Shirpur Education Society's

R. C. Patel Institute of Technology, Shirpur

(An Autonomous Institute)

Course Structure and Syllabus

Final Year B.Tech. (Mechanical Engineering)

with effect from Year 2023-24

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

Semester-VII (w.e.f.2023-24)													
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	PCME7010T	Machine Design - II	3	-	-	20	15	15	15	65	100	3
2	PC	PCME7010L	Machine Design - II Laboratory	-	-	2	25	-	-	-	25	50	1
5	PC	PCME7020T	Finite Element analysis	3	-	-	20	15	15	15	65	100	3
6	PC	PCME7020L	Finite Element analysis Laboratory	-	-	2	25	-	-	-	25	50	1
7	PE	PEME703-T	Professional Elective Course	3	-	-	20	15	15	15	65	100	3
7	OE	OEME704-T	Open Elective Course	3	-	-	20	15	15	15	65	100	3
8	PJ	PJME7050L	Project Stage-II	-	-	8	25	-	-	-	25	50	4
			Total	12	-	12	155	60	60	60	335	550	18
PC-Professional Course, PE- Professional Elective, OE- Open Elective,PJ-Project													

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Sem.-VII-Professional Elective Courses		
Sr. No.	Course Code	Course Title
1	PEME7031	Production Planning and Control
2	PEME7032	Additive Manufacturing
3	PEME7033	Computational Fluid Dynamics
4	PEME7034	Machine Health Monitoring Management
5	PEME7035	Big Data Analysis
6	PEME7036	Robotics
7	PEME7037	Tribology
8	PEME7038	Automobile Engineering

Sem.-VII-Open Elective Courses		
Sr. No.	Course Code	Course Title
1	OEME7041	Product Lifecycle Management
2	OEME7042	Management Information System
3	OEME7043	Operation Research
4	OEME7044	Cyber Security and Laws
5	OEME7045	Personal Finance Management
6	OEME7046	Energy Audit and Management
7	OEME7047	Disaster Management and Mitigation Measures
8	OEME7048	Science of Well-being
9	OEME7049	Research Methodology
10	OEME70410	Public Systems and Policies

Semester-VIII (w.e.f.2023-24)													
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	PE	PEME801-T	Professional Elective-1	3	-	-	20	15	15	15	65	100	3
2	PE	PEME802-T	Professional Elective-2	3	-	-	20	15	15	15	65	100	3
3	PJ	PJME8030L	Internship	-	-	20	150	-	-	-	150	300	10
Total				6	-	20	190	30	30	30	280	500	16
PE- Professional Elective, PJ-Project													

1. *Professional Elective Courses offered for the students doing Internship at institute level.
2. #Professional Elective Courses offered for the students doing Internship at Industry. These courses are to be studied in self study mode using NPTEL/Swayam platform.
3. Students doing internship at industry shall submit certificate of NPTEL examination OR they have to appear examinations conducted by institute like TT1, TT2 and ESE.
4. List of NPTEL courses will be declared by concerned BOS at the beginning of semester.

Sem.: VIII-Professional Elective-1		
Sr. No.	Course Code	Course Title
1	PEME8011	Design of Mechanical Systems*
2	PEME8012	Industrial Engineering*
3	PEME8013	CAD/CAM/CIM*
4	PEME8014	Smart Industries*
5	PEME8015	Sustainable Energy Management*
6	PEME8016	Industrial Waste Management*
7	PEME8017	NPTEL/Swayam Course#

Sem.: VIII-Professional Elective-2		
Sr. No.	Course Code	Course Title
1	PEME8021	Business Analytics*
2	PEME8022	IoT and Applications*
3	PEME8023	Process Equipment Design*
4	PEME8024	Motor Sports Engineering*
5	PEME8025	Advanced Quantitative Techniques*
6	PEME8026	NPTEL/Swayam Course#

Prepared by

Checked by

BOS Chairman

Dean Academic/Dy. Director

C.O.E.

Director

OFFICE SEAL

Shirpur Education Society's

R. C. Patel Institute of Technology, Shirpur
(An Autonomous Institute)

Syllabus Booklet
Mechanical Engineering

Final Year B.Tech

With effect from Academic Year 2023-24

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

Detailed syllabus of Final Year in Mechanical Engineering (Semester VII)

Machine Design -II (PCME7010T)

Teaching Scheme
Lectures : 3 Hrs./week
Credit : 3

Examination Scheme
Term Test : 15 Marks
Teacher Assessment : 20 Marks
End Sem Exam : 65 Marks
Total: 100 Marks

Prerequisite:

Basic Knowledge of Strength of Materials and Basic concepts of Design of machine element with different modes of failures.

Course Objectives:

1. To acquaint with functional and strength design principles of important machine elements.
2. To familiarize selection of standard elements such as rolling contact bearings, chains etc.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Select appropriate gears for power transmission on the basis of given power and speed.	L3	Applying
CO2	Design gears based on the given conditions.	L6	Create
CO3	Select bearings for a given application from the manufacturers catalogue.	L3	Applying
CO4	Design the flywheel for given applications.	L6	Create
CO5	Design cam and follower mechanisms.	L6	Create
CO6	Design clutches and brakes.	L6	Create

Course Contents

Unit-I 13 Hrs

Design of Gears:

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

Gear Box: Two stage Gear box with fixed ratio consisting of spur, helical and bevel gear pairs: gear box housing layout and housing design.

Unit-II 05 Hrs

Rolling Contact Bearings:

Types of bearing, designation, selection of rolling contact bearings based on constant / variable load speed conditions (includes deep groove ball bearing, cylindrical roller, spherical roller, taper roller, self-aligning bearing and thrust bearing)

Unit-III 05 Hrs

Sliding Contact Bearings: Design of hydro dynamically lubricated bearings (self contained), Introduction to hydro static bearings, Types and selection of Mechanical seals.

Unit-IV 09 Hrs

Design of Cams and Followers:

Design of Cam and Roller follower Mechanisms with spring and shaft. Design and selection of standard roller chains.

Design of Brakes:

Shoe and drum type, disk type. Design of lever arm.

Unit-V 10 Hrs

Design of Flywheel: Introduction, Fluctuation of energy and speed, turning moment diagram, estimating inertia of flywheel for reciprocating prime movers and machines, Weight of the flywheel, flywheel for punches, rim constructions, stresses in rims and arms,Construction of flywheel.

Design of Clutches: Introduction, types, Basic theory of plate and cone type clutches,Design of single plate, multi-plate and cone clutches with spring, lever design.

Text Books

1. Design of Machine Elements - V.B. Banadari - Tata McGraw Hill Publication
2. Design of Machine Elements - Sharma, Purohil - Prentice Hall India Publication
3. Machine Design -An Integrated Approach - Robert L. Norton - Pearson Education
4. Mechanical Engineering Design by J.E.Shigley - McGraw Hill
5. Fundamentals of Machine Elements - Hawrock, Jacobson - McGraw Hill
6. Design of Machine Elements - V.M.Faires
7. Design of Machine Elements - Spotts

Reference Books

1. Machine Design - Pandya Shah - Charotar Publishing
2. Machine Design Reshetov - Mir Publication
3. Machine Design - Black Adams - McGraw Hill
4. Machine Design - R.C.Patel, Pandya, Sikh, Vol-I II - C. Jamnadas Co
5. Design Data book - P.S.G. College of Technology, Coimbatore.
6. Design Data Book - Mahadevan

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.
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 hrs.

Machine Design -II Laboratory (PCME7010L)

Practical Scheme	**Examination Scheme**
Practical : 2 Hrs./week	Teacher Assessment : 25 Marks
Credits : 1	End Sem Exam : 25 (Oral) Marks
	Total: 50 Marks

Laboratory work comprises of parts A and B.

Part A: **1. Design Exercises:** Design and detailed assembly drawing of minimum two from the following list(Computer aided drawing on A3 size sheets)

1. Design of Gears and gear box
2. Design of cam and followers
3. Design of clutches
4. Design of brakes

2. Course Project: Students in a group of two to four will design and prepare working drawings of any system having minimum 5 to 6 components by applying the knowledge gained during the course.

Part B: **Assignment:** Each assignment containing at least 2 problems of design calculations with sketches on following topics.

1. Rolling contact bearings
2. Sliding contact bearing
3. Chain and flywheel.

Evaluation Scheme:

Continuous Assessment (A):

Term Work comprises of work carried out during laboratory hours.

The distribution of marks shall be as follows:

1. Part (A): 15 Marks
2. Part (B): 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.

End Semester Examination (C):

Oral examination will be based on the entire syllabus including, the design exercises performed during laboratory sessions.

Finite Element Analysis(PCME7020T)

Teaching Scheme	**Examination Scheme**
Lectures : 3 Hrs./week	Term Test : 15 Marks
Credit : 3	Teacher Assessment : 20 Marks
	End Sem Exam : 65 Marks
	Total: 100 Marks

Prerequisite:

1. Knowledge of Matrices, Differential Equations and Numerical Integrations.

Course Objectives:

1. To familiarize learners with concepts of FEA
2. To study the applicability of FEA to engineering problems
3. To familiarize learners with the FEA softwares to solve Engineering Problems.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Summarize the basics of finite element analysis.	L4	Analyze
CO2	Evaluate differential equations using weak and Non-weak form methods.	L5	Evaluate
CO3	Implement the basic finite element formulation techniques to solve one dimensional engineering problems using elements such as bar/beam/link element.	L3	Apply
CO4	Implement the basic finite element formulation techniques to solve two dimensional engineering problems using elements such as triangular and quadrilateral elements.	L3	Apply
CO5	Implement the basic finite element formulation techniques to find natural frequency of dynamic system.	L3	Apply
CO6	Use commercial FEA software, to solve problems related to mechanical engineering.	L3	Apply

Course Contents

Unit-I 08 Hrs

Introductory Concepts: Introduction to FEM, Historical Background, General FEA procedure, Applications of FEM in various fields, Advantages and disadvantages of FEA.

Definitions of Various Terms used in FEA: Element, order of the element, internal and external node/s, degree of freedom, primary and secondary variables and boundary conditions.

Mathematical Modelling of field problems in engineering, Governing equations, Differential equations in different fields. Approximate solution of differential equations.

Unit-II 08 Hrs

Weak and Non-Weak Form Methods: Discrete and Continuous Models, Weighted Residual Methods and Ritz Technique.

Minimization of a Functional: Principle of minimum total potential, Piecewise Rayleigh-Ritz method, Formulation of stiffness matrix, transformation and assembly concepts.

Unit-III 10 Hrs

One Dimensional Finite Element Formulations: One dimensional second order equations - discretization-element types - linear and higher order elements -derivation of shape functions and stiffness matrices and force vectors.

Assembly of Matrices: Solution of problems in one dimensional structural analysis, heat transfer and fluid flow (stepped and taper bars, fluid network and Spring-Cart Systems).Analysis of Plane trusses and Analysis of Beams.

Unit-IV 08 Hrs

Two Dimensional Finite Element Formulations: Three node triangular element, four-node rectangular element, four-node quadrilateral element and eight node quadrilateral element. Global, Local, Natural coordinates and coordinates transformations: serendipity and Lagranges methods for deriving shape functions for triangular and quadrilateral element. Sub parametric, Iso-parametric, super parametric elements, Compatibility conditions, Patch test, Convergence criterion and sources of errors in FEA.

Unit-V 08 Hrs

Stress Analysis of Two Dimensional Elements: Equations of Elasticity-Plane stress, plane strain and axisymmetric problems. Jacobian matrix, stress analysis of CST and four node Quadratic element.

Finite Element Formulation of Dynamic Systems: Applications to free vibration problems of rod and beam, Lumped and consistent mass matrices.

Solutions techniques to Dynamic problems, longitudinal vibration frequencies and mode shapes, Fourth order beam equation, transverse deflections and natural frequencies of beams.

Text Books

1. Text book of Finite Element Analysis P. Seshu - Prentice-Hall of India Pvt. Ltd.
2. The Finite Element Method Engineering- S S Rao-Butter Worth Heinemann.

Reference Books

1. Finite Element Method - J N Reddy - Tata McGraw Hill.
2. Finite Element Methods - R Dhanraj and K Prabhakaran Nair - Oxford University Press.
3. A first course in Finite Element Method - D. L. Logan - Asia Pvt Ltd.
4. Concepts and Applications of Finite Element Analysis - R. D. Cook, D. S. Malkus, M. E. Plesha - John Wiley Sons.
5. Introduction to Finite Elements in Engineering - Chandrupatla and Belegundu - Prentice-Hall of India Pvt. Ltd.
6. Fundamental Finite Element Analysis and Application with Mathematica and MATLAB Computations - M. Asghar Bhatti - Wiley India Pvt. Ltd.

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.

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 hrs.

Finite Element Analysis Laboratory

(PCME7020L)

Practical Scheme	**Examination Scheme**
Practical : 2 Hrs./week	Teacher Assessment : 25 Marks
Credits : 1	End Sem Exam : 25 Marks
	Total: 50 Marks

List of Laboratory Experiments

Students should use the commercial software (ANSYS/ABAQUS/NASTRAN/HYPERWORKS) or programmes from the text-books or self-developed programs to verify the results obtained by manual calculations.

1. Any two problems using 1D element: Analysis of axially loaded stepped/Tapered bar and beam.
2. Any two problems using truss element: Analysis of plane trusses.
3. Any two problems using 2D element: Analysis of plate with hole/notch.
4. Any one problem on steady state heat conduction.
5. Any one problem using axisymmetric element: Analysis of pressure vessel.
6. Any one problem of free vibration analysis for dynamic system.

While performing the analysis the students should understand the concepts of selection of element type, meshing and convergence of solution.

Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.

Course Project:A group of not more than four students, shall do Finite Element Analysis of any mechanical engineering component /system, which involves element selection, assigning properties, meshing, assigning loads, and boundary conditions, analysis and result interpretation.

Evaluation Scheme:

Continuous Assessment (A):

Term work shall consist of 6 exercises by using FEA software, Course Projects and minimum 2 assignments.

The distribution of marks shall be as follows:

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.

End Semester Examination (C):

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

Production Planning and Control (PEME7031)

Teaching Scheme	**Examination Scheme**
Lectures : 3 Hrs./week	Term Test : 15 Marks
Credit : 3	Teacher Assessment : 20 Marks
	End Sem Exam : 65 Marks
	Total: 100 Marks

Prerequisite:

1. Knowledge of basic concepts of Management

Course Objectives:

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

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.	L2	Understand
CO2	Illustrate various approaches and techniques for designing and developing products.	L2	Understand
CO3	Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.	L1	Remember
CO4	Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant.	L2	Understand

Course Contents

Unit-I 10 Hrs

Introduction to Product Lifecycle Management (PLM): Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications

PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy, Change management for PLM

Unit-II 08 Hrs

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

Unit-III 08 Hrs

Product Data Management (PDM): Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation .

Virtual Product Development Tools: For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modelling and simulations in Product Design, Examples/Case studies

Unit-IV 08 Hrs

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

Environmental Strategies and Considerations for Product Design.

Unit-V 08 Hrs

Life Cycle Assessment and Life Cycle Cost Analysis: Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis.

Text Books

1. Product Lifecycle Management: Paradigm for 21st Century Product Realization, John Stark, Springer-Verlag, 2004.
2. Product Design for the environment-A life cycle approach, Fabio Giudice, Guido La Rosa, Antonino Risitano, Taylor Francis 2006.

Reference Books

1. Product Life Cycle Management?, Saaksvuori Antti, Immonen Anselmie, Springer, Dreamtech.
2. Product Lifecycle Management: Driving the next generation of lean thinking, Michael Grieve, Tata McGraw Hill, 2006.
3. Product Life-Cycle Management: Geometric Variations, Franois Villeneuve, Luc Mathieu, Max Giordano, Wiley, 2010.

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.
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 hrs.

Additive Manufacturing (PEME7032)

Teaching Scheme	**Examination Scheme**
Lectures : 3 Hrs./week	Term Test : 15 Marks
Credit : 3	Teacher Assessment : 20 Marks
	End Sem Exam : 65 Marks
	Total: 100 Marks

Prerequisite: Knowledge of Production Processes and Material Technology.

Course Objectives:

1. To familiarize with importance of Rapid Prototyping in Product Development.
2. To make students aware about latest additive manufacturing technology used in industry,
3. To make students aware about various additive manufacturing processes and material availability.
4. To enable students to understand, describe and evaluate the different post processing techniques currently used on Additive Manufacturing parts.
5. To make students aware about latest research in the area of additive manufacturing.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Understand importance of Rapid Prototyping in product development.	L2	Understand
CO2	Apply basic knowledge of additive manufacturing to decide type of additive manufacturing process and material according components design requirement.	L3	Apply
CO3	To calculate and justify the cost of a typical additive manufacturing operation including labour costs, overhead costs, and consumable costs.	L4	Analyze
CO4	Evaluate the different post processing techniques used on AM parts, including those required for removal of support structures, improvement of surface characteristics and structural integrity.	L5	Evaluate
CO5	Conduct research work and research writing in the field of additive manufacturing.	L6	Create

Course Contents

Unit-I 08 Hrs

Introduction:

Product Development Cycle and the product Life Cycle. Problems in Product Development. Relationship between Product Development Cost and the Selling Price. Rapid prototyping need, Classification of RP systems, advantages and limitations of RP, Applications and scope of RP, Introduction to additive manufacturing.

Unit-II 12 Hrs

Classification of Additive Manufacturing Processes:

Seven Classes of Additive Manufacturing, Binder jetting, Directed Energy Deposition, Powder Bed Fusion, Sheet Lamination, Material Extrusion, Material Jetting, Vat Photo Polymerization Detailed discussion on latest technique available on each type of additive manufacturing processes. Specification, working principal, material compatibility and Post processing.

Unit-III 08 Hrs

Additive Manufacturing System Design: Process selection, Material selection, labor cost involved, overhead cost calculation, consumables cost, machine maintenance, Project Planning, Sensors used , Jigs and fixtures, Thermal management , Manufacturing Quality management.

Unit-IV 08 Hrs

Applications of Additive Manufacturing: Aerospace Applications, Medical applications, Art and Design applications, Energy applications, architecture applications.

Unit-V 06 Hrs

Intellectual Property Rights, IPR in Additive Manufacturing:

Case studies on Latest patents in the field of additive manufacturing, Case studies based on latest article Published in Scopus,SCI, and ESCI indexed journal.

Text Books

1. Additive Manufacturing Technologies Ian Gibson, David W Rosen, Brent Stucker., Mahyar Khorasani Springer.
2. Additive Manufacturing Juan Pou, Antonio Riveiro and J. Paulo Davim Elsevier

Reference Books

1. Multi-dimensional Additive Manufacturing Soshu Kiriharal, Kazuhiro Nakata Springer
2. Additive Manufacturing Processes SanjayKumar Springer
3. Polymer Based Additive Manufacturing Declan M. Devine Springer
4. Materials for Additive Manufacturing Yusheng Shi, Chunze Yan, Yan Zhou, Jiamin Wu, Yan Wang, Shengfu Yu,Ying Chen Academic Press, Elsevier
5. Additive Manufacturing (A Tool for Industrial Revolution 4.0) M. Manjaiah, K. Raghavendra, N.Balashanmugam, J. Paulo Davim Woodhead Publishing

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.
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 hrs.

Computational Fluid Dynamics(PEME7033)

Teaching Scheme

Lectures : 3 Hrs./week

Credit : 3

Examination Scheme

Term Test : 15 Marks

Teacher Assessment : 20 Marks

End Sem Exam : 65 Marks

Total: 100 Marks

Prerequisite: Knowledge of physical science related to heat and Basic concepts learnt in fluid mechanics with respect to boundary conditions.

Course Objectives:

1. To Study the working of CFD, governing Equations and discretization techniques
2. To Study basic heat transfer concepts numerically applicable for steady state and transient conditions

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain the working of a CFD code.	L4	Analyze
CO2	Understand the various Governing Equations.	L2	Understand
CO3	Understand turbulence modelling and various algorithms used in numerical techniques.	L2	Understand
CO4	Apply Finite Volume Method to solve numerical problems.	L3	Apply
CO5	Understanding the software used for simulation of numerical problems.	L2	Understand

Course Contents

Unit-I 05 Hrs

Introduction:

What is CFD, Scope and Application of CFD, Methods of Predictions like Experimental and theoretical, Working of Commercial CFD Softwares, Solution methodology-Preprocessing, Solver, Post processing.

Unit-II 08 Hrs

Mathematical description of Physical Phenomenon:

Governing Differential Equations, Meaning of Differential equation, The Continuity Equation, A Momentum equation, The Energy Equation, The General Differential Equation, Boundary Conditions, Initial and Boundary Conditions, Initial and Boundary Value problems.

Unit-III 08 Hrs

Turbulence Modelling:

Basic Theories of Turbulence, The Time-Averaged Equation for Turbulent Flow, The SIMPLE, SIMPLER Algorithm, Introduction to Finite Difference Method

Unit-IV 16 Hrs

Finite Volume Method applied to Heat Conduction, Convection and Diffusion:

Steady One-dimensional Conduction, Convection, Diffusion, Unsteady One-dimensional Conduction, Two and Three-dimensional Situations introduction.

Unit-V 05 Hrs

Simulation Softwares:

Introduction to the software used for Simulating numerical problems. Demonstrating the use of Python for solving basic fluid problems.

Text Books

1. An introduction to computational fluid dynamics-The finite volume method, Versteeg.H.K. ,

Malalasekera.W., Prentice Hall

Reference Books

1. Computational Fluid Mechanics and Heat Transfer, Anderson, D.A., Tannehill, I.I., and Pletcher, R.H., Hemishphere Publishing Corporation, New York, USA, 1984
2. Introduction to Computational Fluid Dynamics, Niyogi P. ,Laha M.K., Chakrabarty S.K., Pearson Education, India
3. Computational Fluid Flow and Heat Transfer, Muralidhar, K.,andSundararajan,T., Narosa Publishing House, New Delhi
4. Computer Simulation of flow and heat transfer, Ghoshdasdidar, P. S., Tata McGraw-Hill Publishing Company Ltd
5. Finite Element Programming of the Navier Stokes Equation, Taylor, C and Hughes J.B., Pineridge Press Ltd.U.K.
6. Computational Techniques for Fluid Dynamics: Fundamental and General Techniques, Fletcher, C.A.J., Springer- Verlag
7. Numerical Fluid Dynamics, Bose, T. K., Narosa Publishing House
8. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press
9. Anderson, J.D. Computational Fluid Dynamics, McGraw Hill

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.
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 hrs.

Machine Health Monitoring Management(PEME7034)

Teaching Scheme	**Examination Scheme**
Lectures : 3 Hrs./week	Term Test : 15 Marks
Credit : 3	Teacher Assessment : 20 Marks
	End Sem Exam : 65 Marks
	Total: 100 Marks

Prerequisite: Knowledge of Mechanical Vibrations.

Course Objectives:

1. To introduce parameters involved in machine health monitoring management.
2. To make students aware about Instrumentation and Signal Processing in machine health monitoring management.
3. To introduce importance of pattern recognition in machine health monitoring management.
4. To impart knowledge about the application of artificial intelligence techniques in Condition Monitoring
5. To impart knowledge about the application of Machine learning techniques in Condition Monitoring

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Understand basics of machine health monitoring management.	L2	Understand
CO2	Apply basic Instrumentation and signal processing technique in machine health monitoring management.	L3	Apply
CO3	Recognize pattern in problems involved in machine health monitoring.	L4	Analyze
CO4	Gain knowledge about the application of artificial intelligence techniques in Condition Monitoring.	L2	Understand
CO5	Gain knowledge about the application of Machine learning techniques in Condition Monitoring.	L2	Understand

Course Contents

Unit-I 10 Hrs

Introduction to asset Management: Digital Asset Management, Fixed Asset Management, IT Asset Management, Enterprise Asset Management, Financial Asset Management, Infrastructure Asset Management.

Introduction to maintenance strategies: Proactive Maintenance, Predictive Maintenance, Planned Maintenance, Condition-Based Maintenance, Responsive Maintenance, Emergency Maintenance.

Unit-II 12 Hrs

Introduction to Machine Health Monitoring Management: Machine failures, Maintenance strategies, machine condition monitoring, Vibration signatures of faults in rotating and reciprocating machines, detection and diagnosis of faults.

Instrumentation and Signal Processing: Types of sensors used in machine health monitoring: vibration, acoustics and noise, acoustic emission, temperature, ultrasonic and infrared sensors - Signal processing: basic signal and systems concepts, time domain analysis, frequency domain analysis, time-frequency analysis.

Unit-III 08 Hrs

Pattern Recognition:

Feature extraction and feature selection methods, feature reduction using PCA - discriminant functions and decision boundaries, decision trees, maximum likelihood and nearest neighbor. Application and case studies of machine health monitoring: Bearings, gear boxes, engines, structural health monitoring, machine tool condition monitoring etc.

Unit-IV 06 Hrs

Introduction to Condition Monitoring Using Artificial Intelligence: Approaches to Condition Monitoring, Components of Condition Monitoring, Measurement System and Preprocessing, Feature Extraction, Statistical Features, Vibration-based Condition Monitoring, Dissolved Gas Analysis, Artificial Intelligence Approaches, Single AI Approaches, Hybrid AI Approaches.

Unit-V 06 Hrs

Introduction to Machine Learning in Conditioning monitoring: Machine Learning Tools, Artificial Neural Network, Support Vector Machine, Extension Neural Network, Fuzzy ARTMAP. Introduction to Incremental Learning and its Application to Condition Monitoring.

Reference Books

1. Asset Management Telli Van der Lei, Paulien Herder and Ype Wijnia Springer
2. Machine Component Analysis with MATLAB Dan B. Marghitu and Mihai Dupac Butterworth-Heinemann, Elsevier.
3. Mechanical Vibrations and Condition Monitoring Juan Carlos A. Jauregui Correa and Alejandro A. Lozano Guzman Academic Press, Elsevier.
4. Intelligent Data-Analytics for Condition Monitoring Hasmat Malik, Nuzhat Fatema and Atif Iqbal Academic Press, Elsevier.
5. Predictive Maintenance of Pumps Using Condition Monitoring Ray S. Beebe Elsevier Science
6. Instrumentation and Control Systems William Bolton Newnes, Elsevier.
7. Emerging Trends in Image Processing, Computer Vision and Pattern Recognition Leonidas Deligiannidis and Hamid R. Arabnia Morgan Kaufmann, Elsevier.
8. Introduction to Pattern Recognition Sergios Theodoridis, Aggelos Pikrakis, Konstantinos Koutroumbas and Dionisis Cavouras Academic Press, Elsevier.
9. Neural Fuzzy Systems Lin C. and Lee G. Prentice Hall International Inc.
10. Intelligent Data-Analytics for Condition Monitoring Hasmat Malik, Nuzhat Fatema and Atif Iqbal Academic Press, Elsevier.
11. Fuzzy Logic and Expert Systems Applications Cornelius Leondes Academic Press, Elsevier.

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.

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 hrs.

Big Data Analytics(PEME7035)

Teaching Scheme

Lectures : 3 Hrs./week

Credit : 3

Examination Scheme

Term Test : 15 Marks

Teacher Assessment : 20 Marks

End Sem Exam : 65 Marks

Total: 100 Marks

Prerequisite: Knowledge of Data Base Management System.

Course Objectives:

1. To Provide an Overview of an exciting growing field of Big Data Analytics.
2. To introduce the tools required to manage and analyze big data like Hadoop, NoSql, Map Reduce.
3. To teach the fundamental techniques in achieving big data analytics with scalability and streaming capability.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Understand the key issues in big data management.	L2	Understand
CO2	Acquire fundamental enabling techniques using tools in big data analytics.	L2	Understand
CO3	Achieve adequate perspectives of big data analytics in various applications like sensor, recommender systems, social media applications etc.	L2	Understand

Course Contents

Unit-I 12 Hrs

Introduction to Big Data Analytics Hadoop Ecosystem::

Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach.

Technologies Available for Big Data, Infrastructure for Big Data, Big Data Challenges, Case Study of Big Data Solutions.

Introduction to Hadoop. Core Hadoop Components, Physical Architecture, Hadoop limitations.

Introduction, Components of the Hadoop Ecosystem:HDFS (Hadoop Distributed File System), MapReduce, YARN, HBase, Pig, Hive, Sqoop, Flume, Kafka, Zookeeper, Spark.

Unit-II 09 Hrs

NoSQL:

Introduction to NoSQL, NoSQL business drivers, NoSQL case studies.

NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, Variations of NoSQL architectural patterns.

Analysing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer

Introduction to MongoDB, MongoDB commands.

Unit-III 07 Hrs

MapReduce: MapReduce and The New Software Stack: Distributed File Systems, Physical Organization of Compute Nodes, Large Scale File-System Organization.

MapReduce: The Map Tasks, grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping with Node Failures

Matrix vector multiplication using MapReduce, Case studies on MapReduce using Java/Python

Unit-IV 07 Hrs

Big Data Analytics Applications:

Recommendation Systems: Introduction, A Model for Recommendation Systems, Collaborative-Filtering System: Nearest Neighbor Technique, Example. Mining Social-Network Graphs: Social

Networks as Graphs, Types of Social-Network. Clustering of Social Graphs, Applications

Unit-V 07 Hrs

Understanding Analytics and Big Data:

Analytical Approaches and Tool to Analyse Data, Exploring R, Reading Datasets and Exporting Data from R, Manipulating and Processing Data in R, Working with Functions and Packages in R, Performing Graphical Analysis in R, Integrating R and Hadoop

Text Books

1. Radha Shankarmani and M Vijayalakshmi Data Analytics, Wiley
2. Alex Holmes in Practice., Manning Press, Dreamtech Press.
3. Dan McCreary and Ann Kelly Sense of NoSQL. . A guide for managers and the rest of us,Manning Press.

Reference Books

1. Bill Franks, Taming The Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics., Wiley
2. Chuck Lam, Hadoop in Action., Dreamtech Press
3. Tom White gHadoop: The Definitive Guideh Third Edit on, Ofreily Media, 2012.

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.
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 hrs.

Robotics (PEME7036)

Teaching Scheme

Lectures : 3 Hrs./week

Credit : 3

Examination Scheme

Term Test : 15 Marks

Teacher Assessment : 20 Marks

End Sem Exam : 65 Marks

Total: 100 Marks

Prerequisite: Knowledge of basic electronic devices like Diodes, BJT etc. and basic digital electronics.

Course Objectives:

1. To To study the basics of robotics and its control
2. To study various design principles of robotics through kinematic analysis, workspace analysis, and trajectory planning
3. To study applications of robots in industrial inspection and material handling

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Demonstrate the basic functioning of a robot.	L3	Apply
CO2	Identify various components of robots.	L1	Remember
CO3	Carryout kinematic analysis, workspace analysis, and trajectory planning for a robot.	L4	Analyze
CO4	To apply the python skills for Mechanical problems.	L1	Understand
CO5	Select an appropriate robot for given industrial inspection and material handling systems.	L1	Understand

Unit-I 09 Hrs

Introduction:

Definition of robot, Evolution of robots, Laws of robots, International Robotic Standards, Types of robots, Selection of robots, Robot Classifications, Degrees of freedom, Robot configuration, Accuracy and repeatability, Specification of a robot, Robot feedback controls: Point to point control and Continuous path control, Control system for robot joint, Adaptive control, Actuators and sensors, Drives and transmission systems, End effectors, Applications of robots.

Unit-II 09 Hrs

Kinematics of Robots:

Direct: Link coordinates D-H Representation, The ARM equation, Direct kinematic analysis for Four axis, SCARA Robot and three, five, and six axis Articulated Robots.

Inverse: The inverse kinematics problem, General properties of solutions, Tool configuration, Inverse kinematics of four axis SCARA robot and three and five axis Articulated robot.

Unit-III 08 Hrs

Root Intelligence and Robot task planning: Introduction, State space search, Problem reduction, use of predictive

Logic, Means. Ends Analysis, Problem solving, Robot learning and Robot task planning..

Unit-IV 08 Hrs

Robot application in manufacturing

Robotic vision systems, Image representation, Object recognition and categorization, Depth measurement, Image data compression, Visual inspection, Software considerations Concepts of material handling, Principles and considerations in material handling systems design Conventional material handling systems - Industrial trucks, Monorails, Rail guided vehicles. Assembly inspectors, robotic Cell design control, Social issues Economics of Robotics.

Unit-IV 08 Hrs

Programming for Robots

Robotic vision systems, Image representation, Object recognition and categorization, Depth measurement, Image data compression, Visual inspection, Software considerations Concepts of material

handling, Principles and considerations in material handling systems design Conventional material handling systems - Industrial trucks, Monorails, Rail guided vehicles. Assembly inspectors, robotic Cell design control, Social issues Economics of Robotics.

Text Books

1. Robotics for engineers - Yoram Korean - McGrew Hill Co.
2. Industrial Robotics Technology programming and Applications- M.P. Groover, M. Weiss, R.N. Nagel, and N.G. Odrey -McGraw-Hill,
3. Ashitava Ghosal -Robotics: Fundamental Concepts and Analysis - Oxford University Press

Reference Books

1. Robotics and Control -R.K. Mittal and I.J. Nagrath- TMH Publications
2. Fundamentals of Robotics Analysis and Control - Robert J. Schilling - PHI Learning
3. Control in Robtics and Automation Sensor Based integration - Bijay K. Ghosh, Ning Xi, T.J. Tarn, - Academic Press
4. Robotics Control Sensing, Vision and Intelligence - K.S.Fu, R.C.Gonzalex, and C.S.G.Lee - McGrew hill Book co.
5. Kinematics and Synthesis of linkages - Hartenberg and Denavit - McGrew Hill Book Co.
6. Kinematics and Linkage Design - A.S. Hall - Prentice Hall
7. Kinematics and Dynamics of Machinery - J.Hirchhorn - McGrew Hill Book Company

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.
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 hrs.

Tribology (PEME7037)

Teaching Scheme	**Examination Scheme**
Lectures : 3 Hrs./week	Term Test : 15 Marks
Credit : 3	Teacher Assessment : 20 Marks
	End Sem Exam : 65 Marks
	Total: 100 Marks

Prerequisite: Knowledge of Engineering Mechanics, Fluid Mechanics and Machine Design.

Course Objectives:

1. To provide overview of tribology and practical relevance in mechanical design.
2. To appreciate the behaviour of material, nature of surfaces, their profile and surface design procedure.
3. To understand the provenance of friction, the theories/laws.
4. To gain an understanding about wear and its mechanisms, theories of wear applied in machine elements.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply the principles of lubrication, lubrication regimes, and theories of hydrodynamic, elasto-hydrodynamic and mixed / boundary lubrication.	L3	Apply
CO2	Understand the principles of design considerations, principles of bearing selection and arrangement in machines.	L2	Understand
CO3	Design of mechanical components from the aspect of friction, wear and lubrication.	L6	Create
CO4	Understand the principles for selecting compatible materials for minimizing friction and wear in machinery.	L2	Understand

Unit-I Introduction: 08 Hrs

Tribology in design- bearing material its properties and construction, Tribological design of oil seals and gasket, Tribology in industry, Lubricants selection for general application and special application such as low temperatures, high temperature, extreme pressure etc. Tribological considerations- Nature of surfaces and their contact; mechanical properties of surface layer, Geometrical properties of surfaces, methods of studying surfaces; Study of contact of smooth and rough surfaces.

Unit-II Friction and wear: 08 Hrs

Role of friction and laws of static friction, causes of friction, theories of friction, Laws of rolling friction, Friction of metals and non-metals, Friction measurements, Stick-slip motion and friction instabilities. Definition of wear, mechanism of wear, types and measurement of wear, Wear properties of friction and anti-friction metallic and non-metallic materials, Theories of wear. Design of mechanical components against wear. Design of friction surfaces used in clutches and brakes.

Unit-III:Hydrodynamic theory of lubrication: 09 Hrs

Theory of hydrodynamic lubrication, mechanism of pressure development in oil film. Two dimensional Reynolds equation and its limitations, Petroff's equation. Hydrodynamic thrust bearing-Introduction, types. Flat plate thrust bearing-Pressure equation, load, centre of pressure, frictional force equation. Hydrodynamic lubrication: design of plain fixed pad and tilting pad, slider bearing for steady and varying loads. Full and partial journal bearing of infinite length, design of journal bearing for steady loads and varying loads.

Unit-IV Elastohydrodyanamic Lubrication 09 Hrs

Introduction to design of aerostatic bearings and its applications, Elasto-hydrodynamic lubrication: Principle, application to antifriction bearings, cams and gears, Fault diagnosis in bearings and its solutions, bearing maintenance.

Unit-V Lubrication, lubricants and Special Topics: 09 Hrs

Lubrication and lubricants:

Introduction, Importance of Lubrication, Boundary lubrication; classic hydrodynamics, hydrostatic and elasto hydrodynamic lubrication, Functions of lubricants, Types of lubricants and their industrial uses; SAE classification, recycling, disposal of oils, properties of liquid and grease lubricants; lubricant

additives, general properties and selection.

Special Topics:

Diagnostic maintenance of Tribological components and considerations in IC engines and automobile parts, roller chains and wire rope, lubrication systems. Air/gas lubricated bearing and its Advantages and disadvantages.

Reference Books

1. Basu S K., Sengupta A N., Ahuja B. B., Fundamentals of Tribiology, PHI 2006
2. Mujumdar B. C., Introduction to Tribiology bearings, Wheelers and company pvt. Ltd 2001.
3. Cameron A., Basic Lubrication Theory, Wiley Eastern Ltd.
4. ndras Z. Szeri, Fluid film lubrication theory design, 1st Edition, 2005

Reference Books

1. Fuller, D., Theory and Practice of Lubrication for Engineers, New York company 1998
2. Moore, Principles and applications of Tribiology, Pergamaon press 1998
3. Srivastava S., Tribiology in industries, S Chand and Company limited, Delhi 2002
4. Redzimovskay E I., Lubrication of bearings theoretical principles and design, Oxford press company 2000
5. J. Bhatia, Advances in industrial Tribology

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.
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 hrs.

Automobile Engineering (PEME7038)

Teaching Scheme

Lectures : 3 Hrs./week

Credit : 3

Examination Scheme

Term Test : 15 Marks

Teacher Assessment : 20 Marks

End Sem Exam : 65 Marks

Total: 100 Marks

Prerequisite: Knowledge of manufacturing processes, mechanics, dynamics, basic electronics fluid mechanics.

Course Objectives:

1. To describe the working of different mechanical systems of an automobile.
2. To illustrate the working of electrical systems of an automobile.
3. To discuss the advancements in automobile technology.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Describe the types and working of clutch and transmission system.	L2	Understanding
CO2	Illustrate the working of steering and braking systems.	L3	Applying
CO3	Describe the role of vehicle suspension systems and vehicle body.	L2	Understanding
CO4	Describe the different automotive electrical systems.	L2	Understanding
CO5	Acquaint with recent developments in automobiles.	L4	Analyze

Unit-I 10 Hrs

Introduction: Classification of automobiles, Importance of various sub-systems of an automobile, development of an automobile, aspects of automotive engineering.

Clutch: Requirements of Clutches, 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: Necessity 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) and Continuously Variable Transmission (CVT).

Final Drive and Differential: Types of Final drive; spiral, bevel, Hypoid and worm drives. Necessity of differential, Working of differential, Conventional and non-slip differential, Trouble shooting and remedies.

Unit-II 09 Hrs

Propeller Shaft and Axle: Propeller shafts and universal joints: Types and construction, Different types of universal joints and constant velocity joints. Trouble shooting and remedies. Classification of axles, Loads on axles, Semi, Three quarter and Full floating axles.

Steering System: Steering geometry, Steering requirements, Steering linkages and steering gears. Over-steer and Under-steer, Cornering power, 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 10 Hrs

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.

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. Vehicle aerodynamics, Importance of crumple zone in vehicles, Crash safety ratings in India.

Unit-IV 07 Hrs

Automotive Electrical System: 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.

Charging System: Dynamo: Principle of operation, Construction and Working. Regulators, combined current and voltage regulator. Alternator: Principle of operation, Construction, Working. Rectification from AC to DC.

Starting system: Requirements, Various torque terms used, Starter motor drives; Bendix drive, Pre-engaged drive, Overrunning Clutch. Starter motor solenoids, switches and relays.

Unit-V 06 Hrs

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

Text Books

1. Automobile Engineering, Dr. Kirpal Singh, Vol I II, Standard publishers
2. Automobile Engineering, S. K. Gupta, S Chand Publications
3. Automobile Engineering, R. K. Rajput, Laxmi Publications

Reference Books

1. Automotive Engineering Fundamentals, Jeffrey Ball, Richard Stone, SAE International.
2. Encyclopaedia of Automotive Engineering, David Crolla, Wiley Publication
3. Automotive Electrical and Electronic Systems, Tom Denton, Routledge

4. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Mehrdad, Yimin, Sebastian, Ali, CRC Press

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.
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 hrs.

Product Lifecycle Management (OEME7041)

Teaching Scheme	**Examination Scheme**
Lectures : 3 Hrs./week	Term Test : 15 Marks
Credit : 3	Teacher Assessment : 20 Marks
	End Sem Exam : 65 Marks
	Total: 100 Marks

Prerequisite:

1. Knowledge of basic concepts of Management

Course Objectives:

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

Course Outcomes:

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

Course Contents

Unit-I 10 Hrs

Introduction to Product Lifecycle Management (PLM): Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications

PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy, Change management for PLM

Unit-II 08 Hrs

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

Unit-III 08 Hrs

Product Data Management (PDM): Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation .

Virtual Product Development Tools: For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modelling and simulations in Product Design, Examples/Case studies

Unit-IV 08 Hrs

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

Environmental Strategies and Considerations for Product Design.

Unit-V 08 Hrs

Life Cycle Assessment and Life Cycle Cost Analysis: Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis.

Text Books

1. Product Lifecycle Management: Paradigm for 21st Century Product Realization, John Stark, Springer-Verlag, 2004.
2. Product Design for the environment-A life cycle approach, Fabio Giudice, Guido La Rosa, Antonino Risitano, Taylor Francis 2006.

Reference Books

1. Product Life Cycle Management?, Saaksvuori Antti, Immonen Anselmie, Springer, Dreamtech.
2. Product Lifecycle Management: Driving the next generation of lean thinking, Michael Grieve, Tata McGraw Hill, 2006.
3. Product Life-Cycle Management: Geometric Variations, Franois Villeneuve, Luc Mathieu, Max Giordano, Wiley, 2010.

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.
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 hrs.

Management Information System (OEME7042)

Teaching Scheme	**Examination Scheme**
Lectures : 3 Hrs./week	Term Test : 15 Marks
Credit : 3	Teacher Assessment : 20 Marks
	End Sem Exam : 65 Marks
	Total: 100 Marks

Prerequisite:

1. -

Course Objectives:

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

Course Outcomes:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Explain how information systems Transform Business.	L2	Understand
CO2	Identify the impact information systems have on an organization.	L3	Apply
CO3	Describe IT infrastructure and its components and its current trends.	L2	Understand
CO4	Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making.	L2	Understand
CO5	Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses.	L3	Apply

Course Contents

Unit-I 05 Hrs

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

Unit-II 08 Hrs

Information Technologies: Hardware and Software

Computer Systems: End User and Enterprise Computing

Computer Peripherals: Input, Output, and Storage Technologies

Application Software: End User Applications

System Software: Computer System Management

Data Resource Management: Technical Foundations of Database Management, Managing Data Resources, Big data, Data warehouse and Data Marts, Knowledge Management

Networks: The Networked Enterprise (Wired and wireless), Pervasive computing, Cloud Computing models

Unit-III 08 Hrs

MIS Tools and applications for Decision making: ERP and ERP support of Business Process Reengineering,

Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Visualization

MIS Tools and applications for Decision making:

Unit-IV 06 Hrs

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

Unit-V 07 Hrs

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

Unit-VI 08 Hrs

Information System within Organization: Acquiring Information Systems and Applications: Various System development life cycle models.

Enterprise and Global Management of Information Technology: Managing Information Technology, Managing Global IT.

Reference Books

1. Management Information Systems, 11th edition by James A OBrien, George M., Ramesh Behl.
2. Kelly Rainer, Brad Prince, Management Information Systems, Wiley.
3. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
4. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice-Hall, 2008

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.
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 hrs.

Operations Research (OEME7043)

Teaching Scheme	**Examination Scheme**
Lectures : 3 Hrs./week	Term Test : 15 Marks
Credit : 3	Teacher Assessment : 20 Marks
	End Sem Exam : 65 Marks
	Total: 100 Marks

Prerequisite:

1. Basic Knowledge of Algebra, Probability and Statistics

Course Objectives:

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

Course Outcomes:

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

Course Contents

Unit-I 10 Hrs

Introduction to Operations Research: Concept of decision making. Definition of OR. Formulation of decision problem as OR model, Concept of Optimization,

Linear Programming Problem: : Mathematical Formulation. Finding optimal solution - Graphical method, Simplex Method, Big M-method, Two Phase Method. Duality, Primal Dual construction, Symmetric and Asymmetric Dual. Dual Simplex Method.

Unit-II 08 Hrs

Assignment Problems: Mathematical Formulation, Finding optimal solution - Hungarian Method

Transportation problem:: Mathematical Formulation, Finding initial basic feasible solution Northwest corner rule, row minima, column minima, least cost method and Vogels approximation method. Optimality test: the stepping stone method and MODI method.

Improving the solution.

Unit-III 06 Hrs

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

Unit-IV 10 Hrs

Queuing Models: Characteristics of queuing models.

Single Channel Single and multi phase servers, Poisson arrivals, exponential service time - with infinite population and finite population models with infinite and finite capacity.

Multichannel Single phase server - Poisson arrivals, exponential service time with infinite population.

Game Theory: Introduction. Minimax Maximin Criterion and optimal strategy.

Solution of games with saddle points, rectangular games without saddle points - 2 x 2 games, dominance principle.

Approximate methods - Iterative method, m x 2 2 x n games -Graphical method and method of sub-games.

Expressing game as LPP.

Unit-V 08 Hrs

Simulation: Definition. Types of simulation models. Monte Carlo simulation technique. Applications of simulation - Inventory and Queuing problems. Simulation Languages.

Replacement Models: Replacement of items that deteriorate with time - when money value is not counted and counted, Replacement of items that fail suddenly individual and group replacement policy.

Text Books

1. Operations Research, Sharma J. K., Trinity Press
2. Operations Research, Gupta P. K., Hira D. S., S. Chand Limited

Reference Books

1. Operations Research - An Introduction; Taha, H.A.; Prentice Hall
2. Operations Research: Principles and Practice; Ravindran, A, Phillips, D. T and Solberg, J. J.; John Willey and Sons
3. Introduction to Operations Research; Hiller, F. S. and Liebermann, G. J.; Tata McGraw Hill
4. Operations Research Principles and Practice; Pradeep Prabhakar Pai; Oxford University Press
5. Operations Research, R. Panneerselvam, PHI Publications.
6. Operations Research, A. M. Natarajan, P. Balasubramani, A. Tamilarasi, Pearson Education.
7. Operations Research; Kanti Swarup, P. K. Gupta and Man Mohan; Sultan Chand Sons

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.

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 hrs.

Cyber Security and Laws (OEME7044)

Teaching Scheme

Lectures : 3 Hrs./week

Credit : 3

Examination Scheme

Term Test : 15 Marks

Teacher Assessment : 20 Marks

End Sem Exam : 65 Marks

Total: 100 Marks

Prerequisite:

1. -

Course Objectives:

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

Course Outcomes:

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

Course Contents

Unit-I 12 Hrs

Introduction to Cybercrime: Cyber Crime, Cyber Law, Cyber Security, History of Cyber Crime, Hacking, Data Theft, Cyber Terrorism, Virus Worms, Email Bombing, Pornography, online gambling, Forgery, Web Defacements, Web Jacking, Illegal online Selling, Cyber Defamation, Software Piracy, Electronics/ Digital Signature, Phishing, Password Cracking, Key loggers and Spywares, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing Identity Theft (ID Theft)

Cyber offenses: How criminal plan the attacks, Social Engineering, Cyber stalking, Cyber caf and Cybercrimes, Botnets, Attack vector

Unit-II 08 Hrs

Cyber Threats Analysis : Knowledge of Dynamic and Deliberate Targeting

Knowledge of Indications and Warning

Knowledge of Internal Tactics to Anticipate and/or, Emulate Threat Capabilities and Actions

Knowledge of Key Cyber Threat Actors and their Equities

Knowledge of Specific Target Identifiers and Their Usage

Cyber Security Management: Knowledge of Emerging Security Issues, Risks, and Vulnerabilitie.

Unit-III 06 Hrs

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

Unit-IV 08 Hrs

Indian IT Act: Cyber Crime and Criminal Justice, Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments

Multichannel Single phase server - Poisson arrivals, exponential service time with infinite population.

Security aspect in cyber Law: The Contract Aspects in Cyber Law , The Security Aspect of Cyber Law, The Intellectual Property Aspect in Cyber Law ,The Evidence Aspect in Cyber Law

Unit-V 08 Hrs

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

Reference Books and Material

1. Nina Godbole, Sunit Belapure, Cyber Security, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information Technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. E-Commerce Security and Privacy", Anup K. Ghosh, Springer Science and Business Media, 2012
5. Izzat Alsmadi , The NICE Cyber Security Framework Cyber Security Intelligence and Analytics, Springer
6. Cyber Law Cyber Crimes, Advocate Prashant Mali; Snow White Publications, Mumbai
7. Nina Godbole, Information Systems Security, Wiley India, New Delhi
8. Kennetch J. Knapp, Cyber Security Global Information Assurance Information Science Publishing.
9. William Stallings, Cryptography and Network Security, Pearson Publication
10. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
11. Website for more information, A Compliance Primer for IT professional: https://www.sans.org/reading-room/whitepapers/compliance/compliance-primerprofessionals-33538

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.
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 hrs.

Personal Finance Management (OEME7045)

Teaching Scheme	**Examination Scheme**
Lectures : 3 Hrs./week	Term Test : 15 Marks
Credit : 3	Teacher Assessment : 20 Marks
	End Sem Exam : 65 Marks
	Total: 100 Marks

Prerequisite:

1. Basic Knowledge of Algebra, Probability and Statistics.

Course Objectives:

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

Course Outcomes:

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

Course Contents

Unit-I 07 Hrs

Overview of Indian Financial System: Characteristics, Components and Functions of Financial System. Financial Instruments and Financial Markets, Financial inclusion

Introduction to Personal Finance: Person Financial Planning in Action, Money Management Skills, Taxes in Your Financial Plan, Savings and Payment Services. Consumer Credit: Advantages, Disadvantages, Sources and Costs.

Unit-II 07 Hrs

Personal Financial Management: Loans: Home, Car, Education, Personal, Loan against property and Jewel loan.

Insurance: Types of Insurance ULIP and Term; Health and Disability Income Insurance, Life Insurance.

Investment: Investing Basics and Evaluating Bonds, Investing in Stocks and Investing in Mutual Funds, Planning for the Future.

Unit-III 08 Hrs

Income Tax: Income Tax Act Basics- Introduction to Income Tax Act, 1961

Heads of Income and Computation of Total Income and Tax Liability- Heads of Income and Computation of Total Income under various heads, Clubbing Provisions, Set off and Carry forward of Losses, Deductions, Assessment of Income and tax liability of different persons.

Tax Management, Administrative Procedures and ICDS - TDS, TCS and Advance Tax Administrative Procedures, ICDS

Unit-IV 10 Hrs

Goods and Services Tax: GST Constitutional framework of Indirect Taxes before GST (Taxation Powers of Union State Government); Concept of VAT: Meaning, Variants and Methods; Major Defects in the structure of Indirect Taxes prior to GST; Rationale for GST; Structure of GST (SGST, CGST, UTGST IGST); GST Council, GST Network, State Compensation Mechanism, Registration.

Levy and Collection of GST: Taxable event- "Supply" of Goods and Services; Place of Supply: Within state, Interstate, Import and Export; Time of supply: Valuation for GST- Valuation rules, tax-

ability of reimbursement of expenses; Exemption from GST: Small supplies and Composition Scheme: Classification of Goods and Services

Unit-V 10 Hrs

Introduction to Micro finance: Micro-Finance: Definitions, Scope Assumptions, Types of Micro-finance, Customers of Micro-finance, Credit Delivery Methodologies, SHG concept, origin, Formation Operation of Self Help Groups (SHGs).

Models in Microfinance - Joint Liability Groups (JLG), SHG Bank Linkage Model and GRAMEEN Model: Achievements Challenges,

Institutional Mechanism- Current Challenges for Microfinance, Microfinance Institutions (MFIs): Constraints Governance Issues, Institutional Structure of Microfinance in India :NGO-MFIs, NBFC-MFIs, Co-operatives, Banks, Microfinance Networks and Associations; Demand Supply of Microfinance Services in India, Impact assessment and social assessments of MFIs

Reference Books

1. Banking and Financial Sector Reforms in India , by Asha Singh, M.S. Gupta, Serials Publication.
2. Indian Banking Sector: Essays and Issues (1st) , by M.S. Gupta J.B. Singh, Serials Publication.
3. Basics Of Banking Finance , by K.M. Bhattacharya O.P. Agarwal , Himalaya Publishing House
4. Agricultural Finance And Management, by S. Subba Reddy , P. Raghu Ram .
5. The Indian Financial System And Development , by Dr.Vasant Desai, Himalaya Publishing House; Fourth Edition
6. Income Tax Management , Simple Way of Tax Management, Tax Planning and Tax Saving , By Sanjay Kumar Satapathy
7. Direct Tax System Income Tax by Dr. R. K. Jain, SBPD Publications.
8. Simplified Approach to GST Goods and Services Tax, By S K Mishra , Educreation Publishing.
9. Introduction To Microfinance , By Todd A Watkins , World Scientific Publishing Company

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.

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 hrs.

Energy Audit and Management (OEME7046)

Teaching Scheme	**Examination Scheme**
Lectures : 3 Hrs./week	Term Test : 15 Marks
Credit : 3	Teacher Assessment : 20 Marks
	End Sem Exam : 65 Marks
	Total: 100 Marks

Prerequisite:

1. -

Course Objectives:

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

Course Outcomes:

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

Course Contents

Unit-I 05 Hrs

Energy Scenario: Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act2001 and its Features. Basics of Energy and its various forms, Material and Energy balance.

Unit-II 10 Hrs

Energy Audit: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring targeting, Energy audit instruments. Technical and economic feasibility, Classification of energy conservation measures. Safety considerations during energy audit.

Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI) Internal rate of return (IRR).

Unit-III 10 Hrs

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

Unit-IV 10 Hrs

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

Unit-V 07 Hrs

Energy conservation in Buildings: Energy Conservation Building Codes (ECBC): Green Building, LEED rating,

Application of Non-Conventional and Renewable Energy Sources, Energy sources and energy management in electric vehicles.

Reference Books and Material

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science.
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System.
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons.
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B. Smith, Pergamon Press.
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press.
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press.
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.
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 hrs.

Disaster Management and Mitigation Measures (OEME7047)

Teaching Scheme	**Examination Scheme**
Lectures : 3 Hrs./week	Term Test : 15 Marks
Credit : 3	Teacher Assessment : 20 Marks
	End Sem Exam : 65 Marks
	Total: 100 Marks

Prerequisite:

1. -

Course Objectives:

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

Course Outcomes:

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

Course Contents

Unit-I 10 Hrs

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

Unit-II 08 Hrs

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

Unit-III 08 Hrs

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

Unit-IV 08 Hrs

Disaster risk reduction and Mitigation Measures: Need of disaster prevention and mitigation, mitigation guiding principles, challenging areas, structural and non-structural measures for disaster

risk reduction. Mitigation measures for flood, earthquake, cyclone monitoring, air quality, water quality, climate change, land use, winter storms and aquatic biology etc. Use of information management, GIS, GPS and remote sensing Mitigation measure. Dos and donts in case of disasters and effective implementation of relief aids

Unit-V 08 Hrs

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

Reference Books and Reports

1. Disaster Management, by Harsh K.Gupta, Universities Press Publications (2003).
2. Disaster Management: An Appraisal of Institutional Mechanisms in India, by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. Introduction to International Disaster Management, by Damon Copolla, Butterworth Heinemann Elsevier Publications (2015).
4. Disaster Management Handbook, by Jack Pinkowski, CRC Press, Taylor and Francis group (2008).
5. Disaster management rehabilitation, by Rajdeep Dasgupta, Mittal Publications, New Delhi (2007).
6. Natural Hazards and Disaster Management, Vulnerability and Mitigation, by R B Singh, Rawat Publications (2006).
7. Concepts and Techniques of GIS, by C.P.Lo Albert, K.W. Yonng, Prentice Hall (India) Publications (2006).
8. Risk management of natural disasters, by Claudia G. Flores Gonzales, KIT Scientific Publishing (2010).
9. Disaster Management a disaster mangers handbook, by W. Nick Carter, Asian Development Bank (2008).

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

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

12. The Fukushima 2011 Disaster, by Ronald Eisler, Taylor Francis, Florida, 2013. (Learners are expected to refer reports published at national and international level and updated information available on authentic web sites)

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.

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 hrs.

Science of Well-being (OEME7048)

Teaching Scheme	**Examination Scheme**
Lectures : 3 Hrs./week	Term Test : 15 Marks
Credit : 3	Teacher Assessment : 20 Marks
	End Sem Exam : 65 Marks
	Total: 100 Marks

Prerequisite:

1. -

Course Objectives:

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

Course Outcomes:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Describe concepts of holistic health and well-being, differentiate between its true meaning and misconceptions and understand the benefits of well-being.	L2	Understand
CO2	Recognize meaning of happiness, practice gratitude and self-compassion and analyze incidents from ones own life.	L4	Analyze
CO3	Understand the causes and effects of stress, identify reasons for stress in ones own surrounding and self.	L1,L2	Remember, Understand
CO4	Recognize the importance of physical health and fitness, assess their life style and come up with limitations or effectiveness.	L5	Evaluate
CO5	Inspect ones own coping mechanism, assess its effectiveness, develop and strategize for betterment and execute it.	L4	Analyze

Course Contents

Unit-I 06 Hrs

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

Unit-II 08 Hrs

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

Unit-III 10 Hrs

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

Unit-IV 10 Hrs

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

Unit-V 08 Hrs

Dealing with Difficult Times / Coping mechanisms: The concept of chronic stress, Health and safety risks of chronic stress, Forms and Treatment of chronic stress, Coping with Acute and Chronic stress, theories of the stress-illness link, role of stress in mental disorders.
Concept of coping, Ways of coping and stress management, basic knowledge about stress management, various techniques of stress management, stress management programs. Mental strengths and virtues, Hope, Optimism, Resilience concept, pathways and models, Meditation and Self-introspection.

Text Books

1. The Science of well-being by Felicia Huppert, Nick Baylis, Barry Keverne; Oxford University Press
2. Health and Well-Being: Emerging Trends by S. Ojha, U. Rani Srivastava, Shobhna Joshi, Global Vision Publishing House
3. Positive psychology: The scientific and practical explorations of human strengths by Shane J. Lopez, Jennifer Teramoto Pedrotti, Charles Richard Snyder; Sage Publications

Reference Books

1. The pursuit of happiness and the realization of sympathy: Cultural patterns of self, social relations, and well-being by Kitayama, S., Markus, H. R, Culture and subjective well-being, The MIT Press.
2. Man Adapting by Dubos, R; New Haven: Yale University Press.
3. Happiness a history by McMahon D. M., Atlantic Monthly Press.
4. Well-being: The foundations of hedonic psychology by D. Kahneman E. Diener N. Schwarz, New York: Russell Sage
5. Selye H. The Stress of Life. New York; McGraw-Hill; 1984.

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.

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 hrs.

Research Methodology (OEME7049)

Teaching Scheme

Lectures : 3 Hrs./week

Credit : 3

Examination Scheme

Term Test : 15 Marks

Teacher Assessment : 20 Marks

End Sem Exam : 65 Marks

Total: 100 Marks

Prerequisite:

1. Basic Knowledge of Probability and Statistics.

Course Objectives:

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

Course Outcomes:

CO	**Course Outcomes**	**Blooms Level**	**Blooms Description**
CO1	Prepare a preliminary research design for projects in their subject matter areas.	L2, L3	Understand, Apply
CO2	Accurately collect, analyze and report data.	L4	Analyze
CO3	Present complex data or situations clearly.	L2	Understand
CO4	Review and analyze research findings.	L4	Analyze
CO5	Write report about findings of research carried out.	L3	Apply

Course Contents

Unit-I 07 Hrs

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

Unit-II 10 Hrs

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

Unit-III 10 Hrs

Research and Sample Design: Meaning of research and sample design, Need of research design, Features of good research design, Important concepts, Different research designs, Types of sampling designs

Unit-IV 10 Hrs

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

Unit-V 05 Hrs

Interpretation and Report Writing: Interpretation and drawing conclusions on the research, Preparation of the report, Ethical Issues

Reference Books

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd Edition), Singapore, Pearson Education

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.
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 hrs.

Public Systems and Policies (OEME70410)

Teaching Scheme	**Examination Scheme**
Lectures : 3 Hrs./week	Term Test : 15 Marks
Credit : 3	Teacher Assessment : 20 Marks
	End Sem Exam : 65 Marks
	Total: 100 Marks

Prerequisite:

1. Basic Knowledge of Social science and Current affairs.

Course Objectives:

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

Course Outcomes:

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Understand the importance of public systems in a fast-changing environment in the global context.	L2	Understand
CO2	Analyze the transformations in public systems with emphasis on current initiatives and emerging challenges in the field.	L4	Analyze
CO3	Explain public policy and its operations with special focus on policy relating to Government finance.	L2	Understand
CO4	Make policies and know about the happenings in the world, in the nation and those in their locality.	L3	Apply
CO5	Analyze and evaluate the impact of the public policy on firms and economy at large and work under various fields as policymakers.	L4	Analyze

Course Contents

Unit-I 10 Hrs

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

Unit-II 06 Hrs

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

Unit-III 08 Hrs

Public Choice and Fiscal Politics: Direct Democracy; Representative Democracy; The Allocation Function; The Distribution Function; The Stabilization Function; Coordination of Budget Functions; The Leviathan Hypothesis.

Unit-IV 12 Hrs

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

Unit-V 06 Hrs

Case Studies in Expenditure Policy: Public Services A) National Defense B) Highways C) Outdoor Recreation D) Education

Reference Books

1. Introduction to Public Policy by Charles Wheelan, W.W. Norton Company.
2. Understanding Public Policy by Thomas R. Dye, Prentice Hall.
3. Public Policy-Making: An Introduction by Anderson J.E., Boston, Houghton.

4. Public Administration by Avasthi Maheshwari, Lakshminarayan Agarwal, Agra.

5. New Horizons of Public Administration by Bhattacharya, Mohit, Jawahar Publishers, New Delhi.

6. Public Administration and Public Affairs by Henry, Nicholas, Prentice Hall of India, New Delhi.

7. Public Finance 10th Edition by Harvey S Rosen and Ted Gayer, McGraw-Hill Education, 2013.

8. Public Finance in Theory and Practice by Musgrave and Musgrave.

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.

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 hrs.

Project Stage-II (PJME7050L)

Practical Scheme
Practical : 04 Hrs./week
Credit : 01

Examination Scheme
Teacher Assessment : 25 Marks
End Sem Exam : 25 Marks
Total : 50 Marks

Course Objectives:

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

Course Outcomes:

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

Syllabus:

Project-I work done in VI semester shall be continued as Project-II in semester VII.

Students should complete remaining implementation of ideas given in synopsis/Abstract of semester VII.

Students / group must plan their execution of project, so that project work should be completed before end of semester.

Project-II involves fabrication, design, experimentation, data analysis within realistic constraints such as economic, environmental, social, ethical, health and safety, manufacturability, and sustainability. The stage also includes testing, possible results and report writing.

Each project group is required to maintain log book for documenting various activities of Project-II and submit group project report at the end of Semester-VII in the form of Hard bound.

Domain knowledge (any beyond) needed from the various areas in the field of mechanical engineering for the effective implementation of the project.

The above areas can be updated based on the technological innovations and development needed for specific project.

Guidelines:

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

Each group will be reviewed twice in a semester and marks will be allotted based on the various points mentioned in the evaluation scheme.

In the first review of this semester, each group is expected to complete 70 percent of project.

In the second review of this semester, each group is expected to complete 100 percent of project.

The students may use this opportunity to learn different computational techniques towards development of a product.

Interaction with alumni mentor will also be appreciated for the improvement of project.

Assessment Criteria:

- At the end of the semester, after confirmation by the project guide, each project group will submit project completion report in 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).
- The candidate must bring the project part- 1 report and the final report completed in all respect

while appearing for End Semester Examination.

- Oral examination should be conducted by Internal and External examiners. Students have to give presentation and demonstration based on their project.

Prescribed project report guidelines:

Every group should prepare hard bound report (preferrable LaTeX) of about minimum 40 pages on the work carried out by a batch of students in respect of the project work done during semester-VII. Project Report should include appropriate content for:

- Title
- Abstract
- Introduction
- Problem identification and project objectives
- Literature Survey
- Related Theory
- Project design and Implementation details
- Case study/Analysis/Design Methodology
- Project Outcomes
- Result and Conclusion
- Future scope
- 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.

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

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

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

- Product Development

Each review consists of 25 marks. Average of the marks scored in both the two reviews will be considered for final grading. The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

Table 1: Log Book Format

Sr	**Week (Start Date:End Date)**	**Work Done**	**Sign of Guide**	**Sign of Coordinator**
1				
2				

Table 2: Continuous Assessment Table

Sr	**Exam Seat No**	**Name of Student**	**Student Attendance**	**Log Book Maintain**	**Literature Review**	**Depth of Understanding**	**Report**	**Total**
			5	5	5	5	5	25

Table 3: Evaluation Table

Sr	**Exam Seat No**	**Name of Student**	**Project Selection**	**Design/ Methodology**	**Fabrication/ Modeling/ Simulation**	**Result Verification**	**Presentation**	**Total**
			5	5	5	5	5	25

Detailed syllabus of Final Year in Mechanical Engineering (Semester VIII)

Design of Mechanical Systems (PEME8011)

Teaching Scheme

Lectures : 3 Hrs./week

Credit : 3

Examination Scheme

Term Test : 15 Marks

Teacher Assessment : 20 Marks

End Sem Exam : 65 Marks

Total: 100 Marks

Prerequisite:

1. Knowledge of Material Technology, Power Engineering, Machine Design I and Machine Design II.

Course Objectives:

1. To study design of snatch block, belt conveyors, engine system, pumps and machine tool gearbox.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Design gear boxes for a given machine tool application.	L6	Create
CO2	Design hoisting mechanism of an Electric overhead traveling crane.	L6	Create
CO3	Design belt conveyor systems.	L6	Create
CO4	Design engine components such as cylinder, piston, connecting rod and crankshaft.	L6	Create
CO5	Design pumps for a given application.	L6	Create

Course Contents

Unit-I 10 Hrs

Design of Gear Box: Requirements of a gear box, Determination of variable speed range, Graphical representation of speeds, Structure diagram, Ray diagram, Selection of optimum ray diagram, Estimation of numbers of teeth on gears, Deviation diagram, Layout of gear box

Unit-II 08 Hrs

Design of Hoisting mechanism: Selection of wire rope, Design and selection of sheave pulley, axle and bearings, Selection of hook, Design of nut, Selection of thrust bearing, Design of cross-piece with trunion, Design of shackle plate, Design of rope drum, drum shaft and bearing, Selection of motor.

Unit-III 08 Hrs

Design of belt conveyors: Selection of belt, Selection of motor, Design of drive pulley assembly, Design of driven pulley assembly, Design of over running idler assembly, Design of under running idler assembly.

Unit-IV 08 Hrs

Engine Design (Petrol and Diesel): Design of cylinder, Design of piston with pin and rings, Design of connecting rod, Design of crank shaft with bearings

Unit-V 08 Hrs

Design of gear pump: Selection of motor, Design of gear, Selection of bearing, Design of bolts, Design of suction and delivery pipe

Design of centrifugal pump: Selection of motor, Design of impeller and impeller shaft, Design of volute casing, Design of suction and delivery pipe

Text Books

1. Mechanical Engineering Design - J. E. Shigley and C. R. Mischke - McGraw-Hill Education
2. Design of Machine Elements V. B. Bhandari - McGraw-Hill Education

3. Mechanical System Design - S. P. Patil - JAICO Publishing House

Reference Books

1. Material Handling Equipment N. Rudenko - M.I.R. publishers
2. Design of machine tools - S. K. Basu and D. K. Pal - Oxford and IBH Pub. Co.
3. Machine tool design - N. K. Mehta - McGraw-Hill Education
4. Gear Design Handbook - Gitin Maitra - McGraw-Hill Education
5. Design Data book by P.S.G. College of Technology, Coimbatore.
6. Design Data Book- Design of engine parts by Khandare S. S. Kale A. V

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.
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 hrs.

Industrial Engineering (PEME8012)

Teaching Scheme	**Examination Scheme**
Lectures : 3 Hrs./week	Term Test : 15 Marks
Credit : 3	Teacher Assessment : 20 Marks
	End Sem Exam : 65 Marks
	Total: 100 Marks

Prerequisite:

1. Basic knowledge of Manufacturing processes and various manufacturing systems.

Course Objectives:

1. To familiarise with concept of integration of various resources and the significance of optimizing them in manufacturing and allied Industries.
2. To acquaint with various productivity enhancement techniques.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Illustrate the need for optimization of resources and its significance.	L4	Analyzing
CO2	Develop ability in integrating knowledge of design along with other aspects of value addition in the conceptualization and manufacturing stage of various products.	L6	Create
CO3	Demonstrate the concept of value analysis and its relevance.	L3	Applying
CO4	Manage and implement different concepts involved in method study and understanding of work content in different situations.	L6,L3	Create, Applying
CO5	Describe different aspects of work system design and facilities design pertinent to manufacturing industries.	L2	Understanding
CO6	Illustrate concepts of Agile manufacturing, Lean manufacturing and Flexible manufacturing.	L4	Analyze

Course Contents

Unit-I 08 Hrs

Introduction to Industrial Engineering: history and contribution, Industrial engineering approach, Definition and concept of Productivity, productivity measurements, factors influencing productivity and productivity improvement techniques.
Value Engineering and Value Analysis: Distinction between value engineering value analysis and their significance. Steps in value engineering and analysis and check lists.

Unit-II 08 Hrs

Work study: Method study: micro-motion study and principles of motion economy, Therbligs, Work measurement: Time Study, Work Sampling, Standard Data, Predetermined Motion Time System (PMTS); Maynard Operation Sequence Technique (MOST).

Unit-III 10 Hrs

Work system design: Introduction to ergonomics and its scope in relation to work. Outline of discipline of anatomy, physiology and psychology, with respect to ergonomics building blocks such as anthropometry and biomechanics; Industrial Psychology concept, aim and objectives and scope of industrial psychology; Job evaluation, merit rating, incentive schemes, wage administration and business process reengineering.

Unit-IV 08 Hrs

Facility Design: Facility location factors and evaluation of alternate locations; types of plant layout and their evaluation; computer aided layout design techniques; Line Balancing: objectives, constraints, terminology in assembly line, heuristic methods like Kilbridge-Wester, Largest Candidate rule, Rank positional weight; Materials handling systems, AGV. Concepts of Group Technology and cellular manufacturing.

Unit-V 08 Hrs

Agile manufacturing: Introduction, developing agile manufacturing, Integration of Product/Process Development, Application of IT/IS concepts, Agile supply chain management, Design of skill and

knowledge and Computer control of Agile manufacturing. Flexible manufacturing, Lean Manufacturing, Value Stream Mapping.

Text Books

1. Industrial Engineering and Management, Ravi Shankar, Galgotia Publications Pvt Ltd.
2. Industrial Engineering and Management, O.P. Khanna, Dhanpat Rai Publications.

Reference Books

1. Introduction to Work study, ILO, Geneva, and Oxford IBH Pub Co. Pvt. Ltd.
2. Ergonomics at Work, Murrell
3. Plant Layout and Material Handling, James M. Apple, John Wiley Sons
4. Facility Layout and Location An Analytical Approach, Richard L. Francis John A. White, Prentice Hall
5. Production Planning and Control, Samuel Elion
6. Production and Operations Management, Joseph G. Monks
7. Quality planning and analysis, J M Juran, FM Gryana, TMH
8. Total Quality Management, D. H. Bester Field et al. prentice hall
9. TQM in new product manufacturing, HG Menon; TMH

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.
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 hrs.

CAD/CAM/CIM (PEME8013)

Teaching Scheme	**Examination Scheme**
Lectures : 3 Hrs./week	Term Test : 15 Marks
Credit : 3	Teacher Assessment : 20 Marks
	End Sem Exam : 65 Marks
	Total: 100 Marks

Prerequisite:

1. Knowledge of CAMD and Finite Element Analysis.

Course Objectives:

1. To introduce CAD/CAM/CIM with particular focus on engineering product design and manufacturing.
2. To develop a holistic view of initial competency in engineering design and manufacturing by using CAM software.
3. To develop New API for CAD
4. To introduce capabilities of additive manufacturing to replace conventional machining.
5. To make students aware about computer Integrated manufacturing (CIM)

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Understand basics of computer graphics and computer modelling technique.	L2	Understand
CO2	Transform, manipulate objects and computer assisted generation of tool path .	L5	Evaluate
CO3	Apply Artificial Intelligence concept to Design and manufacturing. .	L3	Apply
CO4	Applyand replace conventional manufacturing process by additive manufacturing process.	L3	Apply
CO5	Applyand replace conventional manufacturing process by additive manufacturing process.	L3	Apply

Course Contents

Unit-I 08 Hrs

Computer Graphics and Techniques for Geometric Modeling Basics of computer graphics, Introduction to computer graphics algorithms, Raster Graphics, Vector Graphics, DDA Line generation Algorithm, Bresenhams Line Generation Algorithm, Introduction to Painters Algorithm, Introduction to Area Subdivision Algorithm, The parametric representation of geometry,Bezier curves. Constructive solid geometry (CSG), Boundary Representation (B-Rep), Wire Frame Modelling, Solid Modeling, SurfaceModelling, Parametric Modelling.

Unit-II 10 Hrs

Introduction to Computer Aided Manufacturing (CAM) and CAM software G Code, M Code, CNC Programming, writing a code for Turning Operation, Writing a code for Milling Operation. Machine Setup, Tool Selection, Tool simulation and stock material removal, Automatic Tool Path generation, Generation of CNC code for machining, Produce setup sheets. **2D 3D Transformations** Translation, Rotation, Scaling Magnification. Programming for Transformations.

Unit-III 08 Hrs

Artificial Intelligence in Design Manufacturing The integration of predictive machine learning, Optimizing several variables, Unprecedented customization, Automated experimentation, Smart manufacturing, Predictive Maintenance, Smart Maintenance, 24x7 Production, Safer Operational Environment, Microscopic Defect Identification, Shop floor performance improvement, Generative design, Novel Opportunities for Humans.

Application Programming Interface (API) Concept of customizing applications by writing programs, Creating Scripts and Add-Ins, Creating Programs for Assemblies, Joint, B- Rep Geometry.

Unit-IV 06 Hrs

Introduction to Additive Manufacturing: Classification of additive manufacturing processes, Seven Classes of Additive Manufacturing, Binder jetting, Directed Energy Deposition, Powder Bed Fusion, Sheet Lamination, Material Extrusion, Material Jetting, Vat Photo Polymerization

Discussion on latest technique available on each type of additive manufacturing processes. Specification, working principal, material compatibility and Post processing.

Unit-V 10 Hrs

Computer Integrated Manufacturing, Digital manufacturing Introduction, Evolution, Objectives, CIM Hardware and Software, CIM Benefits, Nature androle of the elements of CIM, Identifying CIM needs, Data base requirements of CIM, Role of CAD/CAM in CIM, Obstacles to Computer Integrated Manufacturing, Concept of the future CIM systems, Socio -techno- economic aspects of CIM.

Computer Aided Product Design and Manufacturing Overview of toy design for entertainment and play, creative product design, Ideas for new toys that serve clients in the community, Fundamental aspects of the product development process, Determining customer needs, brainstorming, estimation, sketching, sketch modeling, concept development, design aesthetics, detailed design, and prototyping.

Text Books

1. CAD/CAM: Computer Aided and Manufacturing Mikell P. Groover and Emory W. Zimmers, Jr. Pearson Education
2. CAD/ CAM: Theory Practice Ibrahim Zeid, R. Sivasubramanian Tata McGraw Hill Publications
3. CAD/CAM Principles and Applications P.N. Rao Tata McGraw Hill Publications

Reference Books

1. Computer Graphics Donald Hearn and M. Pauline Baker Eastern Economy Edition
2. Principle of Computer Graphics William.M. Neumann and Robert.F. Sproul McGraw Hill publishers.
3. Fundamental of CIM technology David L. Goetsch Delmar publication
4. Computer Integrated Design and Manufacturing David Bedworth McGraw Hill publishers.
5. CNC Machines B.S. Pabla and M. Adithan New Age International Publishers.
6. Numerical Control and Computer Aided Manufacturing T.K. Kundra, P.N. Rao and N.K. Tiwari Tata McGraw Hill publishers
7. CNC Technology and Programming Krar S. and Gill A. McGraw Hill publishers

8. Computer Integrated Manufacturing - An Introduction with Case Studies Paul G. Ranky Prentice Hall International

9. Additive Manufacturing Technologies Ian Gibson, David W Rosen, Brent Stucker., Mahyar Khorasani Springer.

10. Additive Manufacturing Juan Pou, Antonio Riveiro and J. Paulo Davim Elsevier

11. Additive Manufacturing (A Tool for Industrial Revolution 4.0) M. Manjaiah, K. Raghavendra, N. Balashanmugam, J. Paulo Davim Woodhead Publishing

12. Additive Manufacturing An Elsevier Journal

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.

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 hrs.

Smart Industries (PEME8014)

Teaching Scheme

Lectures : 3 Hrs./week

Credit : 3

Examination Scheme

Term Test : 15 Marks

Teacher Assessment : 20 Marks

End Sem Exam : 65 Marks

Total: 100 Marks

Prerequisite:

1. Knowledge of Basic courses in Mechanical Engineering.

Course Objectives:

1. To provide students with a comprehensive understanding of the process of Industrial transformation and concepts of smart industry, Industry 4.0.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Understand the basic principles behind smart industry.	L2	Understand
CO2	Identify smart industry key levers and drivers.	L1	Remember
CO3	Understand the supporting technologies for Smart factories.	L2	Understand
CO4	Learn from leading industries and develop smart factory roadmaps.	L2	Understand

Course Contents

Unit-I 07 Hrs

Introduction to Smart Industry Traditional Manufacturing Practices and Limitations, Industry Revolution, Introduction to Fourth Industrial Revolution and Concept of Smart Industry, Journey of Smart Industry, Key Drivers of smart industry/Industry 4.0, Changing society, product and processes, Need for renovating and standardizing production and manufacturing Industries to compete with global challenges, Smart Industry Roadmap, Opportunities and Challenges

Unit-II 10 Hrs

Supporting Tools and Technologies for Smart Industries Part I Introduction to and Use of following Technologies in Smart Industries: IOT, Industrial IOT, Autonomous Robots, Additive Manufacturing, Horizontal and Vertical System Integration

Unit-III 10 Hrs

Supporting Tools and Technologies for Smart Industries Part II Introduction to and Use of following Technologies in Smart Industries: AI, Cloud Computing, Big Data and ICT, Block chain, Simulation, Cyber Physical Systems, Augmented Reality and Virtual Reality in Smart Factories.

Unit-IV 10 Hrs

Dimensions of Smart Manufacturing Smart and connected products, Smart Machinery, Smart materials and manufacturing processes, and Smart material handling. Smart Logistics, Marketing and sales, post sales service and customer relationship management. Smart Money: Digital payment strategy in India.

Unit-V 10 Hrs

Smart Industry applications with case studies Discussion on case studies and success stories across industries who had developed and implemented several smart factory solutions. .

Text Books

1. Handbook of Industry 4.0 and SMART Systems - Diego Galar Pascual, Pasquale Daponte and

Uday Kumar CRC Press.

Reference Books

1. Implementing Industry 4.0: The Model Factory as the Key Enabler for the Future of Manufacturing - Carlos Toro, Wei Wang, and Humza Akhtar - Springer Publications.
2. Smart Digital Manufacturing: A guide of digital transformation with real case studies across industries - Rene Wolf and Raffaello Lepratti - Wiley-VCH publications.
3. Intelligent Transportation Systems: Smart and Green Infrastructure Design - Frank Kreith - Mechanical Engineering Series - Taylor and Francis Group.
4. The Internet of Things: Enabling Technologies, Platforms, and Use Cases - Pethuru Raj and Anupama C. Raman - CRC Press.
5. Internet of Things - Jeeva Jose - Khanna Publishing House, Delhi.
6. Block Chain Basics - Daniel Drescher - Apress.
7. Sensors and Actuators - C.W. de Silava - CRC Press.
8. Introduction to sensors - J. Vetelino and A. Reghu - CRC Press.
9. Smart Plant Factory: The Next Generation Indoor Vertical Farms - Toyoki Kozai - Springer Nature Publications.
10. Introduction to Industry 4.0 and Industrial Internet of Things - Prof. Sudip Misra - NPTEL Course - IIT Kharagpur.
11. Smart Industry Smart Education - Michael E. Auer and Reinhard Langmann Springer Publications

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.
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 hrs.

Sustainable Energy Management (PEME8015)

Teaching Scheme

Lectures : 3 Hrs./week

Credit : 3

Examination Scheme

Term Test : 15 Marks

Teacher Assessment : 20 Marks

End Sem Exam : 65 Marks

Total: 100 Marks

Prerequisite:

1. Knowledge of fundamentals of Thermodynamics, Heat Transfer, Energy conversion systems.

Course Objectives:

1. To gain knowledge of present energy scenario in global and national level.
2. To understand the fundamental of energy economics and methods energy auditing.
3. To understand and analyze the energy efficiency in thermal and electrical utilities.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Know the present energy scenario, global environmental concern, and importance of sustainable energy management.	L3	Apply
CO2	Analyze energy trends in energy intensive sectors and carry out energy action plan .	L4	Analyze
CO3	Understanding the energy economy of the energy intensive sectors.	L2	Understand
CO4	Analyze the energy utilization in thermal and electrical utilities.	L4	Analyze
CO5	Evaluate the efficiency of boilers, steam systems, furnace, HVAC and refrigeration systems.	L4	Analyze

Course Contents

Unit-I 08 Hrs

Introduction: Energy Scenario, various forms of energy, energy management and its importance, recent trends in energy conservation.

Global environmental concerns: United Nations Framework Convention on Climate Change (UNFCC), sustainable development, Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), Prototype Carbon fund (PCF).

Unit-II 08 Hrs

Energy Action Planning: Key elements, force field analysis, Energy policy purpose, perspective, contents, formulation, ratification, Organizing - location of energy management, top management support, managerial function, roles and responsibilities of energy manager, accountability. Motivating-motivation of employees: Information system-designing barriers, strategies; Marketing and communicating-training and planning.

Unit-III 08 Hrs

Energy Economics: Simple payback period, time value of money, IRR NPV, life cycle costing, cost of saved energy, cost of energy generated. Monitoring and Targeting: Defining monitoring and targeting, elements of monitoring, targeting and reporting, Energy accounting, energy monitoring, energy audit process.

Unit-IV 12 Hrs

Energy Efficiency in Thermal Utilities: Boilers, steam systems, furnaces insulation and refractories, FBC boilers, cogeneration, waste heat recovery.

Energy Efficiency in Electrical Utilities: Electrical systems, electric motors, compressed air system, HVAC and refrigeration systems, fans and blowers, pumps and pumping systems, cooling towers, lighting system, diesel generating system.

Unit-V 06 Hrs

Environmental Management: Discussion on case studies and success stories across industries who

had developed and implemented several smart factory solutions.

Text Books

1. Energy Management and Conservation K. V. Sharma and P. Venkataseshaiah, I. K. International Publication House.
2. Industrial Energy Conservation D. A Reay Pergamon Press.
3. Energy Management W. R. Murphy Springer

Reference Books

1. Energy Management and Conservation Handbook Frank Kreith CRC Press.
2. Energy Efficiency Ming Yang and Xin Yu Springer
3. Economics of Solar Energy Conservation Systems Krieth RE West CRC Press

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.
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 hrs.

Industrial Waste Management (PEME8016)

Teaching Scheme

Lectures : 3 Hrs./week

Credit : 3

Examination Scheme

Term Test : 15 Marks

Teacher Assessment : 20 Marks

End Sem Exam : 65 Marks

Total: 100 Marks

Prerequisite:

1. Knowledge of fundamental of Thermodynamics and Energy conversion systems.

Course Objectives:

1. To impart knowledge on source and characteristics of various industrial wastes.
2. To impart the strategies for prevention and control of industrial pollution.
3. To understand the methods and techniques of treatments for wastes.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Know the sources of pollution from industries.	L2	Understand
CO2	Understand the characteristics of pollution.	L2	Understand
CO3	Analyze the effects and hazardless of the industrial pollution.	L4	Analyze
CO4	Plan to minimize of industrial wastes.	L4	Analyze
CO5	Design facilities for the processing and reclamation of industrial waste water.	L6	Create

Course Contents

Unit-I 08 Hrs

Introduction: Types of industries and industrial pollution, Characteristics of industrial wastes Population equivalent Bioassay studies effects of industrial effluents on streams, sewer, land, sewage treatment plants and human health Environmental legislations related to prevention and control of industrial effluents and hazardous wastes

Unit-II 08 Hrs

Waste management: Waste management Approach Waste Audit Volume and strength reduction Material and process modifications Recycle, reuse and byproduct recovery Applications.

Unit-III 08 Hrs

Industrial pollution: Sources, Characteristics, waste treatment flow sheets for selected industries such as Textiles, Tanneries, Pharmaceuticals, Electroplating industries, Dairy, Sugar, Paper, distilleries, Steel plants, Refineries, fertilizer, thermal power plants Wastewater reclamation concepts.

Unit-IV 10 Hrs

Treatment Technologies: Wastewater treatment, Equalisation Neutralisation Removal of suspended and dissolved organic solids - Chemical oxidation Adsorption - Removal of dissolved inorganics Combined treatment of industrial and municipal wastes Residue management Dewatering Disposal.

Unit-V 10 Hrs

Hazardous Waste Management: Hazardous wastes - Physico chemical treatment solidification incineration Secure land fills

Radioactive Waste Management: Sources, Measures on health effects, nuclear power plants and fuel production, Waste generation from nuclear power plants, disposal options.

Text Books

1. Industrial Pollution Prevention T. T. Shen Springer

2. Environmental Pollution and Management Avnish Chauhan Wiley Publication.

Reference Books

1. Environmental Management Systems and Cleaner Production Ruth Hillary Wiley Publication
2. Industrial Water Pollution Control W. W. Eckenfelder Jr McGraw-Hill Publication Company
3. Wastewater Treatment M. N. Rao and A. K. Dutta Oxford Publication

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.
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 hrs.

Business Analytics (PEME8021)

Teaching Scheme

Lectures : 3 Hrs./week

Credit : 3

Examination Scheme

Term Test : 15 Marks

Teacher Assessment : 20 Marks

End Sem Exam : 65 Marks

Total: 100 Marks

Prerequisite:

1. Knowledge of basic statistics and Database.

Course Objectives:

1. To Familiarize with Business Analytics refers to skills, practices and techniques used in converting data into information andknowledge that aid business decision making.
2. To acquaint with Statistical learning including quantitative, qualitative analysis techniques.
3. To acquaint with the use of the above analysis and visualization to aid decision making

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Apply Base SAS programming.	L3	Apply
CO2	Understand and demonstrate visual analytics.	L2	Understand
CO3	Design the report using reporter.	L6	Create
CO4	View various reports using different media devices.	L4	Analyze

Course Contents

Unit-I 09 Hrs

ntroduction to Base SAS: SAS Program: Introduction to SAS program, Submitting a SAS program SAS Studio, SASEnterprise Guide, SAS Windowing environment, SAS program syntax **Accessing Data:** Examining SAS Data sets, Accessing SAS Libraries **Producing Detail Reports:** Subsetting Report data, Sorting and Grouping Report data, Enhancing Reports **Formatting Data Values:** Using SAS Formats, User defined Formats

Unit-II 06 Hrs

Reading SAS Dataset, Spreadsheet and Database data Reading SAS Dataset, Customize SAS Dataset, Router Reading Spreadsheet data, Reading database data.

Unit-III 12 Hrs

Visual Analytics Getting Stated with SAS Visual Analytics: Exploring SAS VA concepts, Using Home page Administrating the Environment and Managing Data: Exploring Data Builder, Exploring Administrator, Demonstrations and Exercises. **Using the Explorer** Selecting Data and defining Data Item properties, Creating Visualizations, Enhancing Visualizations with Analytics, Interacting with Visualizations and Explorations

Unit-IV 09 Hrs

Designing Reports with Reporter Creating a Simple Report, Creating Data Items and Working with GraphsWorking with Filters and Report sections Working with other objects, Demonstrations and Exercises .

Unit-V 06 Hrs

Viewing SAS VA Reports and Case Study Creating Analyses and Reports.Viewing Reports on tthe Web, Viewing Reports on the Mobile Device/ Office Analytics, Case Study Creating Analyses and Reports. .

Reference Books

1. SAS programming 1 Essentials.
2. SAS Visual Analytics Fast Track.
3. SAS Support
4. Business Analytics, Data Analysis and Decision Making - S. Christian Albright, Wayne L. Winston - CENGAGE Learning
5. Business Analytics, A Data-Driven Decision Making Approach for Business, Volume I - Amar Sahay - Business Expert Press
6. Data Science for Business and Decision Making - Luiz Paulo Favero and Patricia Belfiore - Elsevier Science

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.
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 hrs.

IoT and Applications (PEME8022)

Teaching Scheme	**Examination Scheme**
Lectures : 3 Hrs./week	Term Test : 15 Marks
Credit : 3	Teacher Assessment : 20 Marks
	End Sem Exam : 65 Marks
	Total: 100 Marks

Prerequisite:

Knowledge of fundamentals of Electrical and Electronics Engineering and Internet Technology.

Course Objectives:

1. Understand general concepts of Internet of Things (IoT).
2. Recognize various devices, sensors and applications.
3. Apply design concept to IoT solutions.
4. Evaluate design issues in IoT applications.
5. Create IoT solutions using sensors, actuators and Devices.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Understanding of IoT value chain structure (device, data cloud), application areas and technologies involved.	L2	Understand
CO2	Understand IoT sensors and technological challenges faced by IoT devices, with a focus on wireless, energy, power, and sensing modules.	L2	Understand
CO3	Market forecast for IoT devices with a focus on sensors.	L5	Evaluate
CO4	Explore and learn about Internet of Things with the help of preparing projects designed for Raspberry Pi.	L6	Create

Course Contents

Unit-I 10 Hrs

Introduction to Internet of Things: IoT concepts, Definition and Characteristics of IoT, IoT standards, components of IOT System (Sensors, Actuators), relevance of IOT for the future, Physical Design of IoT IoT Protocols, IoT communication models, IoT communication APIs, IOT enabled technologies Wireless Sensor Networks, Cloud Computing, Embedded Systems.

Unit-II 08 Hrs

IoT Physical Devices and Endpoints: Introduction to Arduino and Raspberry PiInstallation, Interfaces (serial, SPI, I2C), Programming Python program with Raspberry PI with focus on interfacing external gadgets, controlling output, reading input from pins.

Unit-III 10 Hrs

Controlling Hardware: Connecting LED, Buzzer, switching high power devices with transistors, Controlling AC power devices with relays, Controlling servo motor, speed control of DC Motor,unipolar and bipolar Stepper motors. Sensors: Light sensor, temperature sensor with thermistor, voltage sensor, ADC and DAC, temperature and humidity sensor DHT11, Motion detection Sensors, Wireless bluetooth sensors, Level sensors, USB sensors, Embedded sensors, distance measurement with ultrasound sensor

Unit-IV 06 Hrs

Introduction of automated high-end vehicles, Drone technology, Automated guided vehicles in material handling.

Unit-V 08 Hrs

IoT Applications: Smart factories, Home automation, Smart city, environment, energy, agriculture and relevant case studies based on real world applications.

Text Books

1. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities

Press.

2. Getting Started with Raspberry Pi, Matt Richardson Shawn Wallace, O'Reilly (SPD).

3. Architecting the Internet of Things, Dieter Uckelmann, Mark Harrison, Michahelles, Florian, Springer.

4. Internet of Things (A Hands-On-Approach), Vijay Madisetti and Arshdeep Bahga, VPT.

Reference Books

1. Peter Waher, 'Learning Internet of Things', Packt Publishing, Editors Ovidiu Vermesan

2. Peter Friess,'Internet of Things From Research and Innovation to Market Deployment', River Publishers.

3. N. Ida, Sensors, Actuators and Their Interfaces, SciTech Publishers.

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.

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 hrs.

Process Equipment Design (PEME8023)

Teaching Scheme

Lectures : 3 Hrs./week

Credit : 3

Examination Scheme

Term Test : 15 Marks

Teacher Assessment : 20 Marks

End Sem Exam : 65 Marks

Total: 100 Marks

Prerequisite:

1. Knowledge of Engineering Thermodynamics, Fluid mechanics, Materials Technology, Heat Transfer, Machine Design I, and Machine Design II

Course Objectives:

1. To understand the design process of various process equipment used in industries

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Understand the basics of process equipment design.	L2	Understand
CO2	Design a reaction vessel to meet the given requirements.	L6	Create
CO3	Design a storage tank as per industrial standards.	L6	Creater
CO4	Design a shell and tube heat exchanger for single phase heat transfer.	L6	Create
CO5	Design vertical towers like distillation columns.	L6	Create

Course Contents

Unit-I 08 Hrs

Process design parameters: Basic concepts in process design, Block diagrams for flow of processes, Material flow balance, Design pressures temperatures, Design stresses, Factory of safety, Minimum shell thickness and corrosion allowance, Weld joints efficiency, Design loading, Stress concentration and thermal stresses, Failure criteria, Optimization technique such as Lagranges multiplier and golden section method, Cost and profitability estimation. Introduction to design codes like IS-2825, ASME-SECT, EIGHT-DIV-II TEMA.API-650, BS-1500 1515.

Unit-II 09 Hrs

Mechanical design of Reaction Vessel: Mechanical design of shell, head, Jacket, coil, agitator, nozzle, body flange, etc., Different types of agitators their selection criteria, Different types of agitator shaft sealing system their selection criteria, Different types of power transmission system, Determination of power required for agitation, shaft diameter, blade thickness, etc., Different types of jackets their selection criteria.

Unit-III 08 Hrs

Mechanical design of Storage Tank: Classification of storage tank as per IS-803, Determination of storage tank capacity, diameter height, Design of shell and bottom plate for storage tank, Design of conical roof, Selection of column, girders and rafters, roof curb angle and floating roof.

Unit-IV 08 Hrs

Mechanical design of Shell Tube Heat Exchangers: Mechanical design of shell, tube, tube sheet, head, channel shell, etc. of shell tube heat exchanger

Unit-V 09 Hrs

Mechanical design of Vertical Tall Tower (Distillation Column): Mechanical design of shell, head, tray support, nozzle, body flange for vertical tall tower, Determination of shell thicknesses at various heights for tray tower packed tower in case of internal external pressure, Different types of tray supports their selection criteria, Design of horizontal structural member with periphery ring

type packing support.

Text Books

1. Process Equipment Design - M. V. Joshi and V. V. Mahajani- Mc-Millan publication
2. Introduction to Chemical Equipment Design (Mechanical Aspects) - B. C. Bhattacharya - CBS publication

Reference Books

1. I.S.: 2825-1969 - Code for Unfired Pressure Vessels
2. ASME Boiler Pressure Vessel Code (BPVC) Section VIII
3. Pressure Vessel Design Manual - D. R. Moss - Gulf Professional Publishing
4. Pressure Vessel Handbook E. F. Megyesy - Pressure Vessel Publishing
5. Process Equipment Design - Lloyd E. Brownell and Edwin H. Young - Wiley publication

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.
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 hrs.

Motor Sports Engineering (PEME8024)

Teaching Scheme	**Examination Scheme**
Lectures : 3 Hrs./week	Term Test : 15 Marks
Credit : 3	Teacher Assessment : 20 Marks
	End Sem Exam : 65 Marks
	Total: 100 Marks

Prerequisite:

1. Knowledge of fundamental concepts of materials technology, Finite Element analysis, Computational fluid dynamics (CFD) concept, electronics and electrical engineering.

Course Objectives:

1. To gain knowledge of different types of advanced materials and their manufacturing techniques for motorsports vehicle.
2. To Understand the fundamental scientific, and engineering principles involved in motorsport responsible for high performance.
3. Design, analysis and performance-based techniques of competition vehicles, and related aspects of materials science, aerodynamics, structural analysis, vehicle systems related to motorsport.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Define selection criteria and specifications of metallic and non-metallic materials.	L1	Remember
CO2	Analyze modelling and simulation results with respect to structural responses behavior.	L4	Analyze
CO3	Distinguish the complex relationships between competition vehicle design aspects and competition vehicle performance.	L4	Analyze
CO4	Evaluate the matching of engine, transmission, and vehicle chassis for motorsport applications.	L4	Analyze
CO5	Understand application of aerodynamics in motorsports.	L2	Understand
CO6	Design, evaluate and optimize data systems based on fundamental principles of electrical and digital information transfer.	L6	Create

Course Contents

Unit-I 08 Hrs

Introduction: History of motorsport and competition vehicle development, Competition vehicle categories, Sporting, and technical regulations

Introduction to advance materials, application, and manufacturing: The physical and metallurgical properties of high strength steels, stainless steels, metal matrix composites and aluminium, and titanium alloys, rubbers, elastomers, plastics, and honeycomb Advance materials application in Motorsport industry through case studies include Materials forms, performance, and selection, advance manufacturing technology and joining techniques in context with motorsports.

Unit-II 08 Hrs

Design, analyses, and optimization techniques: Design of competition vehicles with structural design context, analyses, finite element modelling and simulations, shape optimization, Identification of failure modes and nondestructive test methods.

Unit-III 08 Hrs

Vehicle dynamics: Tyre shear force development, measurement and characterization, Suspension geometry description and analysis, Steady turning equilibrium states, suspension/chassis interactions, stability and controllability ,Limit behavior and design aspects, differentials and brake balancing Simulation tools and model building, Vibration behavior of car and wheels, springs, dampers, track roughness, Minimum time optimization.

Unit-IV 12 Hrs

Powertrain: The design of high-performance vehicle transmission systems, ,Mechanical design of high performance two and four stroke petrol and diesel motorsport engines, the matching of engine, transmission and vehicle, Hybrid and electric powertrains as used in motorsport Aerodynamics: The application of aerodynamic design principles to motorsport components, Mechanisms for controlling aerodynamic lift and drag generation, application of CFDr

Unit-V 06 Hrs

Data Acquisition: Electrical circuit design and its issues, sensors, signal conditioning, Sampling issues in amplitude and frequency domain, Data communications on vehicle and test cell, Data processing and analysis techniques, Introduction to real time software, Practical system packaging.

Text Books

1. Process Equipment Design - M. V. Joshi and V. V. Mahajani- Mc-Millan publication
2. Introduction to Chemical Equipment Design (Mechanical Aspects) - B. C. Bhattacharya - CBS publication

Reference Books

1. Advanced Motorsport Engineering - Andrew Livesey
2. Competition Car Composites: A Practical Handbook - Simon Mc Beath
3. Suspension Geometry and Computation - john C.Dixon.
4. Race Car Vehicle Dynamics - William F. Milliken and Douglas L. Milliken
5. Chassis Engineering - Herb Adams

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.
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 hrs.

Advanced Quantitative Techniques

(PEME8025)

Teaching Scheme	**Examination Scheme**
Lectures : 3 Hrs./week	Term Test : 15 Marks
Credit : 3	Teacher Assessment : 20 Marks
	End Sem Exam : 65 Marks
	Total: 100 Marks

Prerequisite:

1. Knowledge of Basic courses in Mechanical Engineering.

Course Objectives:

1. To equip the students with the expert knowledge and skills needed to apply the various quantitative techniques for decision making.

Course Outcomes:

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	**Explain** significance of sensitivity analysis of LPP and **perform** sensitivity analysis on various parameters involved in LP model.	L4	Analyze
CO2	**Recognize** the limitations of simplex method in deriving integer solution to LPP and **employ** suitable algorithm to obtain integer solution.	L1, L3	Remember, Apply
CO3	**Identify** real-world problems as special cases of Linear Programming Problem and **Solve** the decision problem by choosing appropriate algorithm.	L1,L6	Remember, Create
CO4	**Analyse** various decision-making situations, outline decision alternatives and **select** the best alternative.	L4,L6	Analyze, Create
CO5	**Describe** a real-world problem as a Non-Linear Programming Problem and **Distinguish** local, global extreme points and point of inflectiob.	L4	Analyze

Course Contents

Unit-I 10 Hrs

Introduction to Decision model and Quantitative techniques: Concept of decision making and decision problem, Mathematical Model of decision problem, Concept of Optimization, Quantitative techniques for finding optimal solutions to decision problems.

Linear Programming Problem: Mathematical Formulation. Overview of Simplex Method. Sensitivity Analysis. **Linear Goal programming:** Formulation as Goal programming model, Optimal solution by graphical method and simplex method.

Unit-II 07 Hrs

Integer Programming Problem: Types of Integer Programming Problems. Gomorys cutting plane Algorithm, Branch and Bound Technique.

Introduction to Decomposition algorithms.

Unit-III 07 Hrs

Traveling Salesman Problem: Branch and Bound method **Transhipment Problem:** Formulation and finding optimal solution. **Network Optimization Models:** Shortest Path, Minimum Spanning Tree, and Maximum Flow Problems.

Unit-IV 09 Hrs

Decision Theory: Decision Making under risk, under uncertainty, Decision Trees Utility Theory, Bayesian approach in decision making Decision Making under certainty, Introduction to concepts of AHP (Analytic Hierarchy Process) ANP (Analytic Network Process).

Unit-V 09 Hrs

Nonlinear programming problems (NLPP)- Convex programming Unconstrained NLPP Search Algorithm and Gradient method. Constrained NLPP Kuhn-Tucker Conditions, Geometric Programming Quadratic programming.

Text Books

1. Operations Research, Sharma J. K., Trinity Press
2. Operations Research, Gupta P. K., Hira D. S., S. Chand Limited

Reference Books

1. Operations Research - An Introduction; Taha, H.A.; Prentice Hall
2. Operations Research: Principles and Practice; Ravindran, A, Phillips, D. T and Solberg, J. J.; John Willey and Sons
3. Introduction to Operations Research; Hiller, F. S. and Liebermann, G. J.; Tata McGraw Hill
4. Operations Research Principles and Practice; Pradeep Prabhakar Pai; Oxford University Press
5. Operations Research, R. Panneerselvam, PHI Publications.
6. Operations Research, A. M. Natarajan, P. Balasubramani, A. Tamilarasi, Pearson Education.
7. Operations Research; Kanti Swarup, P. K. Gupta and Man Mohan; Sultan Chand Sons

Evaluation Scheme:

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of 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 paper is 1 hr.
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 hrs.

Internship (PJME8030L)

Practical Scheme
Practical : 20 Hrs./week
Credit : 01

Examination Scheme
Teacher Assessment : 150 Marks
End Sem Exam : 150 Marks
Total : 300 Marks

Course Objectives:

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

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.	L2	Understand
CO3	Ensure a collaborative project environment by interacting and dividing project work among team members.	L3	Apply
CO4	Present their project work in the form of a technical report / paper and thereby improve the technical communication skill.	L3	Apply
CO5	Demonstrate the ability to work in teams and manage the conduct of the research study.	L2	Understand

Guidelines:

The main purpose of this activity is to provide an opportunity to the students of research oriented mindset. It will be an extension of the entire project which student has already done in VIth VIIth semester i. e Project Stage-I II or they can work on new objectives offered by department/ research guide.

- It can be a group or individual activity as it is one of the option that student or group of students can opt in this semester.
- In case of extension of project stage II, it is mandatory that, at least one student should be in the group who has done this project in stage I II.
- In case of the objectives offered by department/research guide, a group of fresh students can be formed.
- Maximum 3 students can form a group.
- In case of extension of project stage II, the outcomes should be in the form of product development/technology transfer along with patent and copy right. Student can work jointly with any government funding agency or industry. In such case, a detailed project report shall be submitted with duly authenticated by internal research guide and industry/funding agency mentor / authority. In case of standalone i.e. without any funding agency/industry collaboration, the detailed project report shall be submitted with duly authenticated by the internal research guide and the student.
- In case of research objectives offered by department/research guide, the outcome of project stage III must be in the form of journal paper publication preferably at least one SCI/ two Scopus / three UGC care listed/ three indexed conference paper. The detailed project report shall be submitted with duly authenticated by the internal research guide and the student.
- All the research work shall be submitted to the department in the form of project report in hard bound and soft copy.

Evaluation Scheme:

Continuous Assessment (A):

- Each project will be reviewed twice in the semester. In the first monitoring at least 40 percent work must be completed which includes; Introduction/scope to the topic, literature overview, problem definition and objectives. The second monitoring remaining 60 percent work must be completed which includes; implementations, key findings, publications, patenting, copy right, product development etc.

- A logbook of the work done must be maintained by the student.

End Semester Exam:

Departmental committee (including project guide) will evaluate project as per Table.

Assessment Formats:

Table 4: Log Book Format

Sr	Week (Start Date:End Date)	Work Done	Sign of Guide	Sign of Coordinator
1				
2				

Table 5: First Monitoring

Sr	Topic Identification and Validation	Literature Overview	Problem Definition	Objectives	Total
	5	10	5	5	25

Table 6: Second Monitoring (Objectives given by dept/research guide)

Sr	Implementation	Publications	Presentation	Report	Total
	5	10	5	5	25

Table 7: Second Monitoring(Extension of Project Stage-II)

Sr	**Product Development/Technology Transfer**	**Patent etc.**	**Presentation and report**	**Total**
	10	10	5	25

Table 8: End Semester Examination

Sr	**Topic Identification and Validation**	**Literature Overview and Problem Definition**	**Objectives and Implementation/Product Development**	**Presentation**	**Report/ Publications/ Patent/IPR documents**	**Total**
	5	5	5	5	5	25