duration allotted for writing the paper is 2 hours.

Incubation, Entrepreneurship and Startups Laboratory

(22PEME5066L)

Teaching Scheme
Practical : 02 Hrs./week
Credit : 01

Examination Scheme
Teacher Assessment: 25 Marks
End Sem Exam : 00 Marks

Prerequisites:

Nil

Course Objectives

1 To enable participants in exploring the Startup World: Investigate global startup stories and the role of incubators in fostering growth.

2 To foster an entrepreneurial mindset in participants: Develop creative problem-solving skills applicable to diverse challenges.

3 To guide participants in building effective Business Models: Learn the art of creating versatile business plans and understanding customer needs.

4 To assist participants in understanding Tech and Innovation: Explore the intersection of technology and entrepreneurship, and basics of idea protection.

5 To educate participants on Fundraising for Innovative Ventures: Explore diverse fundraising avenues and strategies to impress potential investors.

6 To equip participants for Execution and Growth: Develop skills for turning plans into action and strategies for sustained startup growth.

Course Outcomes:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Effectively Navigate the Global Startup Landscape: Understand and navigate the global startup ecosystem, recognizing the role of incubators.	L2	Understand
CO2	Cultivate an Entrepreneurial Mindset: Develop creative problem-solving skills applicable to diverse challenges.	L3	Apply
CO3	Create Effective Business Models: Develop versatile business plans, applying lean startup methodologies and addressing customer needs.	L6	Create
CO4	Navigate Technology and Innovation: Understand the intersection of technology and entrepreneurship, including the protection of intellectual property.	L2	Understand
CO5	Master Fundraising Strategies: Evaluate diverse fundraising avenues and impress potential investors with innovative ideas.	L5	Evaluate
CO6	Execute and Foster Growth: Apply skills for effective startup execution and explore strategies for sustained growth.	L3	Apply

Suggested Exercises

1. Market Research Simulation:
   Conduct a simulated market research project to identify potential customer needs and preferences for a startup idea.
2. Business Model Canvas Workshop:
   Collaboratively create a Business Model Canvas for a startup concept, emphasizing key components like value proposition, customer segments, and revenue streams.
3. Prototyping Challenge:
   Design and build a prototype of a product or service related to mechanical engineering, emphasizing rapid prototyping techniques.
4. Intellectual Property Workshop:
   Explore case studies and scenarios related to intellectual property in the context of startups, fostering an understanding of patenting, trademarks, and copyrights.
5. Pitching Practice Session:
   Engage in pitching sessions where students present their startup ideas, receiving constructive feedback from peers and instructors.
6. Financial Modelling Exercise:
   Develop a financial model for a startup project, considering costs, revenue projections, and potential investment scenarios.
7. Angel Investing Simulation:
   Simulate an angel investing scenario where students evaluate and decide on potential investments in startup projects.
8. Crowdfunding Campaign Design:
   Design a crowdfunding campaign for a startup idea, including the creation of promotional materials, goals, and rewards.
9. Startup Execution Simulation:
   Participate in a simulation that mirrors the challenges of executing a startup plan, allowing students to make decisions and adapt to changing circumstances.
10. Scaling Strategies Discussion:
    Analyse and discuss different strategies for scaling a startup, considering factors such as market expansion, partnerships, and technology adoption.

    Minimum eight 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

Text Books:

1 "Technology Entrepreneurship", Taking Innovation to the Marketplace by Thomas N. Duening.
2 "Entrepreneurship Trajectories", by Diego Matricano
3 "Entrepreneurship Development in India" by Vasant Desai

Reference Books:

1 "The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses" by Eric Ries
2 "Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers" by Alexander Osterwalder and Yves Pigneur

3 "Zero to One: Notes on Startups, or How to Build the Future" by Peter Thiel and Blake Masters
4 "The Art of Startup Fundraising: Pitching Investors, Negotiating the Deal, and Everything Else Entrepreneurs Need to Know" by Alejandro Cremades
5 "The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail" by Clayton M. Christensen
6 "Venture Deals: Be Smarter Than Your Lawyer and Venture Capitalist" by Brad Feld and Jason Mendelson
7 "Disciplined Entrepreneurship: 24 Steps to a Successful Startup" by Bill Aulet
8 "The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company" by Steve Blank and Bob Dorf
9 "Crossing the Chasm: Marketing and Selling Disruptive Products to Mainstream Customers" by Geoffrey A. Moore
10 "The Founder's Dilemmas: Anticipating and Avoiding the Pitfalls That Can Sink a Startup" by Noam Wasserman
11 "Entrepreneurship Development in India" by S. Anil Kumar
12 "Entrepreneurship: Theory and Practice" by Dr. S. Ramesh Kumar
13 "Indian Entrepreneurship: Analysis of Business Practices" by Rajat K Baisya
14 "Start-up Sutra: What the Angels Won't Tell You About Business and Life" by Rohit Prasad
15 "Entrepreneurship Development in India" by Vasant Desai
16 "Startup Capitals: Discovering the Global Hotspots of Innovation" by Zafar Anjum
17 "From Start-Up to Global Success: The Zensar Story" by Ganesh Natarajan
18 "India's Intellectual Property Landscape: Lessons from the Biotechnology and Pharmaceutical Industries" by Kshama V. Kaushik
19 "The Making of India: Gamechanging Transitions" by Akhilesh Tilotia
20 "The Mouse Charmers: Digital Pioneers of India" by Anuradha Goyal

Evaluation Scheme

The distribution of marks shall be as follows:

Continuous Assessment (A):

Term work shall consist of minimum 8 experiments.

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks
4. Subject Specific Lab Assignment/Case Study: 10 Marks

The final certification and acceptance of laboratory journal/manual/report will be subject to satisfactory performance of Laboratory work and upon fulfilling minimum passing criteria in the teacher assessment.

Design Validation through Prototyping (22PEME5067T)

Teaching Scheme	**Examination Scheme**
Lectures: 03 Hr/week	Term Test : 15 Marks
Tutorial: 00 Hr/week	Teacher Assessment : 20 Marks
Credit : 03	End Sem Exam : 65 Marks

Prerequisites:

Fundamentals of Mechanical Engineering

Course Objectives

1 Understand the importance of prototyping in product development and design validation.

2 Learn various prototyping techniques and tools, including low-fidelity and high-fidelity prototyping methods.

3 Develop skills in gathering and interpreting user feedback to inform prototyping decisions.

4 Explore strategies for rapidly iterating on prototypes to refine product concepts.

5 Gain experience in effectively communicating and presenting prototype designs to stakeholders.

Course Outcomes:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Explain the role of prototyping in product development and design validation.	L2	Understand
CO2	Compare various methods of prototyping and select a suitable method for a given application.	L3	Apply
CO3	Demonstrate proficiency in utilizing various prototyping technologies and techniques.	L3	Apply
CO4	Plan and execute design validation tests, including usability, functional, and compliance testing.	L4	Analyze
CO5	Understand regulatory and compliance requirements and integrate them into the design validation process.	L2	Understand

Course Contents

Unit-I 04 Hrs.

Introduction to Prototyping and Design Validation

- Product design and development process
- Need and role of prototyping in product development
- Dimensions of prototyping (four quadrants)
- Prototyping process
- Business case for prototyping
- Concept, need, and goals of product validation
- Overview of design validation methodologies
- Challenges and considerations

Unit-II 10 Hrs.

Classification of Prototyping Techniques

- Low-fidelity prototyping: sketching, wireframing, paper, storyboarding, and card sorting
- Mid-fidelity prototyping
- High-fidelity prototyping: interactive, functional, Augmented Reality (AR), Virtual Reality (VR), simulation and emulators, high-fidelity mockups
- Other approaches: digital/virtual prototyping, physical prototyping, functioning prototyping, iterative prototyping
- Selecting the appropriate prototyping method
- Prototype scale: Full-, half-, quarter-, desktop-, micro-, and macro-scale

Unit-III 05 Hrs.

Prototyping Technologies - I

- 3D printing, CNC machining, Injection molding, Vacuum casting, Laser cutting and engraving, Foam modeling, and Soft prototyping
- Physical prototyping materials and tools

Unit-IV 05 Hrs.

Prototyping Technologies - II

- Prototyping software for 3D modeling and CAD
- Interactive mockup tools
- Code-based prototyping
- Accessibility and inclusive design tools
- Prototyping kits and templates
- Cloud-based prototyping and collaboration platforms

Unit-V 08 Hrs.

Prototyping Planning, Execution, and Design Validation

- Planning prototyping activities: define goals, objectives, requirements and constraints
- Conceptualize and ideate: generate initial design concept
- Select prototyping method
- Develop prototype design: translating requirements and constraints into prototype
- Prototype fabrication
- Tests for design validation: functionality, performance, usability, reliability, etc. qualitative and quantitative testing methods to gather feedback from users and stakeholders
- Iterate and refine
- Finalize Design
- Document and communicate

Unit-VI 07 Hrs.

Regulatory Compliance and Standards

- Importance of regulatory requirements, compliance, and industry standards
- Regulatory agencies and bodies: FDA, ISO, ASTM, etc.
- Industry-specific regulations: medical devices, automotive, aerospace, etc.
- Types of compliance testing: safety, performance, environmental, electromagnetic compatibility (EMC), etc.
- Laboratory testing vs. field testing: advantages and limitations
- Impact of regulatory requirements on prototype planning, design and materials selection
- Incorporating compliance considerations into the design validation process
- Risk assessment and mitigation strategies in compliance testing
- Documentation and recordkeeping; data management strategies
- Case studies: Compliance testing and regulatory challenges

Books Recommended

Textbooks:

1. Prototyping and Modelmaking for Product Design by Bjarki Hallgrimsson, 2nd Edition, Quercus Publishing, 2023.
2. Rapid Prototyping: Principles and Applications in Manufacturing by Chua, C.K., Leong, K.F., John Wiley and Sons Inc., 2003.
3. Rapid Prototyping: Principles and Applications by Noorani, R., John Wiley Sons, Inc., New Jersey, 2006.

Reference Books:

1 Prototyping: A Practitioner's Guide by Todd Zaki Warfel, Rosenfeld Media 2009.
2 Prototype: Design and Craft in the 21st Century, by Louise Valentine, Bloomsbury Publishing 2013.
3 Product Design and Development by Karl T. Ulrich and Steven D. Eppinger, McGraw-Hill/Irwin, 2012.

Web References:

1 Electronics equipment integration and Prototype building - `https://nptel.ac.in/courses/108108157`
2 Physical Modelling for Electronics Enclosures using Rapid prototyping - `https://nptel.ac.in/courses/108108115`

Evaluation Scheme

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of the semester.

Continuous Assessment (B):

1. Two term tests of 15 marks each will be conducted during the semester.
2. Total duration allotted for writing each of the papers is 1 hour.
3. Best of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper will be based on the entire syllabus summing up to 65 marks.
2. Total duration allotted for writing the paper is 2 hours.

Design Validation through Prototyping Laboratory

(22PEME5067L)

Teaching Scheme	**Examination Scheme**
Practical : 02 Hrs./week	Teacher Assessment: 25 Marks
Credit : 01	End Sem Exam : 00 Marks

Prerequisites:

Fundamentals of Mechanical Engineering

Course Objectives

1 Understand the importance of prototyping in product development and design validation.

2 Learn various prototyping techniques and tools, including low-fidelity and high-fidelity prototyping methods.

3 Develop skills in gathering and interpreting user feedback to inform prototyping decisions.

4 Explore strategies for rapidly iterating on prototypes to refine product concepts.

5 Gain experience in effectively communicating and presenting prototype designs to stakeholders.

Course Outcomes:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Explain the role of prototyping in product development and design validation.	L2	Understand
CO2	Compare various methods of prototyping and select a suitable method for a given application.	L3	Apply
CO3	Demonstrate proficiency in utilizing various prototyping technologies and techniques.	L3	Apply
CO4	Plan and execute design validation tests, including usability, functional, and compliance testing.	L4	Analyze
CO5	Understand regulatory and compliance requirements and integrate them into the design validation process.	L2	Understand

Suggested Experiments

1 Study the role of prototyping in the product design and development process.

2 Low-fidelity prototyping: sketching, wireframing, paper, storyboarding, and card sorting.

3 Mid-fidelity prototyping.

4 High-fidelity prototyping: interactive, functional, Augmented Reality (AR), Virtual Reality (VR), simulation and emulators, high-fidelity mockups.

5 Selecting the appropriate prototyping method and scale (Full-, half-, quarter-, desktop-, micro-, and macro-scale).

6 3D printing/ CNC machining/ Injection molding/ Vacuum casting/ Laser cutting and engraving/ Foam modeling/ and Soft prototyping.

7 Prototyping software for 3D modeling and CAD/ Interactive mockup tools/ Code-based prototyping/ Accessibility and inclusive design tools/ Prototyping kits and templates.

8 Cloud-based prototyping and collaboration platforms.

9 Prototyping materials and tools.

10 Study on the prototyping planning and execution process

11 Study on the various regulatory compliance and standards (in a group of 3-4 students)

12 Types of compliance testing: safety, performance, environmental, electromagnetic compatibility (EMC), etc.

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

Books Recommended

Textbooks:

1. Prototyping and Modelmaking for Product Design by Bjarki Hallgrimsson, 2nd Edition, Quercus Publishing, 2023.
2. Rapid Prototyping: Principles and Applications in Manufacturing by Chua, C.K., Leong, K.F., John Wiley and Sons Inc., 2003.
3. Rapid Prototyping: Principles and Applications by Noorani, R., John Wiley Sons, Inc., New Jersey, 2006.

Reference Books:

1 Prototyping: A Practitioner's Guide by Todd Zaki Warfel, Rosenfeld Media 2009.

2 Prototype: Design and Craft in the 21st Century, by Louise Valentine, Bloomsbury Publishing 2013.

3 Product Design and Development by Karl T. Ulrich and Steven D. Eppinger, McGraw-Hill/Irwin, 2012.

Web References:

1 Electronics equipment integration and Prototype building - `https://nptel.ac.in/courses/108108157`

2 Physical Modelling for Electronics Enclosures using Rapid prototyping - `https://nptel.ac.in/courses/108108115`

Evaluation Scheme

The distribution of marks shall be as follows:

Continuous Assessment (A):

Term work shall consist of minimum 8 experiments.

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks
4. Subject Specific Lab Assignment/Case Study: 10 Marks

The final certification and acceptance of laboratory journal/manual/report will be subject to satisfactory performance of Laboratory work and upon fulfilling minimum passing criteria in the teacher assessment.

Environmental Studies
(22MCME5070T)

Teaching Scheme	**Examination Scheme**
Lectures: 01 Hr/week	**Audit Course**

Prerequisites:

Interest in Environment and its impact on Human

Course Objectives

1. Understand environmental issues such as depleting resources, pollution, ecological problems and the renewable energy scenario.
2. Familiarize environment related legislation.
3. Understand and compare solar energy.

Course Outcomes:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Understand how human activities affect environment.	L2	Understand
CO2	Understand the various technology options that can make a difference.	L2	Understand
CO3	Identify the advantages of solar energy over other forms of energy.	L2	Understand

Course Contents

Unit-I 05 Hrs.

Social Issues and Environment

- Ecological footprint and Carrying Capacity
- Depleting nature of Environmental resources such as soil, water, minerals and forests
- Carbon emissions and Global Warming
- Concept of Carbon credit
- Green Building

Unit-II 05 Hrs.

Technological Growth for Sustainable Development

- Social, Economical and Environmental aspects of Sustainable Development
- Renewable Energy Harvesting
- Power and functions of Central Pollution Control Board and State Pollution Control Board

Unit-III 03 Hrs.

Solar Energy

- Basic concept of Solar Radiation
- Study of Solar panels
- Comparative study of Solar energy with other energy sources

Books Recommended

Textbooks:

1. Environmental Studies from Crisis to Cure, R. Rajagopalan, 2012
2. Textbook of Environmental Studies for Undergraduate Courses, Erach Bharucha
3. Solar Engineering Sukhatme

Evaluation Scheme

Continuous Assessment :

Performance in the assignments / quiz / power point presentation / poster presentation / group project / any other tool.

Semester Project-III

(22PJME5080L)

Practical Scheme
Practical: 02 Hrs./week
Credit : 01

Examination Scheme
Teacher Assessment : 25 Marks
End Sem Exam: 25 Marks

Course Outcomes:

Students are expected to design, simulate/implement a project based on the knowledge acquired from current semester subjects.

Course Outcomes:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Conduct a survey of several available literatures in the preferred field of study.	L4	Analyze
CO2	Demonstrate various/alternate approaches to complete a project.	L3	Apply
CO3	Ensure a collaborative project environment by interacting and dividing project work among team members.	L4	Analyze
CO4	Present their project work in the form of a technical report/paper and thereby improve technical communication skills.	L2	Understand
CO5	Demonstrate the ability to work in teams and manage the conduct of the research study.	L2	Understand

Semester Project:

The purpose of introducing a semester project at the Third-year level is to provide exposure to students with a variety of projects based on the knowledge acquired from the semester subjects. This activity is supposed to enrich their academic experience and bring enough maturity to the student while selecting the project. Students should take this as an opportunity to develop skills in implementation, presentation, and discussion of technical ideas/topics. Proper attention shall be paid to the content of report, which is being submitted in partial fulfillment of the requirements of the Third-year, and it is imperative that a standard format be prescribed for the report.

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 Semester Project. Each group shall submit at least 3 topics for the Semester Project. The departmental committee shall finalize one topic for every group. The Semester Project Title or Theme should be based on the knowledge acquired during the semester. The project work shall involve sufficient work so that students get acquainted with different aspects of knowledge acquired from semester subjects.

Student is expected to:

- Select an appropriate project title based on acquired knowledge from current semester 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 (at the end of the semester) will be done by the departmental committee (including project guide).

Prescribed project report guidelines:
The Project Report (minimum of 25 pages) should include appropriate content for:

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

Assessment criteria for the 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

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

Assessment criteria for the departmental committee (including project guide) for End Semester Exam:
The departmental committee (including project guide) will evaluate the project as per Table 3. Each group shall present/publish a paper based on the semester project in reputed/peer-reviewed Conference/Journal/TechFest/Magazine before the end of the semester.

Employability Skill Development Program-II

(22HMME5090L)

Practical Scheme
Practical: 02 Hrs./week
Credit : 01

Examination Scheme
Teacher Assessment : 50 Marks

Course Outcomes:

Basic Mathematics, Basic knowledge of C programming.

Course Objectives:

1. To enhance problem-solving skills with real-life examples.
2. To enable students to express their thoughts and knowledge on various platforms.
3. Able to describe basic database management systems.
4. Able to implement basic programming projects using Python.

Course Outcomes:

CO	Course Outcomes	Bloom's Level	Bloom's Description
CO1	Analyze and solve logical problems based on words, Venn diagrams, etc.	L4	Analyze
CO2	Understand and solve English comprehension, sentence completion, sentence correction problems.	L4	Analyze
CO3	Understand and illustrate the concepts of exception handling, garbage collection.	L3	Apply
CO4	Understand and describe the fundamentals of DBMS, NoSQL, MongoDB.	L2	Understand

Course Contents

Unit-I 10 Hrs.

Aptitude

Reasoning: Data sufficiency, logical deductions, logical sequence of words, logical Venn diagrams, statement and arguments, statement and assumptions, statement and conclusions, syllogism.
English: Reading comprehension, para jumbles, cloze test, tenses/ voice/ speech, prepositions/ SVA/ articles, vocab/ verbal analogy, sentence completion, sentence correction.

Unit-II 10 Hrs.

Fundamental of Programming

Modules: Introduction, importance of modularity programming, import keyword, user-defined modules creation, function-based modules, classes based modules, connecting modules, 'from' keyword.
Exception Handling: Introduction, the need for exception handling, getting exceptions, default exception handler, handling exception, try, except.
Garbage Collection: Introduction, importance of manual GC, self-referenced objects, 'gc' module, collect() method, threshold function.

Unit-III 08 Hrs.

Fundamental of Programmings

Collections Framework: Introduction to collection of data types, importance of data processing, DS algorithms introduction.
textbfList: Create a list, adding elements, deleting elements, predefined functionality of List, nested List, immutability and mutability of List.
Set: The functionality of Set object, frozen set, dictionaries, create a dictionary, adding elements.
Dict: Predefined functions of Dict class, programs using collection types.

Unit-IV 08 Hrs.

Tkinter-GUI

Tkinter-GUI: Types of layouts, create labels and display images, create buttons, create events, StringVar class, calculator program using GUI.
Basic ML AI including projects iterators, nested functions, generators, closures, decorators, basic ML and AI, PIP, visualization, etc.

Project Domain (Per domain 1 or 2 projects)

1. ML/AI Based Projects
2. Data Analysis Based projects
3. Test Summarization based projects
4. Web scraping and crawling

Unit-V 10 Hrs.

DBMS

DBMS Using Python: Introduction to MySQL, MySQL-Python connectivity, execute DDL commands, execute DRL commands, execute DML commands, transaction management examples (rollback and commit), GUI-Database connectivity.
NoSQL Using Python: Installation and configuration, MongoDB advantages, MongoDB data modeling, MongoDB tools, collection and documents, CRUD and the MongoDB shell, introduction to CRUD, introduction to the MongoDB API, creating a database, collection and documents.
Data Modeling and Schema Design: MongoDB database references model tree structures, MongoDB analyzing queries, MongoDB atomic operations, MongoDB MapReduce, MongoDB text search, MongoDB regular expression, MongoDB capped collections.
Administration: MongoDB deployment and cluster setup, MongoDB GridFS, Trident Spout, working with replica sets, MongoDB sharding.

Reference Books:

1 Dr. R S Aggarwal, "Quantitative Aptitude for Competitive Examinations", S. Chand Publication.

2 M. G. Venkateshmurthy, "Programming Techniques through C", Pearson Publication.

3 Behrouz Forouzan, "A Computer Science Structure Programming Approaches using C", Cengage Learning.

4 Yashwant Kanetkar, "Let Us C", BPB Publication.

Evaluation Scheme:

Teacher Assessment (TA):

Teacher's Assessment (TA) will carry weightage of 50 marks. The distribution of marks for term work shall be as follows:

1 MCQ Test based on Aptitude: 20 Marks

2 MCQ Test based on Programming skills: 20 Marks

3 Mock Interview: 10 Marks

Any other component recommended by BOS and approved by Dean Academics.