Pimpri Chinchwad Education Trust's

PIMPRI CHINCHWAD COLLEGE OF ENGINEERING

SECTOR NO. 26, PRADHIKARAN, NIGDI, PUNE 411044

An Autonomous Institute Approved by AICTE and Affiliated to SPPU, Pune

DEPARTMENT OF MECHANICAL ENGINEERING

Curriculum Structure and Syllabus

of

M. Tech. Mechanical Design Engineering

(Approved by BoS Mechanical Engineering)

(Course 2020)

Effective from Academic Year 2023-24

(Updated with minor changes)

Institute Vision

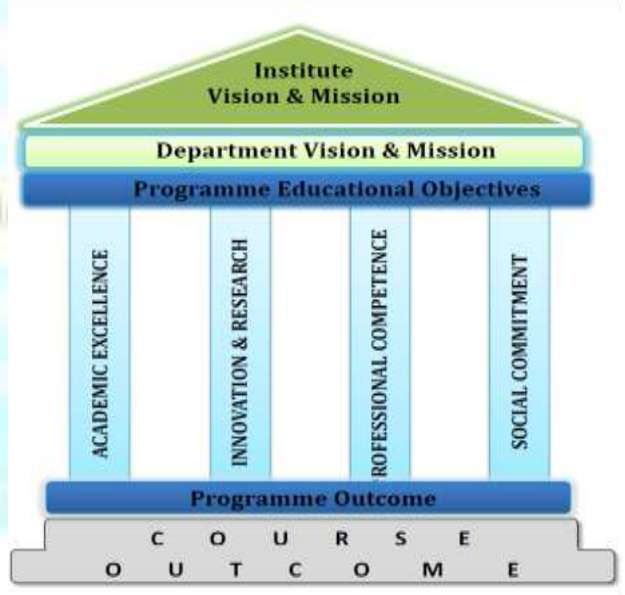
To be one of the top 100 Engineering Institutes of India in coming five years by offering exemplarily Ethical, Sustainable and Value Added Quality Education through a matching ecosystem for building successful careers.

Institute Mission

1. Serving the needs of the society at large through establishment of a state-of-art Engineering Institute.
2. Imparting right Attitude, Skills, Knowledge for self-sustenance through Quality Education.
3. Creating globally Competent and Sensible Engineers, Researchers and Entrepreneurs with an ability to think and act independently in demanding situations**.**

Quality Policy

We at PCCOE are committed to impart Value Added Quality Education to satisfy the applicable requirements, needs and expectations of the Students and Stakeholders. We shall strive for academic excellence, professional competence and social commitment in fine blend with innovation and research. We shall achieve this by establishing and strengthening state-of-the-art Engineering and Management Institute through continual improvement in effective implementation of Quality Management System.



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ABBREVIATION

Abbreviations	Course Full Name
PCC	**P**rogramme **C**ore **C**ourse
PEC	**P**rofessional **E**lective **C**ourse
OEC#	**O**pen **E**lective **C**ourse
PROJ	**Proj**ect, Mini / Minor **Proj**ects, Integrated **Proj**ects
SEM	**Sem**inar
INTR	**Inter**nship
LS	**L**ife **S**kill
AUDIT*	**Audit** Course
MO	**M**assive **O**pen Online Courses

Note: * Indicates that these courses are at institute level

The Course offered by other departments

Curriculum Structure

CURRICULUM STRUCTURE

STRUCTURE FOR 1ST YEAR

M. TECH. MECHANICAL (DESIGN ENGINEERING)

SEMESTER – I

M.Tech. Structure		Semester-I	Teaching Scheme				Examination Scheme					
Course Code	**Course Type**	**Course Name**	**L**	**P**	**H**	**CR**	**IE1**	**IE2**	**ETE**	**TW**	**OR**	**Total**
MMD1401	PCC	Research Methodology & IPR	3	-	3	3	20	30	50	-	-	100
MMD1402	PCC	Stress Analysis	3	-	3	3	20	30	50	-	-	100
MMD1403	PCC	Finite Element Method	3	-	3	3	20	30	50	-	-	100
MMD1404	PCC	Professional core Lab-I (SA, FEM)	-	2	2	1	-	-	-	50	50	100
MMD1405	PCC	Skill Development Lab - I (Software Skills)	-	2	2	1	-	-	-	50	-	50
MMD1501	PEC	Professional Elective-I	3	-	3	3	20	30	50	-	-	100
MMD1502	PEC	Professional Elective-II	3	-	3	3	20	30	50	-	-	100
MMD1503	PEC	Professional Elective Lab-I (PE I , PE II)	-	2	2	1	-	-	-	50	50	100
**	OEC	Open Elective-I	2	-	2	2	20	-	30	-	-	50
M_1961	Audit	Audit course – I	1	-	1	-	-	-	-	-	-	-
		Total	**18**	**6**	**24**	**20**	**120**	**150**	**280**	**150**	**100**	**800**

Abbr: Course Abbreviation; **L**- Lecture; **P**- Practical; **H**- Hours; **CR**- Credits; **IE1** – Internal Evaluation-1; **IE2** – Internal Evaluation-2; **ETE** – End Term Examination; **TW** – Term Work; **OR** – Oral Exam

** Course code of the selected open elective by student

STRUCTURE FOR 1ST YEAR
M. TECH. MECHANICAL (DESIGN ENGINEERING)
SEMESTER – II

M.Tech. Structure Semester -II			Teaching Scheme				Examination Scheme					
Course Code	**Course Type**	**Course Name**	**L**	**P**	**H**	**CR**	**IE1**	**IE2**	**ETE**	**TW**	**OR**	**Total**
MMD2406	PCC	Optimization Techniques in Design	3	-	3	3	20	30	50	-	-	100
MMD2407	PCC	Advanced Vibrations and Acoustics	3	-	3	3	20	30	50	-	-	100
MMD2408	PCC	Professional core Lab-II (OT, AVA)	-	2	2	1	-	-	-	50	50	100
MMD2504	PEC	Professional Elective-III	3	-	3	3	20	30	50	-	-	100
MMD2505	PEC	Professional Elective-IV	3	-	3	3	20	30	50	-	-	100
MMD2506	PEC	Professional Elective Lab-II (EL III, EL IV)	-	2	2	1	-	-	-	50	50	100
MMD2701	PROJ	Integrated Mini-Project	-	6	6	3	-	50	-	-	50	100
**	OEC	Open Elective –II	2	-	2	2	20	-	30	-	-	50
M_2101	HSMC	Skill Development Lab – II (Written & Oral Communication)	-	2	2	1	-	-	-	50	-	50
M_2962	Audit	Audit course – II	1	-	1	-	-	-	-	-	-	-
		Total	**15**	**12**	**27**	**20**	**100**	**170**	**230**	**150**	**150**	**800**

Abbr: Course Abbreviation; **L**- Lecture; **P**- Practical; **H**- Hours; **CR**- Credits; **IE1** – Internal Evaluation-1; **IE2** – Internal Evaluation-2; **ETE** – End Term Examination; **TW** – Term Work; **OR** – Oral Exam

** Course code of the selected open elective by student

STRUCTURE FOR IIND YEAR
M. TECH. MECHANICAL (DESIGN ENGINEERING)
SEMESTER-III

M. Tech. Structure	Semester – III		TEACHING SCHEME				EXAMINATION SCHEME					
Course Code	**Course Type**	**Courses**	**L**	**P**	**H**	**CR**	**IE1**	**IE2**	**ETE**	**TW**	**OR**	**TOTAL**
MMD3702	PROJ	Dissertation Phase - I [Company/ In-house project]	-	20	20	10	-	-	-	100	100	200
MMD3703	SEM	Seminar	-	04	04	02	-	-	-	50	50	100
MMD3801	INTR	Internship [Company/ In-house project] /	-	04	04	02	-	-	-	100	-	100
OR												
MMD3981	MOOC	MOOC's / Entrepreneurship	-	04	04	02	-	-	-	100	-	100
		Total	**-**	**28**	**28**	**14**	**-**	**-**	**-**	**250**	**150**	**400**

*Internship**: -It may be in summer/winter vacation or within semester at least for three months, evaluation after fourth semester**

STRUCTURE FOR IIND YEAR
M. TECH. MECHANICAL (DESIGN ENGINEERING)
SEMESTER-IV

M. Tech. Structure	Semester – IV		TEACHING SCHEME				EXAMINATION SCHEME					
Course Code	**Course Type**	**Courses**	**L**	**P**	**H**	**CR**	**IE1**	**IE2**	**ETE**	**TW**	**OR**	**TOTAL**
MMD4704	PROJ	Dissertation Phase - II [Company/ In-house project]	-	24	24	12	-	-	-	200	200	400
MMD4982	MOOC	MOOC's	-	4	4	2	-	-	-	100	-	100
		Total	**-**	**28**	**28**	**14**	**-**	**-**	**-**	**300**	**200**	**500**

Abbr: Course Abbreviation; **L**- Lecture; **P**- Practical; **H**- Hours; **CR**- Credits; **IE1** – Internal Evaluation-1; **IE2** – Internal Evaluation-2; **ETE** – End Term Examination; **TW** – Term Work; **OR** – Oral Exam

LIST OF PROFESSIONAL ELECTIVE COURSES

Course Code	Elective-I	Course Code	Elective-II
MMD1501A	Advanced Machine Design	**MMD1502A**	Mechanics of Composites
MMD1501B	Mechanical Behavior of Materials	**MMD1502B**	Tribology in Design
MMD1501C	Analysis and Synthesis of Mechanisms	**MMD1502C**	Vehicle Dynamics
MMD1501D	Mathematical Methods in Engineering	**MMD1502D**	Robotics

Course Code	Elective-III	Course Code	Elective-IV
MMD2504A	Fatigue and Fracture Analysis	**MMD2505A**	Design of Material Handling Equipments
MMD2504B	Reliability in Engineering Design	**MMD2505B**	Computer Aided Design
MMD2504C	Mechatronics and Control Systems	**MMD2505C**	Multi-body Dynamics

LIST OF OPEN ELECTIVE COURSES

OFFERED BY MECHANICAL ENGINEERING - DESIGN ENGINEERING

Course Code	Open Elective – I	Course Code	Open Elective –II
MMD1601A	Advanced Materials	**MMD2602A**	Room Acoustics
MMD1601B	Optimization Methods	**MMD2602B**	Design Thinking
MMD1601C	Modeling & Simulation of Dynamic Systems	**MMD2602C**	Reliability Engineering

OFFERED BY MECHANICAL ENGINEERING - COMPUTATIONAL MECHANICS

	Open Elective – I		Open Elective –II
MMC1601A	Battery Management for Electric Vehicles	**MMC2602A**	Waste Management for Smart Cities
MMC1601B	Green Technology	**MMC2602B**	Electronic Cooling
MMC1601C	System Modeling and Simulation	**MMC2602C**	Renewable Energy Sources

OFFERED BY E&TC- VLSI & EMBEDDED SYSTEMS

Course Code	Open Elective – I	Course Code	Open Elective –II
MET1601A	Automotive Electronics & Applications	**MET2602A**	Drone Programming for Beginners
MET1601B	Industrial Drives	**MET2602B**	Instrumentation and Measurement
MET1601C	Basics of FPGA and CPLD	**MET2602C**	Microcontrollers and Microprocessors applications
MET1601D	Robotics	**MET2602D**	Electronics Implementation Platforms

OFFERED BY COMPUTER ENGINEERING

Course Code	Open Elective – I	Course Code	Open Elective –II
MCE1601A	Programming with Python	**MCE2602A**	Image Processing with MATLAB
MCE1601B	Software Engineering Basics	**MCE2602B**	Linux Essentials
MCE1601C	Basics of Machine learning	**MCE2602C**	Design with UML

OFFERED BY CIVIL- CONSTRCTION MANAGEMENT

Course Code	Open Elective – I	Course Code	Open Elective –II
MCI1601A	Project Management and Finance	**MCI2602A**	Contracts, Tendering and Arbitration
MCI1601B	Green Technology	**MCI2602B**	Total Quality Management
MCI1601C	Organization Behavior	**MCI2602C**	Operation Research

OFFERED BY INFORMATION TECHNOLOGY- ARTIFICIAL INTELLIGENCE & DATA SCIENCE

Course Code	Open Elective – I	Course Code	Open Elective -II
MDS1601A	R Programming	**MDS2602A**	Python for Data Science
MDS1601B	Business Analytics	**MDS2602B**	Introduction to Neural Networks

LIST OF AUDIT COURSES (Common to all Programs)

Course Code	Audit Courses-I (SEM-I)	Course Code	Audit Courses –II (SEM-II)
M_1961A	Constitution of India	**M_2962A**	Team Building & Leadership
M_1961B	Value Education	**M_2962B**	English for Research Writing
M_1961C	Stress Management	**M_2962C**	Disaster Management

Course Syllabus

Semester-I

Program:	M. Tech. Mechanical (Design Engineering)		Semester : I			
Course :	Research Methodology and IPR		Code : MMD1401			
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior knowledge of:

a. Project and seminars in undergraduate

Course Objectives:

1. To select and define appropriate research problem and parameters with appropriate methodology.
2. To understand statistical techniques for the specific perspective data in an appropriate manner.
3. To make predictions and decisions for the data set using open-source software.
4. To understand the mathematical modeling and its predicting capability.
5. To learn the various steps in research writing and publication process
6. To introduce fundamental aspects of Intellectual property Rights

Course Outcomes:

After learning the course, the students should be able to:

1. Define a research problem and use appropriate research methodology
2. Examine data using different hypothesis tests and make conclusions about acceptance or rejection of sample data.
3. Analyze numerical data, using standard procedures of probability theory to predict the performance.
4. Develop a mathematical model and analyze the prediction capabilities
5. Write a research paper and research proposal.
6. Write a concept note and prepare to file an IP.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Research Problem and Research Design** Objectives, Motivation, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Criteria of Good Research. Definition and Feasibility study of research problem, Sources of research problem, Meaning of Hypothesis, Characteristics of Hypothesis, Errors in selecting a research problem, Concept & need of research design	7
2.	**Applied Statistics** Measures of Variability: Standard Deviation, variance, Quartiles, Interquartile Range Inferential Statistics: Statistical Significance (p values), Pearson's r test, t- test, Chi square test, ANOVA (Analysis of variance)	8
3.	**Probability** Sampling, Types of Sampling, Probability Distribution: Binomial Distribution, Poisson Distribution, Normal Distribution, Case Study: Develop a model for Prediction and Decision Making for the data set using open-source software	7
4.	**Mathematical Modeling and prediction of performance** Types of Modeling, Types of solutions to mathematical models, Steps in Setting up a computer model to predict performance of experimental system, Validation of results, Multi-scale modeling and verifying performance of process system, Nonlinear analysis of system and asymptotic analysis, Sensitivity analysis.	8
5.	**Research Report writing and Publication** Research Report: Dissemination of research findings, outline and structure of research report, different steps and precautions while writing research report, methods and significance of referencing. Publishing Research work: Selection of suitable journal for publishing research work, Open access Vs Subscription Journals, Identifying indexing of selected journals, Impact factor of the journal, structure of research paper, Check for plagiarism of the article, Research paper submission and review process.	7
6.	**Intellectual property Rights** Definition of IPR, Classification of IP, Patentable and non-patentable inventions, statutory exceptions, Persons entitled to apply for patents. Prior Art Search, Patentability Criteria, Patent Filing Procedure, Forms and Fees, Case Study of Patent, Copyright.	8
	Total	**45**

Textbooks:

1. C. R. Kothari, Research Methodology: Methods and Techniques, New Age International, 2nd Edition, 1985
2. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, 2nd Edition.,2010.
3. Ramakrishna B and Anil Kumar H S., Fundamentals of IPR, Notion Press, 2016
4. Virendra Kumar Ahuja, IPR in India, LexisNexis Butterworths Wadhwa Nagpur, 2017

Reference Books:

1. Stuart Melville and Wayne Goddard, Research methodology: An Introduction for Science & Engineering students
2. S.D. Sharma, Operational Research, Kadar Nath Ram Nath & Co.
3. Wayne Goddard and Stuart Melville, Research Methodology: An Introduction, Juta and Company Ltd, 2004

IE Activities:

1. Write a review paper based on detailed literature survey and cheque for plagiarism.
2. Write a research proposal on your domain specific research problem.
3. Write a concept note and prepare to file an IP

Program:	M. Tech. Mechanical (Design Engineering)		Semester : I			
Course :	Stress Analysis		Code : MMD1402			
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior knowledge of:

a. Strength of Materials
b. Machine Design…….are essential

Course Objectives:

1. To understand and analyse stress and strain at a point in deformable solids.
2. To understand different approaches to obtain stresses, strains and deformations induced in the solids.
3. To solve thin section members for bending and torsion.
4. To evaluate stresses, deflection due to line or point contact in solids.

Course Outcomes:

After learning the course, the students should be able to:

1. Formulate and Analyse Stress Field equations such as equilibrium equations, compatibility and constitutive relationship
2. Formulate and Analyse Stresses in pressurised cylinder and rotating disc.
3. Apply Energy methods to evaluate stresses and strains.
4. Analyse and Determine the Torsion and Bending of thin wall section
5. Analyse and estimate contact stresses in conforming and non-conforming shapes.
6. Understand experimental methods for stress evaluation estimate the same using resistance strain gauging technique and Photoelasticity technique.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Theory of Elasticity** Analysis of Stresses and Analysis of Strain. Stress Tensor, Compatibility equations in two and three dimensions, Airy's stress functions in rectangular and Polar coordinate systems,	7
2.	**Pressurized Cylinders and Rotating Disks,** Governing equations, stress in thick walled cylinder under internal and external pressure, shrink fit compound cylinders, stresses in rotating flat solid disk, flat disk with central hole, disk of uniform strength,	8
3.	**Energy Methods** Energy method for analysis of stress, strain and deflection Theorem's - theorem of virtual work, theorem of least work, Castiglioni's theorem,	7
4.	**Thin wall Members:** Torsion of thin walled members of open cross section. Torsion of Multiply Connected Thin-Walled Sections Concept of shear centre in symmetrical and unsymmetrical bending, Shear centre for thin wall beam cross section, open section with one axis of symmetry.	8
5.	**Contact stresses** Geometry of contact surfaces, method of computing contact stresses and deflection of bodies in point contact, Stress for two bodies inline contact with load normal to contact area and load normal and tangent to contact area, For cases like - gear contacts, contacts between cam and follower, ball bearing contacts.	7
6.	**Experimental stress analysis** Dimensional analysis, analysis techniques, strain gauges, types of strain gauges, materials, configuration, instrumentation, characteristics of strain gauge measurement, theory of photo-elasticity, elements of polariscope, simple and circular polariscope, fringes in dark and white field, isoclinic and isochromatic fringe patterns, evaluation of stresses from these fringe patterns.	8
	Total	45

Text Books:

1. Theory of Elasticity–Timoshenko and Goodier, McGrawHill
2. Advanced Strength and Applied Stress Analysis–Richard G. Budynas, McGrawHill
3. Advanced Mechanics of Materials–Boresi, Schmidt, Sidebottom,Willey

Reference Books:

1. Advanced Mechanics of Materials– Cook and Young, Prentice Hall
2. Advanced Mechanics of Solids, L S Shrinath, Tata McGrawHill
3. Advanced Strength of Materials,Vol.1, 2–Timoshenko, CBS
4. Advanced Strength of Materials–Den Hartog
5. Experimental Stress Analysis–Dally & Riley
6. Mechanics of Materials E J Hern, Buttorwoth
7. Strength of Materials, Singer Andrue Pytel, Pearson

Program:	M. Tech. Mechanical (Design Engineering)		Semester : I			
Course :	Finite Element Method		Code : MMD1403			
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior knowledge of:

a. Engineering Mathematics
b. Machine Design
c. Strength of Material……..are essential

Course Objectives:

1. To understand the philosophy and general procedure of Finite Element Method as applied to solid mechanics and thermal analysis problems.
2. To familiarize students with the displacement-based finite element method for displacement and stress analysis and to introduce related analytical and computer tools.
3. It provides a bridge between hand calculations based on mechanics of materials and machine design and numerical solutions for more complex geometries and loading states.
4. To study approximate nature of the finite element method and convergence of results are examined.
5. It provides some experience with a commercial FEM code and some practical modeling exercises

Course Outcomes:

After learning the course, the students should be able to:

1. Student will be able to apply different variation methods for deriving the stiffness matrices of bar and beam element
2. Student will Understand the Iso-parametric Elements and Formulation of Plane Elasticity Problems
3. Student will be able to create and solve the governing equations for plates using Kirchoff theory and Mindlin plate element theory
4. Student will be able to Evaluate non linear problems related to geometry, material and contact.
5. Student will be able to formulate and solve the dynamic problems related to eigen value and eigen vectors

Detailed Syllabus:

Unit	Description	Duration, (H)
1	**One dimensional problems** Finite element method, brief history, basic steps, advantages and disadvantages, weak formulation, variational methods of approximation – Rayleigh-Ritz methods, Galerkin method of Weighted Residuals. Variational formulation of 1D bar and beam elements (Euler Bernoulli and Timoshenko beam) – governing equation, domain discretization, elemental equations, assembly and element connectivity, application of boundary condition, solution of equations, post-processing of the results. Automatic mesh generation techniques, Mesh quality checks, h & p refinements, Node Numbering scheme	**7**
2	**Two Dimensional Isoperimetric Formulation** Introduction, types of 2D elements (CST, LST, QST, Isoparametric), shape functions – linear & quadratic, displacement function – criteria for the choice of the displacement function, polynomial displacement functions, displacement function in terms of nodal parameters, strain-nodal parameter relationship, stress-strain relationship, element stiffness matrix, convergence of isoparametric elements, rate of convergence, plane elasticity problems – plane stress, plane stain and axisymmetric problems	8
3	**Isoparametric Formulation and Numerical Integration** Isoparametric formulation of 1D and 2D Element, Subparametric , Superparametric and Isoparameetric Element, Numerical Integration – Trapezoidal rule, Simpson's 1/3 rule, Newton-Cotes Formula, Gauss Quadrature formula, Gauss Quadrature in two and three dimensions, reduced and selective integration	**7**
4	**Plate Theories** Thin and thick plates – Kirchhoff theory, Mindlin plate element, triangular and rectangular, conforming and nonconforming elements, degenerated shell elements, shear locking and hour glass phenomenon	8
5	**Non-Linear Analysis** Introduction to non-linear analysis, formulation for geometrical, material and contact nonlinear problems, Nonlinear equation solving procedure - direct iteration, Newton-Raphson method, modified Newton-Raphson method, incremental techniques	**7**
6	**Dynamic Problems – Eigen value and Time Dependent Problems** Formulation of dynamic problems, consistent and lumped mass matrices Solution of eigenvalue problems – transformation methods, Jacobi method, Vector Iteration methods, subspace iteration method [Theoretical Treatment] Forced vibration – steady state and transient vibration analysis, modeling of damping, the mode superposition scheme, direct integration methods – implicit and explicit numerical integration	**8**
	Total	**45**

Text Books:

1. Seshu P., "Text book of Finite Element Analysis", PHI Learning Private Ltd., New Delhi, 2010.
2. Logan D, "First course in the Finite Element Method" Cengage Learning,2012

Reference Books:

1. Bathe K. J., "Finite Element Procedures", Prentice-Hall of India (P) Ltd., New Delhi.
2. Cook R. D., "Finite Element Modeling for Stress Analysis", John Wiley and Sons Inc, 1995
3. Chandrupatla T. R. and Belegunda A. D., "Introduction to Finite Elements in Engineering", Prentice
4. Hall India.
5. Liu G. R. and Quek S. S. "The Finite Element Method – A Practical Course", Butterworth-Heinemann,
6. 2003.
7. Reddy, J. N., "An Introduction to The Finite Element Method", Tata McGraw Hill, 2003.

Program:	M. Tech. Mechanical (Design Engineering)				Semester : I	
Course :	Professional Core Lab-I (SA, FEM)				Code: MMD1404	
Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	TW	PR	OR	Total
2	2	1	50	--	50	100

Guidelines :

1. Total experiments to be conducted are **Three from Part A and Three from Part B**
2. **Total : 6 experiments 12 hours**……..are essential

Prior knowledge of:

a. Engineering Design,
b. Strength of materials……are essential

Course Objectives:

This course is to provide students the tools required for Simulate, correlate and validate theoretical concepts and understand the basic principles.

Course Outcomes:

After learning the course the students should be able to:

1. Simulate the problem and correlate with theoretical concepts
2. Understand the impact of assumptions on the simulated results
3. Obtain stresses and strains using experimental methods of stress analysis
4. Apply strain gauges at appropriate locations, collect data, analyse, interpret results.

Detailed Syllabus:

Part A: Stress Analysis (ANY Three)

Expt	Description	Duration (H)
1.	Analytical and Numerical Evaluation of Stresses for plate with hole and correlate with theoretical model developed for solution	5
2.	Contact stress analysis using FEM software and correlate with theoretical model developed for solution.	5
3.	Shear Centre location for thin section beam.(Box, L-section, C-section)	5
4.	Stain gauge mounting and Measurement of strain in cantilever beam using strain gauges	5
5.	Calibration of Photoelastic materials	5
6.	Evaluation of Stresses using Polariscope	5
	Total (Any Three)	**15**

Prior knowledge of: Engineering Mathematics Machine Design, Strength of Material

Course Objectives:

1. To impart the philosophy and general procedure of Finite Element Method simulations as applied to solid mechanics and thermal analysis problems.
2. To describe and interpret Numerical solutions for more complex geometries and loading states.
3. To study approximate nature of the finite element method and convergence of results are examined.
4. Adequately describes a physical event and establishing or validating a relationship between obtained results and underlying physical principles.

Course Outcomes: After learning the course the students should be able to:

1. Apply General procedure and philosophy of finite element method to simulate complex engineering problems
2. Evaluate linear and non linear problems related to geometry, material and contact.
3. Understand and apply elements, mess sensitivity analysis and convergence study to real life problems.

Detailed Syllabus:

Part B: Finite Element Method (ANY Three)

Expt	Description	Duration (H)
1.	Stress analysis of 1D bar using linear and quadratic elements. Show the variation of stress and strain within the element for linear and quadratic bar element (Convergence Study)	**2**
2.	Modal analysis and stress analysis for 1-D beam (simply supported or cantilever beams) (Convergence Study)	**2**
3.	Static stress concentration factor calculation for a plate with center hole subjected to axial loading in tension using FEA software (Convergence Study)	**2**
4.	Stress, Strain and deflection analysis of any machine component consisting of 3-D elements using FEA software. (Convergence Study)	**2**
	Total Any Three)	**6**

Text Books:

1. Advanced Strength and Applied Stress Analysis–Richard G. Budynas, McGrawHill
2. Seshu P., "Text book of Finite Element Analysis", PHI Learning Private Ltd., New Delhi, 2010.

Reference Books:

1. Theory of Elasticity–Timoshenko and Goodier, McGrawHill
2. Cook R. D., "Finite Element Modeling for Stress Analysis", John Wiley and Sons Inc, 1995

Program	M. Tech. Mechanical (Design Engineering)				Semester : I	
Course :	Skill Development Lab-I				Code : MMD1405	
Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	TW	PR	OR	Total
2	2	1	50	--	--	50

Prior knowledge of:

Course Objectives:

To provide students with a practical knowledge of the finite element methods and the skills required to analyze engineering problems with commercially available FEA software's

Course Outcomes:

After learning the course, the students with the aid of commercial FEA software's should be able to perform:

The static and dynamic linear response for an engineering component

1. Composite and fatigue analysis for an engineering component
2. Nonlinear dynamic analysis for an engineering component
3. The shape and topological optimization for an engineering component

Detailed Syllabus:

List of Experiments/ Assignments:

Each student shall complete **any Four** of the following assignments, with assignment 1 compulsory.

1. Determine static and dynamic linear response of a 3-dimensional engineering component subjected to various combination of loads
2. Investigate effect of various parameters (no. of lay-ups and fiber orientation) on laminated composite structures
3. Perform fatigue analysis using stress and strain life approach of an engineering component
4. Determine frequency/Transient/Random response for members subjected to forced vibration
5. Perform nonlinear dynamic analysis of engineering components subjected to material nonlinearity/Geometric nonlinearity/Contact Nonlinearity. Solve for Impact/Crash/Shock problems
6. Perform topological/Shape optimization

Students can perform above assignments using any of the software mentioned below:
Ansys, ABAQUS, 3D Experience, Nastran, Hyper mesh

Text Books:

1. The Finite Element Method and Applications in Engineering Using ANSYS® by Madenci, Erdogan, Guven, Ibrahim (Springer)
2. Seshu P., "Text book of Finite Element Analysis", PHI Learning Private Ltd., New Delhi, 2010.
3. Mukhopadhyay M and Sheikh A. H., "Matrix and Finite Element Analyses of Structures", Ane Books Pvt. Ltd., 2009.
4. Nitin S. Gokhale, "Practical Finite Element Analysis", Finite to infinite, Pune
5. Ever J. Barbero," Finite element analysis of composite materials using Abaqus",CRC Press taylor Francis group.

Program:	M. Tech. Mechanical (Design Engineering)					Semester : I
Course :	Advanced Machine Design (Professional Elective-I)					Code : MMD1501A
Teaching Scheme			Evaluation Scheme			
Lecture	Credit	Hours	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior knowledge of:

a. Advanced Stress Analysis
b. Engineering Design
c. Manufacturing Processes……..are essential

Course Objectives:

1. To make aware the students about industrial design practices.
2. To enable the students to identify, define and solve the real life engineering problems.

Course Outcomes: After learning the course, the students should be able to:

1. Students will realize that creativity, manufacturability, assembly, maintainability, emotions, reliability are also important aspects of design other than finding dimensions and stresses in the highly competitive, dynamic and customer centered market.
2. Students will demonstrate the ability to identify needs of the customer and convert them into technical specifications of a product.
3. Students will be able to generate different ideas after identifying the need and determining the specifications and constraints of a product for a particular purpose.
4. Students will understand the principals used while designing for manufacture, assembly, emotions and maintenance.
5. Students will know various methods of rapid prototyping the products to test and modify the designs.
6. Students will be able to design the components considering strength based reliability

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Development processes and organizations, Product Planning** Introduction to engineering design, Product development process, Product and process cycles, organization for design and product development, technological innovation	7
2.	Need Identification and problem definition, product specification, concept generation and selection, evaluation, creativity methods, Concept testing Identifying customer needs, requirements, establishing the engineering characteristics, quality function deployment, product design specification	8
3.	Design for manufacture, assembly, maintenance, casting, forging	7
4.	Design for Reliability, strength based reliability, parallel and series systems, robust design	8
5.	Design of dis-assembly, Design for reuse, Design for Environment and Design for cost and Design for Quality	7
6.	Industrial design: Design for Emotion and experience, Introduction to retrofit and Eco design, Human behavior in design	8
	Total	45

Text Books:

1. George E Dieter, “Engineering Design”, McGraw Hill Company, 2000.

Reference Books:

1. Prashant Kumar, “Product Design, Creativity, Concepts and Usability”, Eastern Economy Edition, PHI New Delhi. 2012
2. Woodson T.T., “Introduction to Engineering Design”, McGraw Hill Book Company, 1966.
3. John J.C. “Design Methods”, Wiley Inter science, 1970.
4. Averill M. Law and W. David Kelton “Simulation, modelling and analysis”, McGraw Hill Book Company, 1991.
5. Pahl, G.andW.Beitz, Engineering Design–A Systematic Approach – Springer, 2nd Ed., 1996.
6. Product Design and Development Karl T. Ulrich, Steven Eppinger

Program:	M. Tech. Mechanical (Design Engineering)					Semester: I
Course	Mechanical Behaviour of Materials (Professional Elective-I)					Code : MMD1501B
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior knowledge of:

a. Material science
b. Mechanics of materials……..are essential

Course Objectives:

1 To explore the modern materials with their applications.
2 To provide an ability to identify the response of materials under complex loading.
3 To make students able to interpret the behaviour of plastic & Visco-elastic material

Course Outcomes: After learning the course, the students will be able to:

1. To apply the mechanics of modern materials in recent engineering applications.
2. To solve the basics problems of finding stresses and strains at a point under complex loading conditions
3. To study material behavior under forms of loading other than uniaxial tension
4. To identify and investigate engineering problems involving plastic deformation during strain hardening.
5. To realize the plastic and elastic- plastic behaviour of materials under different loading conditions
6. To formulate the mathematical modelling of Visco-Elastic materials and apply to engineering materials for behavioural study

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Modern Materials in Design Engineering** Dual phase alloy, HSLA, lightweight non-ferrous alloy and their full range stress strain behaviour subjected quasi-static and high strain rate loading, Composites and its orthotropic properties, Plastics, Smart materials, Nano-materials – types, applications and its properties	7
2.	**Response of metals and alloys under applied loading** Stress, strain transformations, Mohr's circle, Isotropic elasticity, Anisotropic elasticity, Anisotropic thermal expansion, Octahedral shear stress, Yield criteria, Yield surface, Yield curve.	8
3.	**Tensile testing** Uni-axial and biaxial tension test, Full range stress-strain curves, True stress-strain curve, Bridgman correction, Temperature rise, Bauschinger effect, Combined bending and torsion test, Three points bend test, Elastic recovery	7
4.	**Stress- Strain relations for work hardening materials** Experimental studies of plastic deformations under simple and complex loading, Strain hardening, Power law approximations, Isotropic, Kinematic and combined hardening models, Theory of plastic flow, Strain-rate and temperature dependence of flow stress	8
5.	**Plastic and Elastic-Plastic Behaviour** Deformation theory of plasticity, Thermo-plasticity, Behaviour of metals with initial deformations. Equations of Elastic-Plastic Equilibrium, Residual stresses and strains, Plastic-rigid body, Elastic-Plastic bending and torsion, Elastic-Plastic bodies under variable loading	7
6.	**Elasto-Visco-Plasticity** Visco-elasticity, Rheological models, Maxwell model, Voigt model, Voigt–Maxwell model, Natural decay, Dependence of damping and elastic modulus on frequency, Thermo-Elastic effect, Low temperature and high temperature Visco-plastic deformation models, Rubber elasticity, Damping, yielding, effect of strain rate, Crazing.	8
	Total	45

Text Books:

1. Mechanical Behaviour of Materials, W.F.Hosford, Cambridge University Press, 2005
2. Theory of Plasticity and Metal Forming Processes, Sadhu Singh, Khanna Publishers

Reference Books:

1. Fundamentals of Materials Science and Engineering, William D. Callister, Jr., John Wiley & Sons,
2. Mechanical Metallurgy, George E. Dieter, McGraw Hill Book Company, 1988
3. Theory of Plasticity, J. Chakrabarty, Elsevier, 2006
4. Foundations of Theory of Plasticity, L. M. Kachanov, Dover Publications, 2004
5. Plasticity for Structural Engineers, W.F. Chen, Da-Jian Han, Springer
6. 6.Mechanical Behavior of Materials, Meyers M A and Chawla K K

Program:	M. Tech. Mechanical (Design Engineering)				Semester : I	
Course :	Analysis and Synthesis of Mechanisms (Professional Elective-I)				Code : MMD1501C	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior knowledge of:

a. Theory of Machines is essential

Course Objectives:

1. To study the kinematic analysis of simple and complex mechanisms
2. To apply kinematic theories to synthesize mechanisms

Course Outcomes:

After learning the course, the students should be able to:

1. **Analyze** Simple and Complex Mechanisms
2. **Identify** the center of curvature and design mechanism with dwell
3. **Synthesize** mechanisms using graphical methods
4. **Apply** kinematic theories to synthesis of mechanism

Detailed Syllabus

Unit	Description	Duration, (H)
1.	**Kinematic analysis of simple mechanisms** Kinematic analysis of mechanisms, degree of freedom, Graphical method of velocity and acceleration analysis of simple mechanism.	7
2.	**Kinematics analysis of complex mechanisms** Types of complex mechanisms, velocity-acceleration analysis of complex mechanisms by the Normal Acceleration method and Auxiliary Point Method.	8
3.	**Curvature theory** Fixed and moving centrodes, Center of curvature, cubic of stationary curvature, Inflection circle, Balls point.	7
4.	**Synthesis of planar mechanisms - Graphical I** Types, number and dimensional synthesis, Accuracy (precision) points, Chebychev spacing, types of errors, branch and order defects. Function generation and rigid body guidance with two and three accuracy points using Relative pole method & Inversion method.	8
5.	**Synthesis of planar mechanisms - Graphical II** Synthesis of four bar mechanism for path generation and rigid body guidance tasks (two, three and four position) for with and without timing.	7
6.	**Synthesis of Planar Mechanisms - Analytical** Freudenstein equation for synthesis of four bar mechanism. Four position synthesis of slider crank mechanism, Complex numbers method of synthesis, Synthesis using dyad method (two and three position)	8
	Total	45

Text Books:

1. Theory of Machines and Mechanisms, A. Ghosh and A.K. Mallik, Affiliated East-West Press.
2. Theory of Machines and Mechanisms, J. E. Shigley and J. J. Uicker,2nd Ed. McGraw-Hill.
3. Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines, Robert L. Norton, Tata McGraw-Hill,3rd Edition.
4. Theory of machines – S. S. Rattan McGraw-Hill Publications.
5. Mechanisms and Machine Theory- A.G. Ambekar. PHI Learning Pvt. Ltd.

Reference Books:

1. Mechanism Design- Analysis and Synthesis (Vol.1and 2), A.G. Erdman and G.N. Sandor, Prentice Hall.
2. Kinematic Synthesis of Linkages, R.S. Hartenberg and J. Denavit, McGraw-Hill.

Program:	M. Tech. Mechanical (Design Engineering)	Semester : I
Course :	Mathematical Methods in Engineering (Professional Elective-I)	Code : MMD1501D

Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior knowledge of:

a. Differential and Integral Calculus is essential

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of mathematical principles related to:

1. Eigen Value and Eigen Vectors to solve Mass spring system.
2. Transforms such as Laplace and Fourier transform and applications
3. Special Functions and Numerical methods to solve PDE.
4. Calculus of variation to optimize functional problems.

Course Outcomes:

After learning the course, the students should be able to:

1. Apply the concept of Eigen Value and Eigen Vector to solve mass spring system.Solve problems related to Laplace transform and applications to Design Engineering.
2. Apply the knowledge of series solution in special functions
3. Find numerical solution of PDE.
4. Analyse the functional optimization using different methodology.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	Basic concept of Laplace Transforms, Laplace transforms and its inverse.	7
2.	Laplace transform of special functions: Unit step, Unit impulse, Periodic and Error. Applications to Differential Equations.	8
3.	Mass spring systems of multi degree freedom, Matrix formulation for differential equations in vibration theory, Normal mode solution, Numerical computation of Eigen value.	7
4.	Series Solution of differential equations, Bessel's and Legendre's differential equations. Least square solution	8
5.	Calculus of Variation Introduction, Functional, Euler's equation, Isoperimetric Problem, Functional involving higher order derivative, Approximate solution of boundary value problem, Rayleigh –Ritz method, Galerkin's method, Lagrange's principal.	7
6.	Numerical Analysis Finite difference analysis, Explicit and Implicit finite difference scheme, Stability of finite difference method, Applications of finite difference analysis in boundary value problems, one dimensional diffusion equation, Wave equation, Laplace equation.	8
	Total	**45**

Text Books:

1. Higher Engineering Mathematics by B.V. Ramana (Tata McGraw-Hill).
2. Advanced Engineering Mathematics by Erwin Kreyszig (Wiley Eastern Ltd.)

Reference Books:

1. Advanced Engineering Mathematics, 7e, by Peter V. O'Neil (Thomson Learning).
2. Advanced Engineering Mathematics, 2e, by M. D. Greenberg (Pearson Education).
3. Higher Engineering Mathematics by B. S. Grewal (Khanna Publication, Delhi).
4. Applied Mathematics (Volumes I and II) by P. N. Wartikar & J. N. Wartikar (Pune Vidyarthi Griha Prakashan, Pune).

Program:	M. Tech. Mechanical (Design Engineering)		Semester : I			
Course :	Mechanics of Composites (Professional Elective-II)		Code : MMD1502A			
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior knowledge of:

a. Advanced Stress Analysis
b. Manufacturing Processes……are essential

Course Objectives:

1. To make aware the students about various composites materials and their applications.
2. To enable the students to analyze, design the composite structures.

Course Outcomes: After learning the course, the students should be able to:

1. Exhibit the ability to choose appropriate type of composite for the given application.
2. Understand and apply the macro-mechanics of the composite lamina.
3. Choose appropriate theory of failure for the design of composite lamina.
4. Analyze the composite laminate for the stresses and stiffness.
5. Design the simple composite structures

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Introduction to Composite Materials** Introduction, Classification, Polymer Matrix Composites, Metal Matrix Composites, Ceramic Matrix Composites, Carbon–Carbon Composites , Recycling Fiber-Reinforced Composites, Mechanics Terminology.	7
2.	**Macro-mechanical Analysis of a Lamina** Introduction , Review of Definitions, Stress, Strain , Elastic Moduli, Strain Energy, Hooke's Law for Different Types of Materials , Anisotropic Material, Monoclinic Material, Orthotropic Material (Orthogonally Anisotropic)/Specially Orthotropic , Transversely Isotropic Material , Isotropic Material , Relationship of Compliance and Stiffness Matrix to Engineering Elastic Constants of a Lamina, Engineering Constants of an Angle Lamina, Invariant Form of Stiffness and Compliance Matrices for an Angle Lamina.	8
3.	**Strength Failure Theories of an Angle Lamina:** Maximum Stress Failure Theory , Strength Ratio , Failure Envelopes , Maximum Strain Failure Theory , Tsai–Hill Failure Theory, Tsai–Wu Failure Theory , Comparison of Experimental Results with Failure Theories, Hygrothermal Stresses and Strains in a Lamina, Hygrothermal Stress–Strain Relationships for a Unidirectional Lamina, Hygrothermal Stress–Strain Relationships for an Angle Lamina.	7
4.	**Micromechanical Analysis of a Lamina** Introduction , Volume and Mass Fractions, Density, and Void Content , Volume Fractions, Mass Fractions , Density , Void Content , Evaluation of the Four Elastic Moduli, l Young's Modulus, Poisson's Ratio, In-Plane Shear Modulus , Elasticity, Ultimate, Coefficients of Thermal Expansion Coefficients of Moisture Expansion.	8
5.	**Macro-mechanical Analysis of Laminates** Introduction , Laminate Code , Stress–Strain Relations for a Laminate , One–Dimensional Isotropic Beam Stress–Strain Relation, Strain-Displacement Equations, Strain and Stress in a Laminate , Force and Moment Resultants Related to Mid-plane Strains and Curvatures , In-Plane and Flexural Modulus of a Laminate, In-Plane Engineering Constants of a Laminate, Flexural Engineering Constants of a Laminate,	7
6.	**Failure, Analysis, and Design of Laminates** Introduction , Special Cases of Laminates , Symmetric Laminates , Cross-Ply Laminates , Angle Ply Laminates , Anti-symmetric Laminates, Balanced Laminate, Quasi-Isotropic Laminates, Failure Criterion for a Laminate , Design of a Laminated Composite , Other Mechanical Design Issues , Sandwich Composites , Long-Term Environmental Effects, Inter-laminar Stresses, Impact Resistance, Fracture Resistance , Fatigue Resistance.	8
	Total	45

Reference Books:

1. Mechanics of Composite Materials, Robert M. Jones, Taylor & Francis.
2. Engineering Mechanics of Composite Materials, Isaac M. Daniel and OriIshai, Oxford University Press.
3. Mechanics of Composite Materials, Autar K. Kaw, CRC Press
4. Mechanics and Analysis of Composite Materials, Valery V. Vasiliev and Evgeny V. Morozov, Elsevier

Program:	M. Tech. Mechanical (Design Engineering)	Semester : I
Course :	Tribology in Design (Professional Elective-II)	Code : MMD1502B

Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior knowledge of:

a. Fluid Mechanics
b. Engineering Metallurgy
c. Strength of Materials……..are essential

Course Objectives:

1. To provide necessary concepts, knowledge and skills in Engineering Tribology with design aspect
2. To impart friction, wear and lubrication theory and their appropriate use in design and maintenance of machine components
3. To provide hands on training with design of bearing, friction ,wear test rig for laboratory purpose

Course Outcomes:

After learning the course, the students will be able to:

1. apply theories of friction and wear to various practical situations by analyzing the physics of the process.
2. select materials and lubricants to suggest a tribological solution to a particular situation.
3. design a hydrodynamic bearing and measure the performance parameters using various bearing charts.
4. analyze the behavior of bearing in different lubrication regimes
5. determine the load carrying capacity in air lubricated bearing
6. understand the tribological aspects in different applications and understand the solution to avoid wear and friction.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Friction and wear** Friction control and wear prevention, Boundary lubrication, Tribological properties of bearing materials and lubricants, Theories of friction and wear, Instabilities and stick-slip motion	7
2.	**Lubrication of bearings** Mechanics of fluid flow, Reynold's equation and its limitations, Idealized bearings, Infinitely long plane pivoted and fixed show sliders, Infinitely long and infinitely short (narrow) journal bearings, Lightly loaded infinitely long journal bearing (Petroff's solution), Finite bearings - hydrostatic, hydrodynamic and thrust oil bearings, Heat in bearings	8
3.	**Hydrostatic squeeze film** Circular and rectangular flat plates, variable and alternating loads, piston pin lubrications, application to journal bearings	7
4.	**Elasto-hydrodynamic lubrication** Pressure-viscosity term in Reynold's equation, hertz theory, Ertel-Grubin equation, lubrication of spheres	8
5.	**Air lubricated bearings** Tilting pad bearings, hydrostatic, hydrodynamic and thrust bearings with air lubrication	7
6.	**Tribological aspects of Rolling motion** Mechanics of tire-road interaction, road grip and rolling resistance, tribological aspects of wheel on rail contact, tribological aspects of metal rolling, drawing and extrusion	8
	Total	45

Text Books:

1. Principles of Lubrication, Camaron, Longman's Green Co. Ltd.
2. Tribology in Machine Design, T. A. Stolarski

Reference Books:

1. Fundamental of Friction and Wear of Metals – ASM
2. The Design of Aerostatic Bearings – J. W. Powell
3. Gas Bearings – Grassam and Powell
4. Theory Hydrodynamic Lubrication, Pinkush and Sterrolicht
5. Principles of Lubrication, Camaron, Longman's Green Co. Ltd.
6. Tribology in Machine Design, T. A. Stolarski

Program:	M. Tech. Mechanical (Design Engineering)			Semester : I		
Course :	Vehicle Dynamics (Professional Elective-II)			Code : MMD1502C		
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior knowledge of:

a. Theory of Machine and Mechanism
b. Automobile Engineering,
c. Mechanical Vibration……..are essential

Course Objectives:

1. To acquaint with vehicle design parameters & vehicle dynamic behavior
2. To develop an ability to evaluate the performance of vehicle
3. To make aware the students about the road dynamics of vehicle

Course Outcomes: After learning the course, the students will be able:

1. To investigate ISO and SAE vehicle coordinate system
2. To examine vehicle Tire model forces and torques
3. To interpret Vibrational behavior of vehicle in terms of human response
4. To analyze the road holding and directional stability of two axel vehicles at different steering inputs.
5. To develop physical and mathematical models to predict the dynamic response of vehicles
6. To analyze and calculate the ride characteristic of quarter car model of an automobile with different road excitations.

Detailed Syllabus:

Unit	Description	Duration, (H)
1	**Basics of Vehicle Dynamics** Tyre mechanics, Vehicle tyre model, ISO and SAE vehicle coordinate system, Basic information of Electric, Hybrid and Autonomous ground vehicle, Different modeling software used for vehicle dynamics study, Different type of safety norms and Bharat stage emission standards	7
2	**Performance characteristics of road vehicles** Equation of motion and maximum tractive effort, Aerodynamic forces and moments, Prediction of vehicle performance, acceleration time and distance, gradeability, Introduction of Static Vehicle Characteristics and Suspension Parameters Measurement Machine	8
3	**Braking Characteristics** Braking characteristics of a two-axle vehicle, Braking efficiency and stopping distance, Braking characteristics of a Tractor-Semitrailer, Antilock brake systems, Traction control systems, Straight line braking event and output characteristics	7
4.	**Handling characteristics of vehicle** Steady-state handling characteristics of a two-axle vehicle, Steady-state response to steering input, Testing of handling characteristics, Transient response characteristics, Directional stability	8
5.	**Vehicle ride characteristics** Human response to vibration, Vehicle ride models - two-degree-of-freedom vehicle model for sprung and un-sprung mass, Numerical methods for determining the response of a quarter-car model to irregular surface profile excitation, Two-degree-of-freedom vehicle model for pitch and bounce, Active and semi-active suspension,	7
6.	**Road and Suspension modeling** Road – modeling aspects, deterministic profile, random profile, auto-correlation function, relation between input and output, effect of wheelbase, K&C characterizes and different type of roads and tires, Different Vehicle Types (Passenger Car, LCV, HCV, and Agricultural)	8
	Total	45

Text Books:

1. Vehicle Dynamics Theory and Application, Raza N. Jazar. Springer International Edition
2. Rajesh Rajamani, Vehicle Dynamics & control, Springer.

Reference Books:

1. Road Vehicle Dynamics – Problems & Solutions, Rao & Dukkipati, SAE,
2. Theory of Ground Vehicles, J.Y. Wong, John Wiley & Sons,
3. Fundamentals of Vehicle Dynamics, T.D. Gillespie, SAE
4. Garrett T K, Newton K and Steeds W, "Motor Vehicle", Butter Worths & Co., Publishers Ltd., New Delhi, 2001.
5. Vittore Cossalter, Motorcycle Dynamics, 2nd Edition, Publisher: LULU.com
6. Milliken W F and Milliken D L, Race car Vehicle Dynamics, SAE

Program:	M. Tech. Mechanical (Design Engineering)		Semester : I			
Course :	Robotics (Professional Elective-II)		Code : MMD1502D			
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior knowledge of:

a. Theory of Machines
b. Mechatronics,
c. Basics of Electrical and Electronics Engineering……..are essential

Course Objectives:

1. To get acquainted with basic components of robotic systems.
2. To understand grippers, sensors and actuators.
3. To understand statistics & kinematics of robots
4. To understand dynamics of robot.

Course Outcomes:

After learning the course, the students should be able to:

1. Identify different type of robot configuration and perform general transformations.
2. Apply DH parameters to a robot configuration thus determine the kinematic parameters.
3. Determine velocities and static forces in the manipulator.
4. Perform dynamic analysis of the manipulator.
5. Plan suitable trajectory to the designed robot
6. Select necessary actuators, sensors, control for satisfactory performance of the robot.

Detailed Syllabus

Unit	Description	Duration, (H)
1.	**Introduction** Structure, classification and applications, robot anatomy, dexterity and compliance of robot. Positions, orientations and frames of a rigid body, homogeneous transformations.	7
2.	**Manipulator kinematics** Representation of joints and link using Denavit-Hartenberg parameters, direct and inverse kinematics of robots, Frames with standard names.	8
3.	**Velocities and static forces** Linear and angular velocity of links, velocity propagation, manipulator Jacobians, Singularity analysis, Static forces in manipulators	7
4.	**Dynamics of robots** Mass and inertia of links, Acceleration of links, Lagrangian formulation for dynamics, Newton-Euler dynamic formulation, Dynamic Simulation.	8
5.	**Trajectory generation** Considerations in path description, Joint space schemes, Cartesian space schemes, Geometric problems with paths.	7
6.	**Actuators, Sensors and Grippers** Mechanical, Hydraulic and Pneumatic actuators, internal and external state sensors used for robots, types of grippers.	8
	Total	45

Text Books:

1. John Craig, *Introduction to Robotics, Mechanics and Control*, 3rd Edition, Pearson Education, 2009
2. K.S. Fu, R.C. Gonzales, C.S.G. Lee, Robotics: Control, Sensing, Vision and Intelligence, McGraw Hill, 1987.
3. S. K. Saha, Introduction to Robotics, Second Edition, McGraw Hill Education, 2014

Reference Books:

1. S B Niku, *Introduction to Robotics, Analysis, Control, Applications*, 2nd Edition, Wiley Publication, 2015.
2. Mathia, *Robotics for Electronics Manufacturing*, Cambridge Uni. Press, India
3. A Ghosal, *Robotics: Fundamental Concepts and Analysis*, Oxford University Press, 2013.
4. R K Mittal & I J Nagrath, *Robotics and Control*, McGraw Hill Publication, 2015.

Program:	M.Tech Mechanical (Design Engineering)					Semester : I
Course :	Professional Elective Lab I (Elective I & Elective II)					Code : MMD1503
Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	TW	PR	OR	Total
2	2	1	50	--	50	100

Prior knowledge of:

Course Objectives:

This course is to provide students the tools required for Simulate correlate and validate theoretical concepts and understand the principles.

Course Outcomes:

After learning the course the students should be able to:

1. Solve open ended Design problem and report the solution.
2. Simulate the problem and correlate with theoretical concepts
3. Understand the impact of assumptions on the simulated results
4. Collect data, Analyse, interpret and report the results.

Guidelines :

1. **Any one subject from Part A and Part B** as per students elective choices
2. Total experiments to be conducted are **Three from Part A and Three from Part B**
3. **Total : 6 experiments 12 hours**

Detailed Syllabus:

Part A: Elective 1- Advanced Machine Design (ANY Three)

Expt.	Description	Duration, (H)
1.	Case Studies Based on : Failure Mode Effect analysis.	2
2.	Case Studies Based on : Environment Impact Assessment	2
3.	Case Studies Based on : Design for Manufacturing and Assembly.	2
4.	Case Studies Based on : Design based on Quality and Reliability.	2
5.	Case Studies Based on : Design based on Cost	2
	Total	**06**

Part A: Elective 1- Mechanical Behavior of Materials (ANY Three)

Expt.	Description	Duration, (H)
1.	Elasto-plastic analysis of a tensile test specimen using FEM software	2
2.	Determination of full range stress strain curve for mild steel and aluminum specimen as per ASTM - E8M	2
3.	Experimental verification of Three point bending test	2
4.	Tensile test for polymer and polymer composite	2
5.	Impact test for plastic	2
	Total	**06**

Part A: Elective 1- Analysis and Synthesis of Mechanisms (ANY Three)

Expt.	Description	Duration, (H)
1.	Kinematic analysis of simple mechanisms	2
2.	Kinematic analysis of complex mechanisms	2
3.	Curvature analysis simple planar mechanism	2
4.	Graphical Synthesis of path generating mechanism	2
5.	Graphical Synthesis of function generating mechanism	2
6.	Graphical Synthesis of rigid body guiding mechanism	2
7.	Analytical Synthesis of path generating mechanism, using MATLAB	2
8.	Analytical Synthesis of function generating mechanism, using MATLAB	2
9.	Analytical Synthesis of rigid body guiding mechanism, using MATLAB	2
	Total	**06**

Part A: Elective 1- Mathematical Methods in Engineering (ANY Three)

Expt.	Description	Duration, (H)
1.	Solution using Matlab for Power Method	2
2.	Solution using Matlab for Mass spring system	2
3.	Solution using Matlab for Least square method	2
4.	Solution using Matlab for Numerical solution to Laplace Equation.	2
5.	Solution using Matlab for Numerical solution to Heat Equation.	2
	Total	**06**

Part B: Elective 2- Mechanics of Composites (ANY Three)		
Expt	**Description**	**Duration, (H)**
1.	Analytical determination of strength of lamina using properties of matrix and fibres.	**2**
2.	Compare the theories of failure for the composite lamina using analytical formulation	**2**
3.	Study of various test standards for behavior testing of composite laminates.	**2**
4.	Determination of the stress distribution across various layers of a laminate using Classical Laminate Theory.	**2**
	Total	**06**
Part B: Elective 2- Tribology in Design (ANY Three)		
Expt	**Description**	**Duration, (H)**
1.	Case study on Tribological aspects of rolling motion / Tribo-characteristics of different materials / Evaluation of friction & wear through experiments under influencing parameters. Coefficient of friction using pin-on-disc type friction monitor	**2**
2.	Friction in Journal Bearings	**2**
3.	Four Ball Tester	**2**
4.	Study of Lubricating systems with example	**2**
5.	Journal Bearing Apparatus	**2**
6.	Tilting pad and thrust bearing apparatus	**2**
	Total	**06**
Part B: Elective 2- Vehicle Dynamics (ANY Three)		
Expt.	**Description**	**Duration, (H)**
1.	Assignment on Road holding characteristics of vehicle and its control	**2**
2.	Assignment on analysis and optimal control of car ride model	**2**
3.	Assignment on ABS or Power-steering for handling analysis - single lane event	**2**
4.	To simulate and understand behavior of sprung / un-sprung mass & lumped mass system MBD software.	**2**
	Total	**06**
Part B: Elective 2- Robotics (ANY Three)		
Expt.	**Description**	**Duration, (H)**
1.	Simulation of Cartesian/ cylindrical/ spherical robot.	**2**
2.	Simulation of Articulated/ SCARA robot.	**2**
3.	Virtual modelling for kinematic and dynamic verification of any one robotic structure using suitable software.	**2**
4.	Design, modeling and analysis of gripper	**2**
	Total	**06**

Course Syllabus
Open Electives - I

Program:	M. Tech. Computational Mechanics (Mechanical Engineering)				Semester: I	
Course :	Battery Management for Electric Vehicles (Open Elective-I)				Code: MMC1601A	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior knowledge of:

a. Basics of Electrical Engineering,

Course Objectives:

1. To understand the various battery performance parameters and types of batteries used for EV applications
2. To understand the requirements of battery management system
3. To make the learners conversant with Equivalent Circuit Cell Modeling of Battery
4. To make the learners conversant with SOC estimation
5. To make the learners conversant with Battery Pack Balancing and Power Estimation
6. To make the learners aware of thermal issues of Lithium Ion battery and thermal management system

Course Outcomes:

After learning the course, the learners will be able

1. Demonstrate understanding of battery operation parameters and design requirements of battery management systems
2. To simulate charge discharge characteristics of a battery using equivalent circuit model
3. To estimate SOC and SOH of battery and demonstrate understanding of various methods of battery pack balancing
4. To estimate heat generation inside battery and propose cooling strategy for the battery pack.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Introduction to battery-management systems** Battery terminology and performance parameters, Types of electrochemical cells, Lithium- Ion Cells components, primary functions and components of BMS **BMS design requirements** Primary functions of BMS, sensing voltage, current and temperature of cell and battery pack, estimation of cell SOC and battery pack SOC, Estimation of available energy and power of cell and battery pack	**7**
2.	**Equivalent Circuit Cell Model (ECM)** Modeling OCV and SOC, Modeling voltage polarization, Warburg impedance, Estimation of Model parameter values: OCV, Columbic Efficiency, total capacity, temperature dependence of OCV, modeling hysteresis, using the ECM to simulate constant voltage/ power charge/ discharge characteristics	**8**
3.	**State-of-Charge (SOC) Estimation and Battery Pack Balancing** Different approaches to estimating battery cell SOC, Kalman-filter method of SOC estimation: linear Kalman filter , extended Kalman filter, Reasons of battery pack unbalancing, criteria for specifying a balancing set point and when to balance a battery pack ,Passive balancing methods for battery packs, Active balancing methods for battery packs: capacitor-based circuits, transformer-based circuits, Estimation of available battery power using a simplified cell model	**7**
4.	**Battery Thermal Management** Heat Generation inside battery, Thermal issues of Lithium Ion Battery, Operating temperature range, Energy analysis and Thermal modeling of LIB, Cooling strategies in thermal management : Air cooling, liquid cooling, PCM based cooling , effect of parameters like cell arrangement, spacing, fluid velocity etc.	**8**
	Total	**30**

Reference Books:

1. Gregory L. Plett, Battery Management Systems, Volume I: Battery Modeling, Artech House, London
2. Gregory L. Plett, Battery Management Systems Volume II, Equivalent-Circuit Methods, Artech House, London
3. Gianfranco Pistoia, Boryann Liaw, Behaviour of Lithium-Ion Batteries in Electric Vehicles_ Battery Health, Performance, Safety, and Cost, Springer International Publication
4. Reiner_Korthauer, Li-I Batteries Basics and Applications, Springer International Publication

Program:	M. Tech. Computational Mechanics (Mechanical Engineering)				Semester : I	
Course :	Green Technology (Open Elective-I)				Code : MMC1601B	
Teaching Scheme				Evaluation Scheme		
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	--	30	50

Prior knowledge of:

a. Environmental study,
b. Types of pollution……..are essential

Course Objectives: After Completing this course, student will have adequate background to:-

1. Evaluate Global warming and its effect
2. Demonstrate knowledge in the reduction of global warming.
3. Apply control measures of carbon emission and accumulation.
4. Apply high tech measures for Reducing Carbon Emissions.

Course Outcomes: After learning the course, the students should be able to:

1. Analyse effects of Global warming
2. Implement the concept of reduction of global warming
3. Apply remedial action for the carbon emission and accumulation.
4. Apply high tech measures for Reducing Carbon Emissions.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Global Warming and its effect:-** Introduction and physical definition of global warming, the New Carbon Problem: Accumulation, Long Half-Life, Heating Potential, Carbon Emission Factors, Carbon Absorption in Nature, The Global Emission Situation and its effect in India, The Kyoto and Other Protocols and its view in India, Effect of climate change and its impact. **Planning for the Future to reduce global warming:-** Steps taken to Control Carbon Emissions universally, Use of Promotional and Punitive Mechanisms for Reducing Carbon in Atmosphere, The General Approach in Planning for the Future, Developing Countrywide Adaptive Measures for Safety of Local People, Developing Mitigative Measures for Global Reduction of Carbon, India's National Action Plan on Climate Change (NAPCC) till date, National Mission for a Green India, The MRV Debate.	7
2.	**Opportunities in Control of Carbon Emissions and Accumulation:-** Essential Steps for Control of Carbon Emissions and Accumulation, Procedure to develop own Priorities and Business Opportunities in India for control of carbon emissions and accumulation, Needs a Mix of Green and Traditional Power Sources in India, A Logical Approach for Carbon Reduction, Need in India —More Forests, Less Deforestation and payment rates procedure for controlling carbon emissions and its Promotional Mechanisms at India**.** **Green Technologies for Energy Production:-** Various Technologies Available for Energy Production, Cost Comparison of a Few Typical Systems for Power Generation, Sources of Energy Production Already in Use, Alternative Methods Ready for Use, Green Technologies Needing some Prior R&D Work.	8
3.	**Green Technologies for Personal and Citywide Application :-** Measures to be taken for Green city, Carbon Emission Reduction at Personal Level, Carbon Emission Reduction at Local Authority and Citywide Level, Carbon Emissions from Imports. **Green Technologies for Specific Applications:-** Promotion of 'Green' Buildings, Guidelines, The Energy Conservation Building Code (ECBC), Green Hotels and Hospitals, Green Technologies for Transport, Green Roads, Ports and Harbors, Industries, Carbon, Carbon Emissions from a Few Selected Industries in India, The Changing Scenario in Cities, Need for Wider Application to Town Planning and Area Re-Development Projects ,'Green' Infrastructure for Municipal Services, Bringing up Indian Villages, Green Services for Crematoria, Spreading Message to all Stakeholders.	7
4.	**Some High-tech Measures for Reducing Carbon Emissions :-** Use of Solar Power with Satellite-Based Systems ,Use of Carbon Capture and Storage (Sequestration) ,Microorganisms, A Quick SWOT Analysis. **Recommended Plan of Action :-** India's National Action Plan Take Us to a Low-Carbon Path, The Missions Help Develop Awareness, Few case studies on Projects undertaken by Various Countries, Adaptive Measures Essential for Indian People to Cope with Climate Change	8
	Total	30

Assignments :

1. Assignment based on Global Warming and its effect and reduction measures.
2. Assignment based on Control of Carbon Emissions and Accumulation
3. Assignment based on Applications of green technologies.
4. Assignment based on High-tech measure for carbon emission reduction/ action plan

Text Books:

1. Soli J. Arceivala, Green Technologies, First edition, Mc Graw Hill Education, 2017.

Reference Books

1. Ritu Singh, Sanjeev Kumar, Green Technologies and Environmental Sustainability. First edition, 2017.
2. http://cpcbenvis.nic.in/greentechnology.html

Program:	M. Tech. Computational Mechanics (Mechanical Engineering)				Semester : I	
Course :	System Modeling and Simulation (Open Elective-I)				Code : MMC1601C	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	-	30	50

Prior knowledge of:

Course Objectives:

1. Students able to model any physical system for realtime applications
2. Students able to simulate any physical system for realtime applications

Course Outcomes:

After learning the course, the students should be able to:

1. Develop mathematical model for practical problem
2. Develop Bond Graph model for system
3. Apply transfer function and State space model techniques
4. Simulate the system using suitable software and Estimate parameters by optimization

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	Introduction to Modelling and Simulation, Basic systems, Introduction and Types of Mathematical modelling, Basic building blocks Mechanical, Electrical, Thermal systems.	7
2.	Bond Graph Modelling of Dynamic Systems: Representation, Elements, Single, Two and multiports Causality, Application to basic Mechanical, Electrical and Electromechanical system	8
3.	Dynamic Response and System Transfer Function: Poles, Stability Block diagram/Signal flow diagram/State Space formulation and Frequency response	7
4.	Simulation and Simulation application Parameter Estimation, System Identification and Optimization	8
	Total	**30**

Text Book

1. Frank L. Severance, System modeling and simulation an introduction, Wiley, 2009.

Reference Books:

1. Brown, Forbes T. Engineering System Dynamics. New York, NY: CRC, 2001. ISBN: 9780824706166.

Program:	M. Tech (E&TC)-VLSI and Embedded Systems	Semester: I
Course:	Automotive Electronics and its Applications (Open Elective-I)	Code: MET1601A

Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior knowledge of:

a. Knowledge of electronics & electrical
b. Instrumentation
c. control systems
d. IC engine operation……..are essential

Course Objectives:

1. To learn and understand the various application of electronics systems and ECU in automotive.
2. To learn and understand principles and applications of sensors and actuators in automotive electronics systems.
3. To learn and understand various control systems in automotive

Course Outcomes:

After learning the course, the students should be able to:

1. Acquire an overview of automotive components, subsystems, and basics of electronic control in today's automotive industry.
2. Use and apply available automotive sensors and actuators in various electronic control systems while designing automotive system design.
3. Apply knowledge of modern technologies in automotive design.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Automotive Systems Overview:** Automotive vehicle technology, Present trends in automobiles with emphasis on increasing role of electronics and software, Overview of typical automotive subsystems and components, Body, Chassis, and Powertrain Electronics	7
2.	**Sensors and Actuators:** Basic sensor arrangement, Types of sensors such as oxygen sensors, Crank angle position sensors, Fuel metering/ vehicle speed sensors, Flow sensor, Temperature, EGO, Air mass flow sensors, Throttle position sensor, Solenoids, Stepper Motors, Relays, etc.,	8
3.	**Engine Control System:** Algorithms for engine control including open loop and closed loop control system, Electronic ignition, EGR for exhaust emission control. Look-up tables and maps, Need of maps, Procedure to generate maps, Engine calibration, Torque table, Dynamometer testing	7
4.	**Active and passive safety systems:** Body electronics including lighting control, Remote keyless entry, Immobilizers etc., Electronic instrument clusters and dashboard electronics, Antilock braking system, Electronic stability program, Air bags, Computer vision based ADAS	8
	Total	30

Text Books:

1. William B. Ribbens, ―Understanding Automotive Electronics- An Engineering Perspective‖, Seventh edition, Butterworth-Heinemann Publications.
2. Ronald K. Jurgen, ―Automotive Electronics Handbook‖, Mc-Graw Hill.

Reference Books:

1. Robert Bosch,‖ Automotive Hand Book‖, Fifth edition, SAE Publications
2. Kiencke, Uwe, Nielsen & Lars, ―Automotive Control Systems for Engine, Driveline and Vehicle‖, Second edition, Springer Publication.
3. Automotive Electronics by Tom H. Denton
4. Automotive Electrical and Electronic Systems by John F. Kershaw, James D. Halderman / Pearson Education

Program:	M.Tech (E&TC)-VLSI and Embedded Systems			Semester: I		
Course:	Industrial Drives (Open Elective-I)			Code: MET1601B		
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior knowledge of:

a. Electrical Drives
b. Dynamics of Electrical drives
c. Control Systems……..are essential

Course Objectives:

1. To define electric drive, its parts, advantages and explain choice of electric drive.
2. To explain dynamics and modes of operation of electric drives.
3. To explain selection of motor power ratings and control of dc motor using rectifiers.
4. To explain the control of induction motor, synchronous motor and stepper motor drives.
5. To discuss typical applications electrical drives in the industry

Course Outcomes:

After learning the course, the students should be able to:

1. Analyze the performance of induction motor drives under different conditions.
2. Control induction motor, synchronous motor and stepper motor drives.
3. Suggest a suitable electrical drive for specific application in the industry
4. To analyze the performance of induction motor drives under different conditions.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Selection of Motor Power Ratings:** Thermal Model of Motor for Heating and Cooling, Classes of Motor Duty, Determination of Motor Rating. **Direct Current Motor Drives:** Controlled Rectifier Fed dc Drives, Single and three Phase Half and Fully Controlled Rectifier Control of dc Separately Excited Motor, Rectifier Control of dc Series Motor, Supply Harmonics, Power Factor and Ripple in Motor Current, Chopper Control of Separately Excited dc Motor, Chopper Control of Series Motor.	7
2.	**Induction Motor Drives:** Analysis and Performance of Three Phase Induction Motors, Analysis of Induction Motor Fed from Non-Sinusoidal Voltage Supply, Starting, Braking, Transient Analysis. Speed Control Techniques-Stator Voltage Control, Variable Voltage Frequency Control from Voltage Sources.	8
3.	Voltage Source Inverter (VSI) Control, Cyclo-converter Control, Closed Loop Speed Control and Converter Rating for VSI and Cyclo-converter Induction Motor Drives, Variable Frequency Control from a Current Source, Current Source (CSI) Control, current regulated voltage source inverter control, and speed control of single phase induction motors.	7
4.	**Synchronous Motor Drives:** Operation from fixed frequency supply-starting, synchronous motor. Self-controlled synchronous motor drive employing load commutated thruster inverter, Permanent Magnet ac (PMAC) Motor Drives, Sinusoidal PMAC Motor Drives, Brushless dc Motor Drives. **Stepper Motor Drives:** Variable Reluctance, Permanent Magnet, Important Features of Stepper Motors, Torque Versus Stepping Rate Characteristics, Drive Circuits for Stepper Motor. **Industrial Drives:** Textile Mills, Steel Rolling Mills, Cranes and Hoists, Machine Tools.	8
	Total	**30**

Text Books:

1. Gopal K Dubey , Fundamentals of the electrical drives Narosa publication
2. N. Mohan T.M. udeland & W.P.Robbins , Power Electronics converter application J.Wiley & sons
3. Vedam Suryavanshi**,** Electrical Drives Concept and application
4. B.K. Bose, Advanced power Electronics & A.C. Drives
5. S.K.Pillar, Analysis of thyristor power conditioned motors

Reference Books:

1. N.K De,P.K. Sen , Electric Drives PHI Learning 1 st Edition, 2009
2. Gobal K.Dubey, Fundamentals of Electrical Drives- Alpha Science Int. Ltd.,
3. Shepherd Hullay & Liag, Power Electronics & Motor Control -, Cambridge Univ. Press
4. Gopal K Dubey, Power Semiconductor controlled Drives, - Prentice Hall pub.
5. R. Krishnan, Electric Motor Drives–Modelling, Analysis and Control, - Pearson Education, 2003
6. P.C. Sen , Thyristorised DC Drives -, Krieger pub.
7. S.B.Dewan, G.R.Slemon & A.Stranghan; Power Semi conductor controlled Drives - John-Willey pub.

Program:	M.Tech. (E&TC)-VLSI and Embedded Systems		Semester : I			
Course :	Basic of FPGA and CPLD (Open Elective-I)		Code : MET1601C			
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	--	30	50

Prior knowledge of:

a. Fundamentals of digital electronics
b. Knowledge of one hardware description language……..are essential

Course Objectives:

1. To make students familiar with programmable logic devices and its architectures.
2. To understand the architecture and features of FPGA and CPLD .
3. To make the students familiar with the design process and how the design is mapped to the existing hardware in FPGA and CPLD.

Course Outcomes:

After learning the course the students should be able to:

1. To understand the depth of CPLD and FPGA architectures.
2. To design a system using FPGAs.
3. To demonstrate an understanding of interfacing of different external devices with FPGA/CPLD.
4. To apply the complete design flow of FPGA and CPLD for the specific application.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Introduction:** Introduction to Hardware Description language, Need of Programmable logic devices, PLA PAL, CPLD, FPGA: General Architecture, features CPLD Architecture: overview, specification and applications, Features of XC9500 series of CPLD family.	7
2.	**FPGA Architecture:** Xilinx Logic Cell Array, Configurable Logic Block, I/O Block, Programmable Interconnects, Programming methods, Advanced features of Xilinx 4000 series Technology Trends: Device capacity, Utilization and Gate Density, Programming methods, General Design Flow, General Design Guidelines.	8
3.	**Interfacing with FPGA/CPLD:** The purpose of interfacing, interfacing of external devices such as WiFi Module, Bluetooth Module, GPS Module, Zigbee Module, Different types of display devices with FPGA/CPLD	7
4.	**Case Studies-FPGA/CPLD:** Xilinx Virtex-6, Spartan-6, Z-board Advanced features in FPGA based on Case studies. **Logical Design by FPGA/CPLD:** Complete design of any combinational circuit by gates, Boolean Algebra, Design of sequential circuits	8
	Total	30

Text Books:

1. P.K.Chan& S. Mourad, Digital Design Using Field Programmable Gate Array, Prentice Hall (Pte), 1994
2. Ronald Sass and Andrew G. Schmidt, ―Embedded systems design with platform FPGAs: Principles and practices‖, Morgan Kaufmann, 2010.
3. Design manuals of Altera, Xilinx and Actel.

Reference Books:

1. S. Trimberger, Edr. Field Programmable Gate Array Technology, Kluwer Academic Publications, 1994.
2. Ronald J Tocci, Neal S. Widmer, Gregory L. Moss, ―Digital Systems: Principles & Applications‖, 10thEdition, Pearson, 2009
3. J. Old Field, R. Dorf, Field Programmable Gate Arrays, John Wiley & Sons, Newyork, Reprint 2008.
4. S. Brown, R. Francis, J. Rose, Z. Vransic, Field Programmable Gate Array, BSP, 2007.
5. S. Brown and J. Rose, "Architecture of FPGAs and CPLDs: A Tutorial", IEEE Design & Test of Computers, Vol. 13, No. 2, pp. 42-57, 1996.
6. S. Brown Zvonko Vranesic – Fundamentals of Digital Logic with VHDL design, McGraw Hill – 2000

Program:	M. Tech. (E&TC)-VLSI and Embedded Systems				Semester : I	
Course :	Robotics (Open Elective-I)				Code : MET1601D	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	--	30	50

Prior Knowledge of

a. Sensors and actuators
b. Programming language 'C', MATLAB ……..are essential

Course Objectives:

To impart knowledge on

1. Electromechanical elements of robots
2. Control system for robot automation
3. Existing robots designed for various applications

Course Outcomes:

After learning the course the students should be able to:

1. Understand kinematics, statistics and dynamic of robots
2. Apply concepts of industrial automation and communication for selection of robots
3. Select sensing and actuating elements for designing robots as per applications requirements
4. Integrate and design control system and information system for various applications.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Introduction to robotics:** Evolution of Robotics, Elements of robots; Kinematics of serial and parallel robots; Velocity and static analysis of robots; Dynamics of robots; Motion planning and control; Flexible manipulators; Wheeled mobile robots, classification of Robots	7
2.	**Advanced concepts in robotics:** Introduction to Cloud and Fog robotics; Basic concepts of industrial automation and communication protocols for PLC, DCS, SCADA systems; Introduction to Internet of Things, Protocols and real time applications.	8
3.	Sensing Elements **for robots:** Classification of Sensors, Encoders and Dead Reckoning Infrared Sensors, Ground-based RF Systems, Active Beacons, Ultrasonic Transponder Trilateration, Accelerometers, Gyroscopes, Laser Range Finder, Vision-based Sensors, Color- tracking Sensors, safety and motion sensors, Force/ Torque Sensors , Tactile Sensors, DC Motors, Controlling a DC Motor, Pulse Width Modulation, Stepper Motors, Servo Motor.	7
4.	Control System of Robots: Automatic-Feedback Control System, Control Elements, Control System Design, A Robot's System Dynamics, Sensory Feedback, Control Algorithms and Performances, Space Control, Introduction to Information System of Robots.	8
	Total	30

Text Books:

1. John J C, Introduction to Robotics: Mechanics and Control , Addison-Wesley (1989).
2. Appin Knowledge Solutions, Robotics (2007)
3. Ming Xie, Fundamentals of Robotics - Linking Perception to Action (2003)

Reference Books:

1. Thomas Bräunl, Embedded Robotics - Thomas Braunl (2006)
2. Bruno S and Sciavicco L, Robotics: Modelling, Planning and Control, Springer (2009).
3. Fu K S, Ralph G and Lee C S G, Robotics: Control Sensing. Vision, and Intelligence , Tata McGraw-Hill (1987).
4. Mukhopadhyay S, Sen S and Deb A K, Industrial Instrumentation, Control and Automation, Jaico (1999).
5. Rajkumar B and Dastjerdi A V, Internet of Things: Principles and Paradigms , Morgan Kaufmann (2016).

Program:	M.Tech (Computer Engineering)				Semester : I	
Course :	Programming with Python (Open Elective-I)				Code: MCE1601A	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior knowledge of: .

a. Basics of Programming

Course Objectives:

1. To acquire knowledge in Python and R programming
2. To develop Python programs with conditionals and loops and data structures
3. Acquire skills to apply data analysis methods to a problem

Course Outcomes:

After learning the course the students should be able to:

1. Describe the Numbers, Math functions, Strings, List, Tuples and Dictionaries in Python
2. Interpret Object oriented programming in Python
3. Apply a solution clearly and accurately in a program using Python.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Introduction to Python Programming:** Python Introduction, Installing and setting Python environment in Windows and Linux, basics of Python interpreter, Execution of python program, Editor for Python code, syntax, variable, Data types. Flow control if if else, for, while, range() function, continue, pass, break. Strings: Sequence operations, String Methods.	7
2.	**Lists:** Basic Operations, List slices,list methods,list and strings **Dictionaries:** looping and dictionaries, dictionaries & lists. **Tuples and Files :** reading and writing Functions: Definition, Call, Arguments ,Input output file handling.	8
3.	**Object Oriented Programming features in Python:** Classes, Objects, inheritance,Errors and Exceptions: try, except and else statements, Exception Objects, Regular expressions.	7
4.	**Numpy and Matplotlib** :Array operations, Numpy Side Effects, 2D Numpy Arrays , Numpy Basic Statistics. Matplotlib: Introduction, Simple plots, Line API, Legend API, Figures, Subplots. **Pandas:** Look Ups, Selections and Indexing, Filling Methods, Series operation, Handling NaN values, Mapping, Data Frames, Reading Files, Plotting, Joins, Correlation, Histograms, Rolling calculation.	8
	Total	30

Text Books:

1. Allen B Downey, ―Think PYTHON‖, O_Rielly, ISBN: 13:978-93-5023-863-9, 4th Indian Reprint 2015
2. Peng, Roger D and Elizabeth Matsui, ―The Art of Data Science." A Guide for Anyone Who Works with Data. Skybrude Consulting 200 (2015): 162

Reference Books:

1. Zed A. Shaw,Learn Python the Hard Way

Program:	M.Tech (Computer Engineering)			Semester : I		
Course :	Software Engineering Basics (Open Elective-I)			Code : MCE1601B		
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior knowledge of:- None

Course Objectives:

1. To learn and understand the principles of Software Engineering
2. To be acquainted with methods of capturing, specifying, visualizing and analyzing software requirements.
3. To apply Design and Testing principles to S/W project development.
4. To understand project management through life cycle of the project.
5. To understand software quality attributes.

Course Outcomes:

After learning the course the students should be able to:

1. Decide on a process model for a developing a software project
2. Classify software applications and Identify unique features of various domains
3. Design test cases of a software system.
4. Understand basics of IT Project management.
5. Plan, schedule and execute a project considering the risk management.
6. Apply quality attributes in software development life cycle.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Introduction to Software Engineering and Software Process Models:** Software Engineering Fundamentals: Nature of Software, Software Engineering Principles, The Software Process, Software Myths. Process Models :A Generic Process Model, Prescriptive Process Models: The Waterfall, Incremental Process(RAD), Evolutionary Process, Unified Process, Concurrent. Advanced Process Models & Tools: Agile software development: Agile methods, Plan-driven and agile development.	7
2.	**Software Requirements Engineering and Analysis:** Requirements Engineering: User and system requirements, Functional and non-functional requirements, Types & Metrics, A spiral view of the requirements engineering process. Software Requirements Specification (SRS): The software requirements Specification document, The structure of SRS, Ways of writing a SRS, Requirements elicitation & Analysis: Process, Requirements validation, Requirements management.	8
3.	**Design Engineering:** Design Process & quality, Design Concepts, The design Model, Pattern-based Software Design. Architectural Design :Design Decisions, Views, Patterns, Application Architectures, Modeling Component level Design: component, Designing class based components, conducting component-level design, User Interface Design: The golden rules, Interface Design steps & Analysis, Design Evaluation	7
4.	**Project Risk Management:** Risk Analysis & Management: Reactive versus Proactive Risk Strategies, Software Risks, Risk Identification, Risk Projection, Risk Refinement, Risk Mitigation, Risks Monitoring and Management, The RMMM plan for case study project	8
	Total	**30**

Text Books:

1. Roger Pressman, ―Software Engineering: A Practitioner _s Approach‖, McGraw Hill, ISBN 0–07–337597
2. Ian Sommerville, ― Software Engineering‖, Addison and Wesley, ISBN 0-13-703515-2

Reference Books:

1. Carlo Ghezzi, ―Fundamentals of Software Engineering", Prentice Hall India, ISBN-10: 0133056996
2. Rajib Mall, ―Fundamentals of Software Engineering‖, Prentice Hall India, ISBN-13: 978- 8120348981
3. Pankaj Jalote, ―An Integrated Approach to Software Engineering‖, Springer, ISBN 13: 9788173192715.
4. S K Chang, ―Handbook of Software Engineering and Knowledge Engineering‖, World Scientific, Vol I, II, ISBN: 978-981-02-4973-1
5. Tom Halt, ―Handbook of Software Engineering‖, Clanye International, ISBN10: 1632402939
6. Christine Bresnahan, Richard Blum –Linux command line and Shell Scripting Bible -Weilly , ISBN-978-0-470-25128-7

Program:	M.Tech (Computer Engineering)				Semester : I	
Course :	Basics of Machine Learning (Open Elective-I)				Code : MCE1601C	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior knowledge of:

a. Linear Algebra, Statistics, Probability and Calculus
b. Basic Programming Skills……..are essential

Course Objectives:

1. To master the concepts of supervised and unsupervised learning, recommendation engine, and time series modeling
2. To gain practical knowledge over principles, algorithms, and applications of Machine Learning through a hands-on approach and to validate Machine Learning models and decode various accuracy metrics. Improve the final models using another set of optimization algorithms, which include Boosting & Bagging techniques
3. To acquire thorough knowledge of the statistical and heuristic aspects of Machine Learning and To comprehend the theoretical concepts and how they relate to the practical aspects of Machine Learning.
4. 4.To implement models such as support vector machines, kernel SVM, naive Bayes, decision tree classifier, random forest classifier, logistic regression, K-means clustering

Course Outcomes:

After learning the course the students should be able to:

1. Understand machine learning techniques and computing environment that are suitable for the applications under consideration.
2. Solve problems associated with batch learning and online learning, and the big data characteristics such as high dimensionality, dynamically growing data and in particular scalability issues.
3. Develop scaling up machine learning techniques and associated computing techniques and technologies for various applications.
4. Implement various ways of selecting suitable model parameters for different machine learning techniques.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Foundations for Machine Learning [ML]:** ML Techniques overview: Supervised; Unsupervised, Reinforcement Learning, Validation Techniques(Cross-Validations);Feature education/ Dimensionality reduction; Principal components analysis (Eigen values, Eigen vectors, Orthogonality)	7
2.	**Clustering:** Distance measures;Different clustering methods (Distance, Density, Hierarchical); Iterative distance-based clustering; Dealing with continuous, categorical values in K-Means; Constructing a hierarchical cluster; K-Medoids, k-Mode and density-based clustering; Measures of quality of clustering	8
3.	**Classification: Naïve Bayes Classifier** Model Assumptions; Probability estimation; Required data processing; M-estimates; Feature selection: Mutual information; Classifier **K-Nearest Neighbors:** K-Nearest Neighbor algorithm; Aspects to consider while designing K-Nearest Neighbor Support Vector Machines; SVM for classification and regression problems.	7
4.	**Association Rule mining:** The applications of Association Rule Mining: Market Basket, Recommendation Engines, etc. ; A mathematical model for association analysis; Large item sets; Association Rules; Apriori: Constructs large item sets with mini sup by iterations; Interestingness of discovered association rules; Application examples; Association analysis vs. classification ; FP-trees **Research Aspects: Application of ML in various domains-**Research Paper Publication in Quality Indexed International Journals/ Conferences;Practical Implementation of Industry Projects/Applications**;** IPR	8
	Total	30

Text Books:

1. T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2008.
2. Christopher Bishop. Pattern Recognition and Machine Learning. 2e.

Reference Books:

1. Ethem Alpaydin, Introduction to Machine Learning

Program:	M. Tech. (Civil) Construction Management				Semester : I	
Course :	Project Management and Finance (Open Elective-I)				Code : MCI1601A	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior knowledge of:

a. Basics of Management,
b. Basics of Finance…….are essential

Course Objectives:

After Completing this course, student will have adequate background to

1. To demonstrate knowledge and understanding of engineering and management principles.
2. To function effectively as an individual, and as a member or leader in diverse teams.
3. To understand the concepts of finance and accounts carried out in project management.

Course Outcomes:

After learning the course, the students should be able to:

1. Study the current market trends and choose projects.
2. Prepare project feasibility reports.
3. Ability to implement the project effectively meeting government norms and conditions.
4. Ability to understand the role and responsibility of the Professional Engineer.
5. Ability to choose projects which benefit the society and organization.

Detailed Syllabus:

Unit	Description	Duration, (H)
1	**Introduction to Management** What is Management? It's Need ,Importance & Purpose, Evolution of Managements thought, Different Schools/ approaches to Management: Behavioral, Quantitative, Systems, Contingency Approach	7
2.	**Project Implementation, Monitoring and Control** Project representation: Role of project managers, relevance with objective of organization, preliminary manipulations, Basic Scheduling concepts: Resource levelling, Resource allocation, Setting a base line, Project management information system: Importance of contracts in projects: Team work in Project Management: Formation of Effective terms.	8
3.	**Organizing** Organizing as a Management process, Principles of Organization, Different Structures of organizations such as line, Line & Staff, Functional, Matrix or project Organization: Characteristics, Features, their Merits and Limitation, Ownerships of Organization: Sole Proprietorship, Partnership, Private Ltd., Public Ltd., Introduction to Organizational climate, Decision Making, Group Decision Making, Staffing: What is Staffing? Steps involved in Staffing, Recruitment, Staffing, Performance Appraisal Development	8
4.	**Financial Statements and Their Analysis** Understanding of Financial Statements and Their Analysis, Like Balance Sheet, Profit & Loss Account, Ratio Analysis, Fund Flow Analysis, Statement of Changes In Financial Position.	7
	Total	**30**

Text Books:

1. Project Management Institute A Guide to the Project Management Body of Knowledge PMBOK Guide (Sixth Edition), Sept 2017.
2. James C.Van Horne, Fundamentals of Financial Management, Person Education 2004.
3. Khanna, R.B.,Project Management, PHI 2011.

Reference Books:

1. Kuster J., Huber, E., Lippmann, R., Schmid, A., Schneider, E., Witschi, U., Wust, R. Project Management Handbook, 2015.
2. Prasanna Chandra, Financial Management, Tata McGraw-Hill, 2008.
3. Carl S. Warren, James M. Reeve, Jonathan Duchac.
4. Financial and Managerial Accounting, 2016
5. Paneer Selvam, R., and Senthilkumar, P., Project Management, PHI, 2011.

Program:	M. Tech. (Civil) Construction Management		Semester : I			
Course :	Green Technology (Open Elective-I)		Code : MCI1601B			
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior knowledge of:

a. Environmental study,
b. Types of pollution…….are essential

Course Objectives:

After Completing this course, student will have adequate background to understand and solve the problem involving:

1. To learn about Global warming and its effect
2. To demonstrate knowledge in the reduction of global warming.
3. To learn the control measures of carbon emission and accumulation.
4. To learn high tech measures for Reducing Carbon Emissions.

Course Outcomes:

After learning the course, the students should be able to:

1. Study the effects of Global warming
2. Implement the concept of reduction of global warming
3. Understand the remedial action for the carbon emission and accumulation.
4. Apply high tech measures for Reducing Carbon Emissions.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Global Warming and its effect:-** Introduction and physical definition of global warming, the New Carbon Problem: Accumulation, Long Half-Life, Heating Potential, Carbon Emission Factors, Carbon Absorption in Nature, The Global Emission Situation and its effect in India, The Kyoto and Other Protocols and its view in India, Effect of climate change and its impact. **Planning for the Future to reduce global warming:-** Steps taken to Control Carbon Emissions universally, Use of Promotional and Punitive Mechanisms for Reducing Carbon in Atmosphere, The General Approach in Planning for the Future, Developing Countrywide Adaptive Measures for Safety of Local People, Developing Mitigative Measures for Global Reduction of Carbon, India's National Action Plan on Climate Change (NAPCC) till date, National Mission for a Green India, The MRV Debate.	7
2.	**Opportunities in Control of Carbon Emissions and Accumulation:-** Essential Steps for Control of Carbon Emissions and Accumulation, Procedure to develop own Priorities and Business Opportunities in India for control of carbon emissions and accumulation, Needs a Mix of Green and Traditional Power Sources in India, A Logical Approach for Carbon Reduction, Need in India —More Forests, Less Deforestation and payment rates procedure for controlling carbon emissions and its Promotional Mechanisms at India. **Green Technologies for Energy Production:-** Various Technologies Available for Energy Production, Cost Comparison of a Few Typical Systems for Power Generation, Sources of Energy Production Already in Use, Alternative Methods Ready for Use, Green Technologies Needing some Prior R&D Work.	8
3.	**Green Technologies for Personal and Citywide Application :-** Measures to be taken for Green city, Carbon Emission Reduction at Personal Level, Carbon Emission Reduction at Local Authority and Citywide Level, Carbon Emissions from Imports. **Green Technologies for Specific Applications:-** Promotion of 'Green' Buildings, Guidelines, The Energy Conservation Building Code (ECBC), Green Hotels and Hospitals, Green Technologies for Transport, Green Roads, Ports and Harbors, Industries, Carbon, Carbon Emissions from a Few Selected Industries in India, The Changing Scenario in Cities, Need for Wider Application to Town Planning and Area Re-Development Projects,'Green' Infrastructure for Municipal Services, Bringing up Indian Villages, Green Services for Crematoria, Spreading Message to all Stakeholders.	7
4.	**Some High-tech Measures for Reducing Carbon Emissions :-** Use of Solar Power with Satellite-Based Systems ,Use of Carbon Capture and Storage (Sequestration) ,Microorganisms, A Quick SWOT Analysis. **Recommended Plan of Action :-** India's National Action Plan Take Us to a Low-Carbon Path, The Missions Help Develop Awareness, Few case studies on Projects undertaken by Various Countries, Adaptive Measures Essential for Indian People to Cope with Climate Change	8
	Total	**30**

Text Books:

1. Green Technologies, Soli J. Arceivala, Mc Graw Hill Education.

Reference Books

1. Green Technologies and Environmental Sustainability edited by Ritu Singh, Sanjeev Kumar
2. http://cpcbenvis.nic.in/greentechnology.html

Program:	M. Tech. (Civil) Construction Management				Semester: I	
Course:	Organization Behavior (Open Elective-I)				Code: MCI1601C	
Teaching Scheme			Evaluation Scheme			
Lecture	Credit	Hours	IE -1	IE-2	ETE	Total
2	2	2	2	-	30	50

Prior knowledge of:

a. Different types of Organizations structures is essential

Course Objective: To introduce the students with various features of Microsoft Project.

Course Outcomes: At the end of the course, students will be able to understand

1. Understand important and organisation culture of OB for organisation.
2. Apply different learning theories of learning to organisation.
3. Appraise group behavior, leadership skills, power and politics in organisation.
4. Relate to organisation culture, climate and work stress.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Introduction to OB**: Disciplines contributing to OB, Need and Importance of OB, Challenges and Opportunity for OB, OB model, Approaches to Organizational Behaviour, Inherited characteristics, Learning, theories of learning, reinforcement.	7
2.	**Motivation and behavior in group and team work**: Motivation at work; theories of motivations, motivation from concept to applications, Designing motivating jobs, Group Decision Making, Differences Between Groups and Teams, Types of Teams, Creating Effective Teams	8
3.	**Leadership, Power and Politics:** Trait Theories, behavioural Theories, Contingency Theories, Authentic Leadership: Ethics and Trust, A Definition of Power, Bases of Power, Power Tactics, Causes and Consequences of Political behaviour	7
4.	**Organization culture, climate and stress management:** signifance of culture in organization, creating sustainable cultures, Creating a Positive Organizational Culture, Creating a Culture for Change, Work Stress and Its Management, Case studies of OD intervention sin mega-construction projects.	8
	Total	30

Reference Books:

1. Gregery Moorhead, Ricky W. Griffin, Organizational Behaviour: Managing People and Organizations, 3rd Edition, Houghton Miffin Company, 2000
2. Stephen, P Robbins, Organizational Behaviour, 9th edition, Pearson Education Asia, New Delhi, 2001
3. Wendell L French, Cecil H. Bell, Jr., Organization Development: Behavioural Science Interventions for Organization Improvement, 6th edition, Pearson Education Asia, New Delhi, 2001.
4. Jit. S. Chander, Organizational Behaviour, 3rd edition, Vikas Publishing House Pvt. Ltd.,, New Delhi, 2005.

Program:	M. Tech. (Artificial Intelligence and Data Science)		Semester : I			
Course :	R Programming (Open Elective-I)		Code :MDS1601A			
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	-	30	50

Prior knowledge of:

a. Knowledge of Statistics in Mathematics
b. Prior Knowledge of any programming…….are essential

Course Objectives:

1. To use R and R Studio Environment
2. To understand different data types and control structures in R
3. To interface R with other languages.
4. To understand the use of R for Big Data analytics.

Course Outcomes:

After learning the course, the students should be able to:

1. Explain the basics in R programming in terms of constructs, control statements, string functions.
2. Apply the use of R for Big Data analytics.
3. Learn to apply R programming for Text processing.
4. Able to appreciate and apply the R programming from a statistical perspective.

Detailed Syllabus:

Unit	Description	Duration (H.)
1.	**Getting Started with R Programming:** Introduction to the R-Studio, user-interface, Basic commands, Data Structures in R,Reading data into R Subsetting	7
2.	**Matrices, Arrays And Lists:** Creating matrices ,Matrix operations ,Applying Functions to Matrix Rows and Columns, Adding and deleting rows and columns, Vector/Matrix Distinction, Avoiding Dimension Reduction, Higher Dimensional arrays, Lists, Creating lists, General list operations,– Accessing list components and values, Applying functions to lists, Recursive lists	8
3.	**Data Frames:** Creating Data Frames, Matrix-like operations in frames, Merging Data Frames, Applying functions to Data frames, Factors and Tables: factors and levels, Common functions used with factors, Working with tables, Other factors and table related functions, Control statements: Arithmetic and Boolean operators and values, Default values for arguments, Returning Boolean values, Environment and Scope issues: Writing Upstairs – Recursion ,Replacement functions, Tools for composing function code, Math and Simulations in R	8
4.	**Interfacing:** Interfacing R to other languages, Parallel R, Basic Statistics, Linear Model, GeneralizedLinear models, Non-linear models, Time Series and Auto-correlation – Clustering	7
	Total	30

Text Books:

1. Mark Gardener, " Beginning R – The Statistical Programming Language", Wiley,2013
2. Norman Matloff , "The Art of R Programming: A Tour of Statistical Software Design", No Starch Press,2011

Reference Books:

1. Jared P. Lander, "R for Everyone: Advanced Analytics and Graphics", Addison-Wesley Data & AnalyticsSeries, 2013
2. Robert Knell, "Introductory R: A Beginner's Guide to Data Visualization, Statistical Analysis and Programming in R", Amazon Digital South Asia Services Inc,2013.

Program:	M. Tech. (Artificial Intelligence and Data Science)	Semester : I
Course :	Business Analytics (Open Elective-I)	Code : MDS1601B

Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	-	30	50

Prior knowledge of:

a. Machine Learning
b. Data Science…….are essential

Course Objectives:

1. Understand the different basic concept / fundamentals of business statistics
2. Understand the concept of Probability and its usage in various business applications.
3. Understand the practical application of Descriptive and Inferential Statistics concepts and their uses forBusiness Analytics.
4. Evaluate different data analytics tools.

Course Outcomes:

After learning the course, the students should be able to:

1. Gaining Knowledge of basic concept / fundamentals of business analytics.
2. Evaluating basic concepts of probability and perform probability theoretical distributions.
3. To perform practical application by taking managerial decision and evaluating the Concept of Business Analytics.
4. Evaluate different tools.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Introduction** What is business analytics?, Business Analytics process: problem framing, Data modeling, model building, Deployment, Different types of business analytics, application of business analytics, current trends, roles within data analytics team.	8
2.	**Analytics Techniques** Optimization techniques: Linear Programming, Goal Programming, Integer Programming, Non –linear programming, Predictive modelling :- regression, multiple linear regression for predictive analysis, logistic regression, linear discriminate analysis, Data Mining: Introduction to supervised and unsupervised learning, clustering	8
3.	**Probability Theory & Distribution** Probability: Theory of Probability, Addition and Multiplication Law, Baye's Theorem Probability Theoretical Distributions: Concept and application of Binomial; Poisson and Normal distributions. Concept of Business Analytics- Meaning types and application of Business Analytics, Use of Spread Sheet to analyze data-Descriptive analytics and Predictive analytics	8
4.	**Data analytics tools** Data Visualization using Tableau/Python/R/SQL. Case study.	6
	Total	30

Text Books:

1. R.N. Prasad , Seema Acharya, "Fundamentals of business analytics", Wiley

Reference Books:

1. James Evans, Business Analytics, 2nd Edition, Pearson

Course Syllabus
Audit Course -I

Program:	M.Tech. (Design Engineering)			Semester :	I and II	
Course :	Audit Courses (Semester I and II)			Code :	M_1961 M_2962	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
1	1	--	--	--	--	--

Guidelines:

1. The audit courses are common to all M.Tech Courses.
2. Students can select any audit course from list of audit courses for semester I and II
3. These are non-credit courses but mandatory to comply the submission of the semester.

LIST OF AUDIT COURSES
(Common to M.Tech and MCA programs)

	SEM-I
M_1961A	Constitution of India
M_1961B	Value Education
M_1961C	Stress Management

Program	M.Tech(Design Engineering)				Semester: I	
Course	Constitution of India (Audit Courses-I)				Code : M_1961A	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
1	1	-	--	--	--	--

Course Objectives:

a. To understand the constitution and the centre-state relations and functioning
b. To understand the rules and regulations under which public and private sector work
c. To understand E-governance through computers and knowledge of cyber laws

Course Outcomes:

After learning the course, the students should be able to

1. Understand the functions of the Indian government and identify and explore the basic features, modalities about Indian constitution and assessment of the Parliamentary System in India.
2. Differentiate the functioning of Indian Political system at Central and State level and comprehend the fundamental rights and abide the rules of the Indian constitution

Detailed Syllabus:

Unit	Description	Duration (H)
1.	Introduction to Constitution & System of Government Meaning of the constitution law and constitutionalism, making of constitution, Salient features and characteristics of the Constitution of India, Preamble, Fundamental Rights, Directive Principles of State Policy, Fundamental Duties and it's legal status, Citizenship. Structure and Function of Central Government, President, Vice President, Prime Minister, Cabinet, Parliament, Supreme Court of India, Judicial Review, Federal structure and distribution of legislative and financial powers between the Union and the States, local self-government	6
2.	Judiciary and Constitution Functions: Governor, Chief Minister, Cabinet, State Legislature Judicial System in States, High Courts and other Subordinate Courts, Parliamentary Form of Government in India. Constitution Functions: Indian Federal System and it's characteristics, Center& State Relations, President's Rule, Constitutional Amendments and powers, Constitutional Functionaries, Emergency Provisions, Assessment of working of the Parliamentary System in India.	6
	Total	12

Text Books:

1. Durga Das Basu, "Introduction to the Constitution of India ", Prentice Hall of India, New Delhi,24th edition, 2020, ISBN-109388548868
2. Clarendon Press, Subhash C, Kashyap, "Our Constitution: An Introduction to India's Constitution and constitutional Law", NBT, 5th edition, 2014, ISBN-9781107034624

Reference Books:

1. Dr J N Pandey : Constitutional Law of India
2. https://www.meity.gov.in/divisions/national-e-governance-plan
3. https://www.meity.gov.in/DeitY_e-book/e-gov_policy/download/Policy%20Document.pdf
4. http://www.iibf.org.in/documents/cyber-laws-chapter-in-legal-aspects-book.pdf
5. Maciver and Page, "Society: An Introduction Analysis ", Laxmi Publications, 4th edition, 2007, ISBN-100333916166
6. PM Bhakshi, "The constitution of India", Universal Law Publishing - An imprint of Lexis Nexis, 14th edition, 2017, ISBN-108131262375

Program	M.Tech(All Branches)/MCA				Semester: I	
Course :	Value Education (Audit Courses-I)				Code : M_1961B	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
1	1	-	--	--	--	--

Course Objectives:

1. To identify and develop Attitude and Core Faith values
2. To expose students to Family Relations
3. To enable student to understand Creative Thinking and Problem solving
4. To enable students to understand Humanistic Education.

Course Outcomes:

After learning the course the students should be able to:

1. Change in awareness levels, knowledge and understanding of student
2. Change in attitudes / behaviour of students with regards to their education improved teamwork, institutional leadership and other life skills
3. Improvement in social health and attitude.

Detailed Syllabus:

Unit	Description	Duration (H)
1	Why Human Relations are so important? Understanding Behaviour, Human Relations, and Performance, Personality, Stress, Learning, and Perception, Attitudes, Self-Concept, Natural acceptance of human values, and Ethics, Dealing with Conflict, Leading and Trust	6
2	Justice in Humankind, Nurturing and Exploitation, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in professional ethics	6
	Total	12

Text Books:

1. A Foundation Course in Human Values and Professional Ethics" R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi and Teacher's Manual, R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi

Reference Books:

1. Human Relations in Organizations Applications and Skill Building" Robart Lussier, eighth edition, McGraw-Hill (2014).
2. Atkinson and Hilgard's, "Introduction to psychology" Nolen-Hoeksema, S., Fredrickson, B. L., Loftus, G. R., & Lutz, C., Cengage Learning EME.

Program	M.Tech(All Branches)/MCA				Semester: I	
Course :	Stress Management (Audit Courses-I)				Code : M_1961C	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
1	1	-	--	--	--	--

Course Objectives:

1. To overcome stress
2. To achieve overall health of body and mind
3. To learn to achieve the highest goal happily
4. To become a person with stable mind, pleasing personality and determination

Course Outcomes:

Students will be able to:

1. Develop healthy mind in a healthy body thus improving social health also
2. Improve working efficiency

Detailed Syllabus:

Unit	Description	Duration (H)
1	Definitions of Eight parts of Yog. (Ashtanga) Yam and Niyam. Do`s and Don't's in life.	6
2.	Pranayam Regularization of breathing techniques and its effects- Types of pranayama Approach to day to day work and duties, wisdom	6
	Total	12

Text Books:

1. Yogic Asanas for Group Tarining-Part-I" : Janardan Swami Yogabhyasi Mandal, Nagpur

Reference Books:

1. Swami Vivekananda, Rajayoga or conquering the Internal Nature, Advaita Ashrama (Publication Department), Kolkata
2. Wendelin Küpers, David J. Pauleen, A Handbook of Practical Wisdom Leadership, Organization and Integral Business Practice, 2016
3. A Foundation Course in Human Values and Professional Ethics Presenting a Universal Approach to Value Education - Through Self-exploration

Course Syllabus

Semester-II

Program:	M. Tech. Mechanical (Design Engineering)			Semester : II		
Course :	Optimization Techniques in Design			Code : MMD2406		
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior knowledge of:

a. Engineering Mathematics is essential

Course Objectives:

1. To introduce students to the modeling of constrained decision-making problems and optimization.
2. Provide students with the basic mathematical concepts of optimization.
3. Provide students with the modelling skills necessary to describe and formulate optimization problems.
4. Provide students with the skills necessary to solve and interpret optimization problems in engineering.

Course Outcomes:

After learning the course, the students should be able to:

1. Formulate mathematical programs in various practical systems and apply classical optimization techniques
2. Interpret the results of linear programming model and present the insights
3. Obtain optimum parameters for non-linear problems.
4. Simulate the optimized model.
5. Use software to solve problems using modern methods.
6. Apply topology optimization for design.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Classical Optimization Techniques** Mathematical Modeling, Classification of models, single variable optimization and multi variable optimization, with and without constraints.	7
2.	**Linear Programming** Two phase simplex method, primal and dual Simplex Method, revised simplex method.	8
3.	**Non-Linear Programming** Elimination and iterative methods for one-dimensional minimization and multi dimension minimization.	7
4.	**Modern Methods of Optimization** Genetic algorithms, Simulated Annealing, Particle Swarm Optimization, Ant Colony Optimization, etc.	8
5.	**Simulation Modeling** Introduction, definition and types, limitations, various phases of modeling, Monte Carlo method, applications, advantages and limitations of simulation.	7
6.	**Topology Optimization** Problem formulation and parameterization of design, solution methods, topology optimization as a design tool, Complications, Combined Topology and shape optimization.	8
	Total	45

Text Books:

1. Engineering Optimization: Theory and Practice, Singiresu S. Rao, John Wiley & Sons
2. Practical Optimization Methods with Mathematical Applications, M. Asghar Bhatti, Springer
3. Optimization for engineering design, K. Deb, PHI

Reference Books:

1. Topology Optimization – Theory, Methods and Applications, M. P. Bendse, Q. Sigmund
2. Evolutionary Topology Optimization of Continuum Structures, Methods and Applications, X. Huang, Y.M. Xie, Wiley
3. Structural Optimization, Raphael T. Haftka and Zafer Gurdal, Kluwer Academic Publishers
4. Mathematical Modelling, J N Kapur, New age international publication
5. Optimization concepts and applications in engineering, Belegundu, Chandrupatla, Pearson Education

Program:	M. Tech. Mechanical (Design Engineering)		Semester : II			
Course :	Advanced Vibrations and Acoustics		Code : MMD2407			
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior knowledge of:

a. Physics
b. Engineering Mathematics
c. Dynamics of Machinery……..are essential

Course Objectives:

1. To enable students to analyse model physical systems, categorize and apply principles of Vibrations to obtain response to different excitation conditions.
2. Students will be able to acquire knowledge of acoustic terms their measurement and apply acoustic design principles.

Course Outcomes:

After learning the course, the students should be able to:

1. **Formulate** and **Evaluate** problems of MDOF mechanical vibrations. **Apply** the understanding to design the system.
2. **Formulate** the mathematical models Transient Vibrations and study its impact on design of system.
3. **Analyse** Vibration in System and **Design** a Vibration Control Strategies,
4. Understand Random process parameters and **analyse** vibration response of single degree linear system.
5. Understand Basic principles in acoustics, measurement of sound Power and **apply to analyze** effectiveness in compliance to noise regulations.
6. **Analyze and Design** of Acoustic Enclosures, Barriers, muffler elements for noise control.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Multi Degree Freedom System** Free vibration equation of motion, influence coefficient i) stiffness coefficient (ii) flexibility coefficient generalized coordinates, coordinate couplings, Lagrange's equations matrix method Eigen values Eigen vector problems, modal analysis, forced vibrations of un-damped system and modal analysis.	7
2.	**Transient vibrations** Response to an impulsive input, Response to step input, Response to a pulse input-rectangular pulse and half sinusoidal pulse.	8
3.	**Vibration Control** Balancing of rotating machine, in-situ balancing of rotors, control of natural frequency, vibration isolation and vibration absorbers, Passive, active and semi-active control, free layer and constrained layer damping.	7
4.	**Random Vibrations** Probability, Auto and cross correlation function, spectral density, response of linear systems, and analysis of narrow band systems	8
5.	**Acoustics** Basics of acoustics – Terminologies speed of sound, wavelength, frequency, and wave number, acoustic pressure and particle velocity, acoustic intensity and acoustic energy density, spherical wave, Directivity factor and directivity index, levels and the decibel, combination of sound sources, octave bands, weighted sound levels. Sound Power measurement in a reverberant room, Sound power measurement in an anechoic, sound power survey measurements,	7
6.	**Acoustics of Partitions, Enclosures, Barriers and Mufflers** Transmission of Sound: changes in media with normal incidence, changes in media with oblique incidence, sound transmission through a wall, transmission loss for walls - stiffness-controlled region- mass-controlled region - damping-controlled region, Design of Acoustic Enclosures, Barriers, muffler elements. Noise control strategies and Applications	8
	Total	45

Text Books:

1. Mechanical Vibrations, S. S. Rao, Pearson Education, Delhi
2. Theory of Vibrations with Applications, W. T. Thomson, Pearson Education, Delhi
3. Industrial Noise Control, Randell Barron, Marcel Dekker, Inc.
4. Noise and Vibration Control, M L Munjal, World Scientific Publishing Co. Ltd.

Reference Books:

1. Mechanical Vibrations, G K Groover, Nem Chand & Bros, Roorkee, India
2. Fundamentals of Vibration, Leonard Meirovitch, McGraw Hill International Edison
3. Principles of Vibration Control: Ashok Kumar Mallik, Affiliated East-West Press, New Delhi.
4. Mechanical Vibrations, A H Church, John Wiley & Sons Inc
5. Mechanical Vibrations & Noise Engineering, A.G.Ambekar, Prentice Hall of India, New-Delhi.

Program:	M. Tech. Mechanical (Design Engineering)				Semester : II	
Course :	Professional Core Lab-II (OT, AVA)				Code : MMD2408	
Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	TW	PR	OR	Total
2	2	1	50	--	50	100

Prior knowledge of:

a. Engineering Mathematics is essential

Course Objectives:

1. Provide students with the modelling skills necessary to describe and formulate optimization problems.
2. Provide students with the skills necessary to solve and interpret optimization problems in engineering.

Course Outcomes:

After learning the course, the students should be able to:

1. Formulate mathematical programs in various practical systems
2. interpret the results of a model and present the insights (sensitivity, duality)
3. Use software to solve problems

Guidelines :

1. Total experiments to be conducted are **Three from Part A and Three from Part B**
2. **Total : 6 experiments 12 hours**

Detailed Syllabus:

Part A: Optimization Techniques in Design (ANY Three)

Expt.	Description	Duration, (H)
1.	Mathematical modeling of a real life problem	2
2.	Primal dual simplex method	2
3.	Sensitivity analysis of linear problem	2
4.	Optimization using non-linear methods	2
5.	Optimization using modern methods	2
	Total (Any Three)	6

Prior knowledge of:

a. Physics
b. Engineering Mathematics
c. Dynamics of Machinery……..are essential

Course Objectives:

To impart students with various Vibration and Noise Analysis Techniques, interpret data and report, to obtain the results for validation and effective understanding of system.

Course Outcomes:

After learning the course, the students should be able to:

1. Apply Vibration measurement techniques and Analyse using modern tools and technique.
2. Understand Basic principals in acoustics, measurement of sound Power and apply to analyze effectiveness in compliance to noise regulations.

Detailed Syllabus:

Part B: Advanced Vibrations and Acoustics (ANY Three)

Expt	Description	Duration, (H)
1.	Case Study on - Time domain and Frequency domain analysis of signals / experimental modal analysis / machine conditioning and monitoring / fault diagnosis	2
2.	Simulation study using finite element Analysis Tool on a. Modal analysis b. Harmonic analysis c. Transient analysis	2
3.	Modal Analysis with Impact Hammer Test	2
4.	Electro Dynamic Shaker to Obtain Natural Frequency and Dynamic Studies of a Cantilever Beam.	2
5.	Case study Analysis machine noise signature and analyze effectiveness in compliance to noise regulations.	2
	Total (Any Three)	6

Text Books:

1. Engineering Optimization: Theory and Practice, Singiresu S. Rao, John Wiley & Sons
2. Mechanical Vibrations, S. S. Rao, Pearson Education, Delhi
3. Industrial Noise Control, Randell Barron, Marcel Dekker, Inc.

Reference Books:

1. Optimization Concepts and Applications in Engineering, Belegundu, Chandrupatla,
2. Machinery Condition Monitoring: Principles and Practices, A. R. Mohanty, CRC Press, 2014
3. Vibration and Acoustic: Measurement and Signal Analysis, C. Sujatha, Tata McGraw Hill Education Pvt. Ltd

Program:	M. Tech. Mechanical (Design Engineering)	Semester : II
Course :	Fatigue and Fracture Analysis (Professional Elective-III)	Code : MMD2504A

Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior knowledge of:

a. Machine Design
b. Engineering Metallurgy
c. Material Science……are essential

Course Objectives:

1. To assess fatigue life at different loading conditions
2. To make aware about the analysis of Fracture Mechanics of mechanical components

Course Outcomes:

After learning the course, the students should be able to:

1. Identify and describe the basic fracture and fatigue mechanisms.
2. Understand experimental techniques to determine fatigue testing and standards.
3. Identify and evaluate fatigue failures in specific applications.
4. Apply linear elastic fracture mechanics to predict brittle fracture.
5. Understand Crack resistance and energy release rate for crack criticality
6. Understand the relationship between crack tip opening displacement, SIF and application of such parameters for ductile and brittle materials

Detailed Syllabus

Unit	Description	Duration, (H)
1.	**Fatigue Mechanics** Time varying uniaxial, biaxial and multiaxial loading of components, load spectra, cycle counting, fatigue damage theories of crack initiation, stress based and strain based approach	7
2.	**Fatigue Testing** Data acquisition and instrumentation, classical methods of fatigue testing, ASTM standards - specimen preparation, procedure	8
3.	**Special Cases in Fatigue** Fatigue analysis in frequency domain, vibration fatigue, fatigue of welded structure, corrosion fatigue, high temperature and low temperature fatigue	7
4.	**Linear Elastic Fracture Mechanics** Mechanisms of fracture, initiation of fracture and crack propagation, stress and energy criteria and fracture - effects of geometry, Inglis theory of stress, energy concept – Griffith theory of fracture, energy balance during crack growth, modes of loading,	8
5.	**Stress Intensity factors** – Concept, calculation for center crack, single edge crack, double edge crack, round hole with crack, superposition of stress intensity factors, leak before break (LBB) criterion	7
6.	**Elastic – Plastic Fracture Mechanics** Introduction, crack tip stress state, Irwin's approximation, Dugdale's approximation, crack opening displacement, shape of the plastic zone – von Mises and Tresca yielding criteria,	8
	Total	45

Text Books:

1. Fatigue Testing and Analysis – Theory and Practice, YUNG-LI LEE, Elsevier
2. Fatigue of Structures and Materials, Japp Schijve, Kluwer Academic
3. Metal Fatigue in Engineering, Ali Fatemi, Wiley-Interscience
4. Elements of Fracture Mechanics, Prashant Kumar, Mc Graw Hill Education

Reference Books:

1. Metal Fatigue Analysis Handbook, YUNG-LI LEE, Elsevier
2. Design & Analysis of Fatigue Resistant Welded Structure, Dieter Radaj, Woodhead Publishing
3. Fracture Mechanics Anderson T.L., CRC Press
4. Fracture Mechanics, Nestor Perez, , Kluwer Academic Publishers
5. Fracture Mechanics – An Introduction, Gdoutos E. E., , Springer
6. Nonlinear Fracture Mechanics for Engineers, Ashok Saxena, , CRC Press
7. Deformation and Fracture Mechanics of Engineering Materials, Hertzberg, R. W., John Wiley & Sons, Inc.

Program:	M. Tech. Mechanical (Design Engineering)				Semester : II	
Course :	Reliability in Engineering Design (Professional Elective-III)				Code : MMD2504B	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior knowledge of:

a. Engineering Mathematics is essential

Course Objectives:

1. To perform reliability engineering analysis.
2. To compute reliability engineering parameters and estimates for applications in mechanical devices and manufacturing environments.

Course Outcomes:

After learning the course, the students should be able to:

1. Identify the possible faults in systems and their impacts to the overall system reliability.
2. Develop fault trees for a sub-system and apply various reliability models on fault analysis.
3. Evaluate maintenance schedules and assess the corresponding risk with appropriate techniques and tools.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Fundamental concepts – I** Failure density, failure rate, hazard rate, MTTF, MTBF, maintainability, availability, pdf, cdf, Life characteristic phases, modes of failure, Areas of reliability.	7
2.	**Fundamental concepts – II** Quality and reliability assurance rules, product liability, probability distributions binomial, normal, Poisson, lognormal, Weibull, exponential, standard deviation, variance, skewness coefficient.	8
3.	Sy**stem reliability** Series, parallel, mixed configuration, k- out of n structure, complex systems- enumeration method, conditional probability method, cut set and tie set method,	7
4.	**Redundancy** Element redundancy, unit redundancy, standby redundancy- types of stand by redundancy, parallel components single redundancy, multiple redundancy. Markov analysis.	8
5.	**System reliability Analysis** Reliability apportionment, Reliability apportionment techniques – equal apportionment, AGREE, ARINC, feasibility of objectives apportionment.	7
6.	**Failure Mode, Effects and Criticality Analysis** Failure mode effects analysis, severity/criticality analysis, FMECA examples, RPN, Ishikawa diagram for failure representation, fault tree construction.	8
	Total	45

Text Books:

1. L.S. Srinath, Concepts of Reliability Engg., Affiliated East-Wast Press (P) Ltd., 1985.
2. E. Balagurusmy, Reliability Engineering, Tata McGraw-Hill Publishing Co. Ltd., 1984.

Reference Books:

1. A.K. Govil, Reliability Engineering, Tata McGraw-Hill Publishing Co. Ltd., 1983.
2. B.S. Dhillion, C. Singh, Engineering Reliability, John Wiley & Sons, 1980.
3. M.L. Shooman, Probabilistic, Reliability, McGraw-Hill Book Co., 1968.
4. P.D.T. Conor, Practical Reliability Engg., John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, Reliability in Engineering Design, John Wiley & Sons, 1977.
6. A.Birolini , Reliability Engineering, Theory and Practice, Third Edition, Springer, 1999

Program:	M. Tech. Mechanical (Design Engineering)				Semester : II	
Course :	Mechatronics and Control Systems (Professional Elective-III)				Code : MMD2504C	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior knowledge of:

a. Engineering Mathematics
b. Mechatronics……..are essential

Course Objectives:

1. Select and Apply various sensors/transducers for suitable application
2. Select sensors/transducers based on static and dynamic characteristics
3. Understand and apply, interfacing with DAQ microcontroller
4. Model mechanical and electromechanical systems
5. Design controller in time and frequency domain
6. Understand control actions such as Proportional, derivative and integral and study its significance in industrial application

Course Outcomes:

After learning the course, the students should be able to:

1. Analyse static and dynamic characteristics of instruments and Select and Apply sensors/ transducers for measurements of physical quantities.
2. Apply interfacing techniques to acquire measurement data from external environment and apply filtering techniques to attenuate measurement noise.
3. Formulate the mathematical model in by using transfer function and state space modelling approach.
4. Analyze system stability based on pole location and by Routh-Hurwitz criterion.
5. Design the control system for meeting desired specification in time domain based on transient response.
6. Design the control system in frequency domain and Analyze system stability in open and closed loop in frequency domain by Bode plot.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Fundamentals of Instrumentation** Classification of instruments; Characteristics of Measurement system: Static and Dynamic; Sensors and Transducers: Force, Speed Measurement, Strain Measurement, Vibration and Noise Measurement: Accelerometer, Laser Doppler Vibrometer, Temperature: Pyrometer, Varying Resistance; pressure: Pirani, Mcleod; flow rate: Ultrasonic; and humidity measurement.	7
2.	**Interfacing with Microcontroller** Data Acquisition System, Analog and Digital Signals, Bandwidth, Sampling theorem, ADC: Successive Approximation, Dual slope, DAC: R-2R, binary weighted, Noise Filters: Low Pass, Band Pass and High Pass; Interfacing of sensors/actuators with Arduino	8
3.	**Mathematical Modelling of Dynamic Systems** Classification of modelling, Modelling of Mechanical, Electro-mechanical, Transfer function, State space modelling, Block diagram representation and reduction	7
4.	**Stability analysis of Dynamic Systems** Poles and Zeros, System response of second order system, Transient response specifications, Absolute and relative stability, System Stability analysis using Poles and Zeros of System, Stability of system using Lyapunov's criterion, Stability of system based on Routh Hurwitz criterion	8
5.	**Control in Time Domain** Introduction to open loop and closed loop control, Conversion of transfer function to state space. Controllability and observability of system, Full state feedback control of system using pole placement technique, Pole placement using Ackerman's formula	7
6.	**Control in Frequency Domain** Frequency response of system, Bode plot to determine Phase margin and gain margin, PID control system design and tuning PID parameters based on transient and frequency response.	8
	Total	45

Text Books:

1. Measurement and Instrumentation – Theory and Application, Alan Morris, Reza Langari, Elsevier
2. Alciatore & Histand, Introduction to Mechatronics and Measurement system, 4th Edition, McGraw Hill publication, 2011
3. Control System Engineering, Norman Nise, 6th Edition, John Wiley and Sons

Reference Books:

1. Mechanical Measurements, S.P. Venkateshan, Ane Books Pvt. Ltd.
2. Measurement Systems-Application and Design, Doebelin E.O, McGraw Hill Publication
3. Park & Mackay, Practical Data Acquisition for Instrumentation & Control System, Elsevier, 2003
4. Dorf& Bishop, Modern Control Systems, 12th Ed, Prentice Hall
5. Ogata, Modern Control Engineering, 4th Ed, Prentice Hall
6. Golnaraghi & Kuo, Automatic Control Systems, John Wiley publications, 2010
7. C. D. Johnson, Process Control Instrumentation Technology, Prentice Hall, New Delhi
8. Astrom & Hagglund, PID Controllers: Theory, Design & Tuning, Chapter 2, 2nd Ed, Instrument Society of America, 1995.
9. J. P. Holman; "Experimental Methods for Engineers" McGraw Hill International Editions, Mechanical Engineering Series. ISBN 0-07-113354-2

Program:	M. Tech. Mechanical (Design Engineering)	Semester : II
Course :	Design of Material Handling Equipment (Professional Elective-IV)	Code : MMD2505A

Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior knowledge of:

a. Theory of Machines
b. Machine Design……..are essential

Course Objectives:

1. To reasilze the importance of materials in both in product and service
2. Understand the benefit of an efficient material handling system
3. Identify and select various types of material handling equipments
4. Design of material handling systems for variety of scenario pertaining to manufacturing and service industry.

Course Outcomes:

After learning the course, the students should be able to

1. Identify the use and importance of material handling
2. Identify different loads and classify material handling based on application
3. Apply the design procedures of various material handling equipment & components and design the material handling system.
4. Design load lifting & load movement attachments with proper design consideration understand the use of automation in material handling.
5. Design the auxiliary equipment

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Material handling system** Principles and features of material handling system, importance, terminology, objectives and benefits of better material handling, classification of material handling equipment	7
2.	**Selection of material handling equipment** Choice of material handling equipment, factors affecting for selection, general analysis procedures, basic analytical techniques, the unit load concept	8
3.	**Design of cranes** Hand-propelled and traveling mechanisms of cantilever and monorail cranes, design considerations for structures of rotary cranes with fixed radius, fixed post and overhead traveling cranes, stability of stationary rotary and traveling rotary cranes,	7
4.	**Design of cranes** Electric overhead travelling crane - essential parts, design parameters, structural considerations, end carriages, long and cross travel mechanisms, brakes, motor selection, safety arrangements, electrical control system	8
5.	**Load lifting attachments** Load chains and types of ropes used in material handling system, forged, standard and Ramshorn hooks, crane grabs and clamps; grab buckets; electromagnet; drums, sheaves, sprockets	7
6.	**Study of bulk material handling systems** Design consideration for conveyor belts, Objectives of storage; bulk material handling; gravity flow of solids through slides and chutes; storage in bins and hoppers; screw conveyor, vibratory conveyor, pneumatic & hydraulic conveyor (classification, types, principles of operation)	8
	Total	45

Text Books:

1. N. Rudenko, 'Material Handling Equipment', Peace Publishers
2. James M. Apple, 'Material Handling System Design', John-Wiley and Sons
3. John R. Immer, 'Material Handling' McGraw Hill

Reference Books:

1. Colin Hardi, 'Material Handling in Machine Shops'. Machinery Publication Co. Ltd.,
2. M .P. Nexandrn, 'Material Handling Equipment', MIR Publication,
3. C. R. Cock and J. Mason, 'Bulk Solid Handling', Leonard Hill Publication Co. Ltd.,
4. Spivakovsy, A.O. and Dyachkov, V.K., 'Conveying Machines', Volumes I and II, MIR Publishers,
5. Kulwiac R. A., 'Material Handling Hand Book', John Wiley Publication

Program:	M. Tech. Mechanical (Design Engineering)			Semester : II		
Course :	Computer Aided Design (Professional Elective-IV)			Code : MMD2505B		
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior knowledge of:

a. Vectors, Programming languages.
b. It is recommended to have knowledge of any geometric modeling software. ……..are essential

Course Objectives:

This course intends to give students an insight into use of computers in various stages of the product development like conceptualization, geometric modelling, design and graphical representation.

Course Outcomes:

After learning the course, the students should be able to:

1. Evaluate mathematical transformations and projections of rigid bodies.
2. Design & model curves, surfaces & solids.
3. Develop codes to solve engineering problems.
4. Implement various algorithms studied in Computer Graphics

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Computer aided Design – An insight** A typical product cycle, the design process, computers for design. CAD tools for the design process, Hardware requirements in CAD, Input / Output devices; Graphics Displays, graphical memory, Concept of Coordinate Systems, Software requirements in CAD	7
2.	**Geometric Transformations** Homogeneous representation; Translation, Scaling, Mirror Reflection, Rotation, Shearing in 2D and 3D; Orthographic and perspective projections.	8
3.	**Curves and Surfaces** Lines, scan conversion algorithms for lines, point on a line, parallel lines, perpendicular lines, distance of a point, Intersection of lines, Circle, Ellipse and general curves (parabola and hyperbola), Cubic Spline: equation, properties and blending. Bezier Curve: equations, properties; Properties and advantages of B-Splines and NURBS. Various types of surfaces along with their typical applications.	7
4.	**Computer Aided Geometric Design - Curves** Plane Curves, Space Curves, Bezier Curve, Explicit, Implicit, Parametric curves. The de Casteljau Algorithm, de Boor Algorithm, NURBS Theory, Properties And Algorithms, Geometric continuity, Projection Of Point On Curve, Curve-Curve Intersection, Hermit, Bezier, B-Spline curves	8
5	**Computer Aided Geometric Design - Surfaces** Trim Surfaces, Curve and Surface Subdivision, Curve And Surface From Algebraic Equation, Curve And Surface Fitting, Principal curvatures, Curve-Surface Intersection, Surface-Surface Intersection, Projection Of Curves On Surfaces, Projection Of Surface On Surfaces	7
6	**Solid Modelling and Applications** Introduction, solid representation, Concept of Topology, Boundary Representations (B-Rep), Constructive Solid Geometry, Feature Based Modeling - Part Modeling, Assembly, Drawings, Extrusion, Revolve, Shell, Draft, Patterning, Surface and Solid Boolean Operations	8
	Total	**45**

Text Books:

1. Rogers & Adams, Mathematical Elements for Computer graphics, Tata McGraw –Hill, New Delhi, 2nd Edition, 2002
2. Donald Hearn and M. Pauline Baker, Computer Graphics, Eastern Economy Edition- Prentice Hall, 3rd Edition, 1986
3. Computer graphics, Schaum Series, McGraw Hill, 2nd Ed, 2000
4. Computer graphics- Foley Van Dam, Addision-Wesley, 2nd edition, 1996

Reference Books:

1. Rooney, J. and Steadman, P., Principles of Computer Aided Design, Design, Prentice Hall.
2. Kuang-Hua Chang, Product Design Modeling using CAD/CAE - The Computer Aided
3. Engineering Design Series, Elsevier Inc., 2014

Program:	M. Tech. Mechanical (Design Engineering)		Semester : II			
Course :	Multi-body Dynamics (Professional Elective-IV)		Code : MMD2505C			
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
3	3	3	20	30	50	100

Prior knowledge of:

a. Theory of Machines
b. Engineering Mathematics……..are essential

Course Objectives:

1. To Kinematically and dynamically analyse planar bodies
2. To Kinematically and dynamically analyse rigid bodies

Course Outcomes:

After learning the course, the students should be able to:

1. Derive equations of motion for interconnected bodies in multi-body systems with three dimensional motion.
2. Implement and analyze methods of formulating equations of motion for interconnected bodies.
3. Write programs to solve constrained differential equations for analyzing multi-body systems.
4. Simulate and analyze all types of static and dynamic behaviors of the multi-body systems including the kineto-static analysis.

Detailed Syllabus

Unit	Description	Duration, (H)
1.	**Basic principles for analysis of multi-body systems** The constraints for planar kinematic analysis. Revolute, prismatic, gear and cam pairs. The automatic assembly of the systems of equations for position, velocity and acceleration analysis. Iterative solution of systems of non-linear equations.	7
2.	**Computation of Forces, planar** Geometry of masses, computation and assembly of mass matrix. Computation of planar generalized forces for external forces and for actuator-spring-damper element.	8
3.	**Computation of Forces, special** Computation of spatial generalized forces for external forces. Computation of reaction forces from Lagrange's multi- pliers.	7
4.	**Dynamics of Planar Systems** Dynamics of planar systems, Simple applications of inverse and forward dynamic analysis.	8
5.	**Kinematics of rigid bodies in space** Reference frames for the location of a body in space. Euler angles and Euler parameters. Screw motion in space. Velocity, acceleration and angular velocity. Relationship between the angular velocity vector and the time derivatives of Euler parameters.	7
6.	**Kinematic analysis of spatial systems** Basic kinematic constraints. Joint definition frames. The constraints required for the description in space of common kinematic pairs (revolute, prismatic, cylindrical, and spherical). Equations of motion of constrained spatial systems.	8
	Total	45

Text Books:

1. Wittenburg, J., *Dynamics of Systems of Rigid Bodies*, B.G. Teubner, Stuttgart, 1977.
2. Kane, T.R, Levinson, D.A., *Dynamics: Theory and Applications*, McGraw-Hill Book Co., 1985.
3. Nikravesh, P.E., *Computer Aided Analysis of Mechanical Systems*, Prentice-Hall Inc., Englewood Cliffs, NJ, 1988.
4. Roberson, R.E., Schwertassek, R., *Dynamics of Multibody Systems*, Springer-Verlag, Berlin, 1988.
5. Haug, E.J., *Computer-Aided Kinematics and Dynamics of Mechanical Systems-Basic Methods*, Allyn and Bacon, 1989.
6. Huston, R.L., *Multibody Dynamics*, Butterworth-Heinemann, 1990.
7. Schielen, W. *ed.*, *Multibody Systems Handbook*, Springer-Verlag, Berlin, 1990.
8. de Jalo n, J.C., Bayo, E., *Kinematic and Dynamic Simulation of Multibody Systems*, Springer-Verlag, 1994.
9. Shabana, A.A., *Computational Dynamics*, John Wiley & Sons, 1994.

Reference Books:

1. "Why Do Multi-Body System Simulation?" by Rajiv Rampalli, Gabriele Ferrarotti & Michael Hoffmann, Published NAFEMS Publications, January 12
2. "Principles of Dynamics" by Donald T. Greenwood, 2nd ed., Prentice Hall

Program:	M.Tech. Mechanical (Design Engineering)					Semester : II
Course :	Professional Elective Lab II (Elective III & Elective IV)					Code : MMD2506
Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	TW	PR	OR	Total
2	2	1	50	--	50	100

Prior knowledge of:

Course Objectives:

This course is to provide students the tools required for Simulate, correlate and validate theoretical concepts and understand the principles.

Course Outcomes:

After learning the course the students should be able to:

1. Solve open ended Design problem and report the solution.
2. Simulate the problem and correlate with theoretical concepts
3. Understand the impact of assumptions on the simulated results
4. Collect data, analyse, interpret and report the results.

Guidelines :

1. **Any one subject from Part A and Part B** as per students elective choices
2. Total experiments to be conducted are **Three from Part A and Three from Part B**
3. **Total : 6 experiments 12 hours**

Detailed Syllabus:

Part A: Elective 1- Fatigue and Fracture Analysis (ANY Three)

Expt.	Description	Duration, (H)
1.	Case Studies based on Rain Flow Counting Technique	2
2.	Stress / Strain Based Fatigue Analysis	2
3.	FEA Simulation of fatigue / Fracture Problem	2
4.	Crack tip stresses using Photoelasticity	2
5.	Stress Analysis using Image Processing	2
	Total	**06**

Part A: Elective 1- Reliability in Engineering Design (ANY Three)

Expt.	Description	Duration, (H)
1.	Characteristics of Binomial and Poisson distributions	2
2.	Characteristics of Normal and Log-Normal distributions	2
3.	Determination of MTTF for series and parallel systems	2
4.	Evaluation of basic probability indices for series and parallel systems	2
5.	Markov Analysis of system	2
6.	Reliability allocation to system	2
7.	Failure mode effects analysis, severity / criticality	2
	Total	**06**

Part A: Elective 1- Mechatronics and Control Systems (ANY Three)

Expt.	Description	Duration, (H)
1.	Interfacing of any sensor / actuator with Arduino	2
2.	Modelling and Analysis in Time Domain: State Space Modelling of MIMO/SISO System using MATLAB and Simulink.	2
3.	Modelling and Analysis in Frequency Domain: Transfer Function Modelling of MIMO/SISO System using MATLAB and Simulink	2
4.	Mapping of pole- zero and analysis of system stability of mechanical system	2
5.	Design of full state feedback controller / PID controller (software based)	2
	Total	**06**

Part B: Elective 2- Design of Material Handling Equipment (ANY Three)

Expt.	Description	Duration, (H)
1.	Case Studies Based on Use and importance of different material handling equipment's.	2
2.	Safety in Material handling system.	2
3.	Design aspects and failures in the material handling system	2
4.	Design of any one material handling system based on Manufacturing assembly and cost consideration.	2
	Total	**06**

Part B: Elective 2- Computer Aided Design (ANY Three)		
Expt.	**Description**	**Duration, (H)**
1.	Curves: Line DDA, Line Bresenham, Circle Bresenham	**2**
2.	Curves & Clipping: Mid-point ellipse, Window Clipping	**2**
3.	Transformations: Translation, Rotation, Scaling, Shear, Mirror	**2**
4.	Transformations: Combination of above	**2**
5.	Curves: Bezier curve, B-spline Curve, Hermite Curve,	**2**
6.	Surfaces: Lofted Surfaces, Bezier surface, B-spline Surface	**2**
	Total	**06**
Part B: Elective 2- Multi-body Dynamics (ANY Three)		
Expt.	**Description**	**Duration, (H)**
1.	Velocity and acceleration analysis of planar systems	**2**
2.	Constraint analysis for planar kinematic analysis for revolute, prismatic, gear and cam pairs	**2**
3.	Dynamic analysis of planar systems	**2**
4.	Inverse and forward dynamic analysis	**2**
5.	Kinematic analysis of rigid bodies	**2**
6.	Kinematic analysis of spatial systems	**2**
7.	Reaction forces from actuator-spring-damper system	**2**
	Total	**06**

Program:	M. Tech. Mechanical (Design Engineering)				Semester : II	
Course :	Integrated Mini-Project				Code : MMD2701	
Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	IE2	TW	OR	Total
6	6	3	50	--	50	100

Prior knowledge of:

a. Basics of Design, Finite element Methods, Vibrations and Acoustics, Composites
b. Basics of MATLAB and Simulation software's. …….are essential

Course Objectives:

1. To understand the 'Product Development Process' including budgeting through Mini Project.
2. To plan for various activities of the project planning and execution.
3. To build, design and implement real time application preferably multidisciplinary domain using available platforms.

Course Outcomes:

After learning the course the students should be able to:

1. Understand, plan and execute a Mini Project.
2. Design real time application.
3. Prepare a technical report based on the Mini project.
4. Deliver technical seminar based on the Mini Project work carried out.
5. Understand publication and copyright process of research.

Guidelines : Total : 36 hours

1. Individual student need to design and demonstrate Mini-project under the guidance of allocated guide.
2. Students can choose area of project in field of Multi-disciplinary Designing considering their future implementation in Major Project in second year
3. The hardware implementation on the board and software simulation is compulsory.
4. Mini-Project Report should be submitted as a compliance of term work associated with subject.
5. Paper publication associated with mini-project as research outcome is appreciable.
6. Mini-project work preferably should be completed in laboratory.

Detailed Syllabus:

Integrated Mini-Project

Sr. No.	Activity	Duration, (H)
1.	Week 1 & 2 : Mini-project guide allotment, finalization of topic and platform, Planning of the work	7
2.	Week 3 & 4: Literature review and specification and Methodology Finalization, Review 1 for finalization of topic and specification.	8
3.	Week 5 & 6 : Simulation of Idea on appropriate software tools and finalization of hardware platform	7
4.	Week 7 & 8 : understanding platform implementation and related software flow and execute block level design , Review 2 to understand the progress of the project	8
5.	Week 9 & 10: Mini Project Report writing and publication or copyright planning and execution.	7
6.	Week 11 & 12: Demonstration of Project work and Final Review for submission and term work compliances.	8
	Total	45

Open Electives- II Syllabus

Program:	M. Tech. Computational Mechanics (Mechanical Engineering)				Semester: II	
Course:	Waste Management for Smart Cities (Open Elective-II)				Code: MMC2602A	
Teaching Scheme				Evaluation Scheme		
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	-	30	50

Course Objective:

1. To provides an in-depth understanding of Municipal waste characteristics and management.
2. To make aware about regulations in the area municipal waste management.
3. To equip with the methods of environment risk assessment of waste.
4. To provide an in-depth understanding of Physiochemical and biological treatment of Municipal waste.
5. To be able to design the land-fields for the smart cities.

Course Outcomes:

The learners will be

1. Identify and evaluate the sources; composition; generation rates, methods of separation and collection methods of municipal waste treatment.
2. Evaluate and analysis the risk and methods ofhandling the hazardous and radioactive waste based on health effects.
3. Evaluate the Physiochemical and biological waste for its treatment and disposal
4. Design the land field for solid and hazardous wastes collection and removal

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Municipal Solid Waste Management** Fundamentals Sources; composition, generation rates, collection of waste, separation, transfer and transport of waste, treatment and disposal options. Municipal waste management and handling rules for solid waste, hazardous waste, biomedical waste, fly ash, recycled plastics usage and batteries	7
2.	**Hazardous and Radioactive Waste Management** Fundamentals Characterization of waste, fate and transport of chemicals, health effects, Fundamentals sources, measures and health effects; nuclear power plants and fuel production; waste generation from nuclear power plants; disposal options	8
3.	**Physiochemical Treatment of Solid waste** Physicochemical Treatment of Solid and Hazardous Waste Chemical treatment processes for MSW (combustion, stabilization and solidification of hazardous wastes); physicochemical processes for hazardous wastes (soil vapour extraction, air stripping, chemical oxidation); ground water contamination and remediation	7
4.	**Biological Treatment of Solid waste and landfill design** Biological Treatment of Solid and Hazardous Waste Composting; bioreactors; anaerobic decomposition of solid waste; principles of biodegradation of toxic waste; inhibition; co-metabolism; oxidative and reductive processes; slurry phase bioreactor. Landfill design Landfill design for solid and hazardous wastes; leachate collection and removal; landfill covers; incineration	8
	Total	30

Text Books:

1. John Pichtel, Waste Management Practices CRC Press, Taylor and Francis Group 2005.
2. LaGrega, M.D.Buckingham,P.L. and Evans, J.C. Hazardous Waste Management, McGraw Hill International Editions, New York, 1994.

References:

1. Richard J. Watts, Hazardous Wastes - Sources, Pathways, Receptors John Wiley and Sons, NewYork, 1997.
2. Basics of Solid and Hazardous Waste Mgmt. Tech. by Kanti L.Shah 1999, Prentice Hall.
3. Solid And Hazardous Waste Management 2007 by S.C.Bhatia Atlantic Publishers & Dist.

Program:	M. Tech. Computational Mechanics (Mechanical Engineering)				Semester: II	
Course:	Electronic Cooling (Open Elective-II)				Code: MMC2602B	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior knowledge of:

a. Thermodynamics,
b. Fluid Mechanics,
c. Heat Transfer……are essential

Course Objectives:

1. To establish fundamental understanding of heat transfer in electronic equipment.
2. To select a suitable cooling process for electronic components and systems.
3. To increase the capabilities in design and analysis of cooling of electronic packages.
4. To analysis the thermal failure for electronic components and define the solution.

Outcomes:

After learning the course, the students should be able to

1. Understand Heat transfer processes involved in electronics cooling.
2. Analyze thermal failure for electronic components and define the solution.
3. Assign the best cooling method for each individual application.
4. Design cooling system for any electronic device and select Best packaging approach for any design.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Introduction to Electronics Cooling** Introduction, Packaging Trends and Thermal Management, Basics of Heat Transfer, Conduction Heat Transfer, Multi-Dimensional Conduction, Transient Conduction, Natural Convection in Electronic Devices, Forced Convection Heat Transfer, Radiation Heat Transfer, contact and spreading resistances.	7
2.	**Electronics Cooling Methods in Industry** Thermal interface and phase change materials, passive and novel air-cooling approaches, Heat Sinks, Heat Pipes in Electronics Cooling, Thermoelectric Cooling, Liquid Immersion Cooling (Single and Two-phase), Cooling Techniques for High Density Electronics	8
3.	**Packaging of Electronic Equipment** Components of Electronic Systems, Packaging of Electronic Equipment, Conduction Cooling for Chassis and Circuit Boards, Chip/circuit material for augmenting heat transfer.	7
4.	**Control Parameters Measurement and simulation** Temperature & humidity requirement, CFD analysis for Airflow & temperature evaluation, thermography etc	8
	Total	30

Text Books:

1. D. S. Steinberg," Cooling Techniques for Electronic Equipment ", Second Edition, John Wiley & Sons, 1991.
2. S. J. Kim and Sang Woo Lee, "Air cooling Technology for Electronic Equipment", CRC press, London, 1996.
3. F. P. Incropera, "Liquid Cooling of Electronic Devices by Single-Phase Convection", John Wiley& sons, inc, 1999.

Reference Books:

1. J. L. Sloan, "Design and Packaging of Electronic Equipment", Van Nostrand Reinhold Company, 1985.
2. F. P. Incropera, "Introduction to Heat Transfer ", Fourth Edition, John Wiley, 2002.
3. C. Belady, "Standardizing Heat Sink Performance for Forced Convection, Electronics Cooling", Vol. 3, No. 3, September, 1997.
4. C. Biber, Wakefield Engineering, Wakefield, Massachusetts, "Characterization of the Performance of Heat Sinks,", Personal Communication, October 1997.
5. A. B.-Cohen, ―Encyclopedia of Thermal Packaging volume 1 to 6‖, February 2013, World Scientific Publication

Program:	M. Tech. Computational Mechanics (Mechanical Engineering)				Semester: II	
Course:	Renewable Energy Sources (Open Elective-II)				Code: MMC2602C	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior knowledge of:

a. Thermodynamics;
b. Fluid Mechanics;
c. Heat Transfer;
d. Elements of Electrical Engineering; ……are essential

Course Objectives:

Following concepts to be taught to the students,

1. Demonstrate significance of analysis solar and Wind Resources Sources and design technologies of their utilization
2. Expose them to conceptualize and design renewable energy appliances and equipment
3. Enable them to independently analyze, implement and asses the real-life systems
4. Develop a research insight about renewable technologies so as to motivate all concerned for their enhanced deployment

Course Outcomes:

After learning the course, the learners will be able to

1. Determine the fundamental performance characteristics of solar thermal, photovoltaic and wind energy systems
2. Estimate the potential of solar and wind energy resources
3. Demonstrate understanding of the fundamentals of energy conversion from biomass, geothermal, tidal or wave energy conversion systems
4. Determine the economic feasibility of renewable energy technologies

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Solar energy:** Potential of Renewable energy sources, Current scenario of worldwide installed capacity, Estimation of solar radiation **Solar thermal collectors** – General description and characteristics of flat plate and concentrating solar collectors, characteristic equation for performance evaluation **Solar Photovoltaic Systems**– Working, Constructional details & performance assessment, Effect of various parameters on output of solar cell, economics	7
2.	**Wind energy:** Principles and classification of wind energy conversion systems– Aerodynamics and performance, Site selection considerations, Wind resource / energy potential measurement, wind electric generator components, Operation, maintenance and economics	8
3.	**Energy from biomass :** Sources of biomass, Properties of biomass, Conversion of biomass into fuels – Energy through fermentation – Pyrolysis, gasification and combustion – Aerobic and anaerobic bio-conversion, Biogas plants – Types of plants –operation in dual fuel mode– Properties and Economics	7
4	**Geothermal, Tidal or Wave Energy Conversion** Geothermal energy: hot springs and steam ejection site selection, power plants, and economics. Environmental impacts, Economic and social considerations, Availability, system development and limitations, Wave and tidal energy –Scope and economics, Introduction to integrated energy systems.	8
	Total	30

Text Books

1. S.P. Sukhatme, Solar Energy – Principles of thermal collection and storage, II edition, Tata McGraw Hill, New Delhi, 1996.
2. Garg H.P., Prakash J., Solar energy Fundamentals and Applications, Tata Mc Graw Hill Publishing Company, New-Delhi, Latest Edition
3. V.V. N. Kishore, Editor, Renewable Energy Engineering and Technology, A knowledge Compendium, The Energy and Resources Institute, New Delhi, 2008

Reference Books:

1. J.A.Duffie and W.A.Beckman, Solar engineering of Thermal processes, II edition, John Wiley, New York, 1991.
2. D.Y.Goswami, F.Kreith and J.F.Kreider, Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2000.
3. J F Manwell, J.G.McGowan, A.L.Rogers, Wind Energy Explained: Theory, Design and Application, John Wiley and Sons, May 2002.
4. R D Begamudre, Energy Conversion Systems, New Age International (P) Ltd., Publishers, New Delhi, 2000.
5. Bureau of Energy Efficiency – Volume 1

Program:	M.Tech (E&TC)-VLSI and Embedded Systems				Semester: II	
Course:	Drone Programming for Beginners (Open Elective-II)				Code: MET2602A	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior knowledge of:

a. Basic understanding of physics (Force, Velocity, Acceleration, etc), Understanding of sensors and actuators,
b. Control systems, Modelling Basics –MATLB & SIMULINK, Programming in python……..are essential

Course Objectives:

1. To understand the physics behind drones
2. To create the mathematical model of quadcopter drone from simple mathematics & Experimental data
3. To implement model into Simulink & check it against real life performance

Course Outcomes:

After learning the course, the students should be able to:

1. Identify & select different accessories of Drones as per applications
2. Establish the mathematical model & the Physics behind Quadcopter drone
3. Design Simulink model simulating the complete dynamics of quadcopter drone.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Introduction to drones:** Unmanned Aerial Systems (UAS), Basics of drones, Introduction to Drones programming and Development Tools, Current rules and regulations governing owning and operating a UAS, concerns surrounding UAS safety, security and privacy issues	7
2.	**Drone accessories and Applications:** Sensors, Motors, Propellers, Battery, Concept of propulsion, Forces working on a Flight, Principal axes and rotation of aerial systems, Stable, unstable and neutral systems, Control drone (roll, pitch and yaw), Application of drones.	8
3.	**Drone control system development in Simulink:** Control system architecture, Quadcopter with actuator & propellers functionality block, Sensing & estimation functionality block, controller functionality block, Motor mixing algorithm (RPYT) functionality block	7
4.	**Modelling, Simulation & Flight control design:** Dynamic quadcopter system Model, flight control design, 3D visualization, testing & Tuning the model, Flight operations, Applicable software for data collection, processing, and analysis	8
	Total	30

Text books:

1. John Baichtal ,Building your own drones, a beginner's guide to drones, UAVS, and ROVs
2. Muhammad Usman , Quadcopter modelling and control with Matlab/Simulink implementation
3. Ryan Gordon , Model based design of a quadcopter
4. K.S.Fu, R.C.Gonzalez, C.G.Lee , Robotics control, sensing, vision and intelligence

Reference Books:

1. - R.K.Mittal , I.J.Nagrath,Robotics and control
2. Ben Rupert , Drones (The ultimate guide), , CreateSpace Independent Publishing Platform
3. Agam Kumar Tyagi Matlab and Simulink for engineers, , Oxford University Press, 2012

Program:	M. Tech (E&TC)-VLSI and Embedded Systems	Semester: II
Course :	Instrumentation and Measurements (Open Elective-II)	Code: MET2602B

Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior knowledge of:

a. Basics of sensors and Actuators
b. Basic of Electronics
c. Analog and Digital Systems……..are essential

Course Objectives:

To impart knowledge on the following Topics -

1. Basic functional elements of instrumentation
2. Fundamentals of electrical and electronic instruments
3. Comparison between various measurement techniques
4. Various storage and display devices
5. Various transducers and the data acquisition systems

Course Outcomes:

After learning the course, the students should be able to:

1. Analyse different measuring parameters of any electronics/mechatronics system
2. Design and evaluate characteristics of different types of mechatronics/ electrical/ electronic system
3. Understand different types of wave/spectrum analyzer.
4. Interface various system components and analyse its data using data acquisition system.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	Basics of Measurements: Accuracy, Precision, resolution, reliability, repeatability, validity, Errors and their analysis, Standards of measurement. Bridge Measurement: DC bridges- wheatstone bridge, AC bridges – Kelvin, Hay, Maxwell, Schering and Wien bridges, Wagner ground Connection. Electronic Instruments for Measuring Basic Parameters: Amplified DC meter, AC Voltmeter, True- RMS responding Voltmeter, Electronic multi-meter, Digital voltmeter, Vector Voltmeter.	7
2.	Oscilloscopes: Cathode Ray Tube, Vertical and Horizontal Deflection Systems, Delay lines, Probes and Transducers, Specification of an Oscilloscope. Oscilloscope measurement Techniques, Special Oscilloscopes – Storage Oscilloscope, Sampling Oscilloscope. Signal Generators: Sine wave generator, Frequency – Synthesized Signal Generator, Sweep frequency Generator. Pulse and square wave generators. Function Generators.	8
3.	Signal Analysis: Wave Analyzer, Spectrum Analyzer. Frequency Counters: Simple Frequency Counter; Measurement errors; extending frequency range of counters Transducers: Types, Strain Gages, Displacement Transducers	7
4.	Digital Data Acquisition System: Interfacing transducers to Electronics Control and Measuring System. Instrumentation Amplifier, Isolation Amplifier. An Introduction to Computer-Controlled Test Systems.IEEE-488 GPIB Bus	8
	Total	30

Text Books:

1. Albert D.Helstrick and William D.Cooper, Pearson Education , Modern Electronics Instrumentation & Measurement Techniques, . Selected portion from Ch.1, 5-13.
2. Joshph J.Carr ,Elements of Electronics Instrumentation and Measurement-3rd Edition.Pearson Education. Selected portion from Ch.1,2,4,7,8,9,13,14,18,23 and 25.

Reference Books:

1. Electronics Instruments and Instrumentation Technology – Anand, PHI
2. Doebelin, E.O., Measurement systems, McGraw Hill, Fourth edition, Singapore, 1990.

Program:	M.Tech (E&TC)-VLSI and Embedded Systems	Semester : II
Course :	Microcontrollers and Microprocessors Applications (Open Elective-II)	Code : MET2602C

Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	--	30	50

Prior knowledge of:

a. Digital Electronics

Course Objectives:

1. To explain architecture and features of typical Microcontroller.
2. To make students understand need of microcontrollers in real life applications.
3. To explore interfacing of real-world peripheral devices, various hardware and software tools for developing applications.
4. To explain the architecture and programmer's model of advanced processor and microcontroller
5. To acquaint the learner with application instruction set and logic to build assembly language programs.

Course Outcomes:

After learning the course, the students should be able to:

1. Learn importance of microcontroller and microprocessor in designing embedded application
2. To apply the programming skills to develop real-life embedded application.
3. Learn use of hardware and software tools.
4. Develop interfacing to real world devices.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Introduction to single chip Microcontrollers:** Intel MCS-51 family features, 8051/8031-architecture, 8051 assembly language programming, addressing modes, Programming interrupts, timers and serial communication	7
2.	**Microcontrollers and system design:** Assembly vs High-Level language programming, System Development Environment: assembler, compiler and integrated development environment, Debugging and Simulation, system design with 8051.	8
3.	**System level interfacing design;** Advanced Microprocessor Architectures- 286, 486, Pentium; Introduction to RISC processors; ARM microcontrollers; Embedded system design methodologies, embedded controller design for communication, digital control.	7
4.	**Microcontroller & Processors Applications:** Interfacing with display devices, Sensors, actuators, and memory devices. Case Study on real time embedded system.	8
	Total	30

Text Books:

1. BarryB Brey, The intel microprocessor: architecture, programming and interfacing, Prentice hall of India, New Delhi, 2003.ISBN-0138027455, 4th Edition
2. Mohammad Ali Mazidi and Janice Gillispie Maszidi ―The 8051 Microcontroller and Embedded Systems‖ Pearson education, 2003, ISBN- 9788131710265, 2nd Edition

Reference Books:

1. Chris H. Pappas, William H. Murray, ―80386 Microprocessor Handbooks‖, McGraw-Hill Osborne Media, ISBN-10: 0078812429, 13: 978-0078812422.
3. Walter A. Triebel, ―The 80386Dx Microprocessor: Hardware‖, Software, and Interfacing, Pearson, Education, ISBN: 0137877307, 9780137877300.
4. Mohammad Rafiquzzaman, ―Microprocessors: Theory and Applications: Intel and Motorola", Prentice Hall, ISBN: -10:0966498011, 13:978:0966498011.
2. K. Bhurchandi, A. Ray, ―Advanced Microprocessors and Peripherals, McGraw Hill Education, Third Edition, ISBN: 978-1-25-900613-5

Program:	M. Tech (E&TC)- VLSI & Embedded Systems			Semester: II		
Course:	Electronics Implementation Platform (Open Elective-II)			Code: MET2602D		
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	--	30	50

Prior knowledge of:

a. C language,
b. Python
c. Electronic circuits. ……..are essential

Course Objectives:

1. Explain about the Arduino, Raspberry Pi, PLDs and all other associated platforms
2. Understand of the importance of micro controllers and computers in science and technology.
3. Discuss basic programming and structures required for basic operation of the platform,
4. Describe how to recognize functions, operations and syntax of Python, C and C++

Course Outcomes:

After learning the course, the students should be able to:

1. Apply logical thinking and problem-solving skills with Arduino platform.
2. Acquire knowledge about Raspberry pi for implementation of applications
3. Understand Digital Signal processing implantation basics
4. Understanding rapid prototyping using PLDs.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	Arduino: A open-sourceHardware, Working, Interfacing, Coding basics and small applications and Debugging.	7
2.	Raspberry pi : Working, Interfacing, Coding basics and small applications and Debugging.	8
3.	DSP processor for Real time Video and Inage Processing. : Working, Interfacing, Coding basics and small applications and Debugging.	7
4.	Programmable Logic devices: FPGA: Working, Interfacing, Coding basics and small applications and Debugging.	8
	Total	30

Text Books:

1. Ryan Turner,Arduino Programming: The Ultimate Beginner's & Intermediate Guide to Learn Arduino Programming Step by Step, 2019
2. Derek Molloy Exploring Raspberry Pi: Interfacing to the Real World with Embedded Linux 1st Edition,2006
3. Avtar Singh , Digital Signal Processing Implementations : Using DSP Microprocessors (with examples from TMS320C54XX),2003
4. Roger Woods, John McAllister, Ying Yi, Gaye Lightbody, FPGA- based Implementation of Signal Processing Systems, Second Edition, 2017

Reference Books:

1. Mark TorvaldsARDUINO - ARDUINO PROGRAMMING - ARDUINO FOR BEGINNERS, Second Edition June 7, 2018
2. Eben Upton Raspberry Pi User Guide 4th Edition 2019
3. Sen M. Kuo ,Real-Time Digital Signal Processing, : Implementations, Application and Experiments with the TMS320C55X, 2001
4. Cem Unsalan, Bora Tar ,Digital System Design with FPGA: Implementation Using Verilog andx VHDL , 2017

Program:	M.Tech (Computer Engineering)				Semester : II	
Course :	Image Processing with MATLAB (Open Elective-II)				Code: MCE2602A	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior knowledge of:

a. Programming Basics

Course Objectives:

1. Develop an overview of the field of image processing.
2. Cover the basic theory and algorithms that are widely used in digital image processing.
3. Develop hands-on experience in using computers to process images.
4. Familiarize with MATLAB Image Processing Toolbox Course

Course Outcomes:

1. After learning the course the students should be able to:
2. Understand the need for image transforms different types of image transforms and their properties. 2: Learn different techniques employed for the enhancement of images.
3. Understand the need for image compression and to learn the spatial and frequency domain techniques of image compression.
4. Learn different feature extraction techniques for image analysis and recognition.
5. Develop any image processing application.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Introduction:** What is image processing?, What are the fundamental issues? , What is the role of perception? Image sampling and quantization, Basic relationship between pixels, MATLAB orientations. **Image Transformations** Discrete Fourier transform, Properties of 2D DFT, FFT, Convolution, Correlation, Discrete cosine transform, Discrete Wavelet transform.	7
2.	**Image Enhancement Techniques** Spatial Domain Techniques: Basic gray level transformations, Histogram processing, Image subtraction, Image averaging, Spatial filtering, Smoothing filters, Sharpening filters. Frequency Domain Techniques: Frequency domain filtering, Image smoothing and Image sharpening using frequency domain filters.	8
3.	**Color image processing:** Color fundamentals, Color models, Color transformation, Smoothing and Sharpening **Image Compression:** Fundamentals, Encoder-Decoder model, Types of redundancies, Lossy and Lossless compression, Huffman coding, Arithmetic coding, Golomb coding, LZW coding, Block transform coding, Run-length coding, JPEG Lossless predictive coding, Lossy predictive coding, Wavelet coding.	7
4.	**Morphological Image processing:** Basics, Erosion, Dilation, Opening, Closing, Hit-or-Miss transform, Boundary Detection, Hole filling, Connected components, Convex hull, Thinning, Thickening, Skeletons, Pruning. **Image Segmentation and Representation:** Point, Line and Edge detection, Edge linking and Boundary detection, Thresholding, Basic global tresholding, Otsu's method, Region based segmentation, Use of motion in segmentation	8
	Total	**30**

Text Books:

1. R. C.Gonzalez, R.E.Woods,‖ Digital Image processing‖, Pearson edition, Inc3/e,2008.
2. A.K.Jain,‖ Fundamentals of Digital Image Processing‖, PHI,1995

Reference Books:

1. J.C. Russ,‖ The Image Processing Handbook‖, (5/e), CRC, 2006
2. R.C.Gonzalez & R.E. Woods; ‒Digital Image Processing with MATLAB‖, Prentice Hall, 2003
3.W. K. Pratt, *Digital Image Processing*, John Wiley & Sons, 2006.
4.S. Ahmed, *Image Processing*, McGraw -Hill, 1994.
5.S. J. Solari, *Digital Video and Audio Compression*, McGraw-Hill, 1997

Program:	M.Tech (Computer Engineering)				Semester : II	
Course :	Linux Essentials (Open Elective-II)				Code: MCE2602B	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior knowledge of:

Course Objectives:

1. To acquire knowledge of basic Linux OS, commands, and terminologies
2. To develop programs using Shell scripting
3. To acquire skills related to Linux file system

Course Outcomes:

After learning the course the students should be able to:

1. Use common and simple Linux commands
2. Demonstrate programming ability using Unix Shell
3. Develop collaboratively using GIT and write research-papers using LaTex
4. Apply a solution clearly and accurately in Linux environment

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Introduction to Linux:**Linux introduction; Understanding philosophy of Linux; Understanding Software Licensing and Linux Distributions; Architecture of Linux OS; Installation of Linux OS (direct and using virtual machine); Using common Linux programs: Linux desktop environment, working with different productivity software; Understanding and managing hardware: CPU, Disk issues, Device drivers, Display etc.;	7
2.	**Basic Commands and Shell Scripting:** Introduction to Linux commands, concept of shell, shell variables,getcwd() and pwd; Introduction to shell programming features: Variables declaration & scope,test, return value of a program, if-else and useful examples, for andwhile loop, switch case; Shell functions, pipe and redirection, wildcards, escape characters; Awk script: Environment andworkflow, syntax, variables, operators, regular expressions, arrays, control flows, loops,functions, output redirections	8
3.	**Linux File System and Networking:** File System - Manipulating Files: creating, deleting, copying, moving, renamingetc; Using absolute and relative path; Manipulating Directories: Creating, Deleting and Managing; Basic File and Directory commands; Understanding Linux file system; Networking - Understanding network features; Configuring a network connection; Testing a network connection;	7
4.	**Essential System Administration** **Users and Group Management:** Users and Group management: Creation, Updating, Deletion of user and group; Commands –shadow, useradd, usermod, userdel, groupadd, groupmod, groupdeletc; Managing ownership and permission. **Process and PackageManagement:** Understanding package management,package management commands like rpm, yum, apt; Understanding Process hierarchy and identifying running processes; Log files. **Or** **Introduction to GIT and LaTEX:** LaTEX:Basic syntax, compiling and creating documents; Document structure including sections and paragraphs; Adding Images, Table ofcontents, Source code, graphs; Adding references, and Bibliography; Installation and Hands-on of LaTEX. GIT: Creating a project using GIT locally, add, commit; Branch and Merge; Cloning a remote repo, working with a remote repo; Working on a project in a distributed fashion; Hands-on of GIT.	8
	Total	**30**

Text Books:

2. Christine Bresnahan, Richard Blum ―Linux Essentials, Sybex, ISBN 9781119092063
3. Sumitava Das, Unix Concepts and Applications, Tata-McGraw Hill, ISBN 0-07-063546-3

Reference Books:

Christine Bresnahan, Richard Blum –Linux command line and Shell Scripting Bible -Weilly , ISBN-978-0- 470-25128-7

Program:	M.Tech (Computer Engineering)				Semester : II	
Course :	Design with UML (Open Elective-II)				Code: MCE2602C	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior knowledge of:

a. Basic understanding of computer programming
b. Related programming paradigms…….are essential

Course Objectives:

1. To introduce the concept of Object-oriented design
2. To understand and differentiate Unified Process from other approaches
3. To design static and dynamic UML diagrams

Course Outcomes:

After learning the course the students should be able to:

1. Understand Basic features and elements of the object-oriented approach
2. Identify, analyze, and model structural and behavioral concepts of the system.
3. Apply the concepts of architectural design for deploying the code for software.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	Introduction to UML: Importance of modeling, principles of modeling, object-oriented modeling, conceptual model of the UML, Architecture, Software Development Life Cycle	7
2.	Basic Structural Modeling: Classes, Relationships, common Mechanisms, and diagrams. Advanced Structural Modeling: Advanced classes, advanced relationships, Interfaces, Types and Roles, Packages. Class & Object Diagrams	8
3.	Basic and Advanced Behavioral Modeling: Interactions, Interaction diagrams. Use cases, Use case Diagrams, Activity Diagrams. Advanced Behavioral Modeling Events and signals, state machines, processes and Threads, time and space, state chart diagrams.	7
4.	Architectural Modeling: Component, Deployment, Component diagrams and Deployment diagrams. Common modeling techniques	8
	Total	**30**

Text Books:

1. Grady Booch, - The unified modeling language user guide. Pearson Education India, ISBN: 0-201-57168
2. James Rumbaugh. Micheal Blaha- Object-Oriented Modeling and Design with UML: Pearson Education India, ISBN-13: 978-0130159205

Reference Books:

2. Charles Ritcher - Designing Flexible Object-Oriented systems with UML. New Riders Publishing.
3. Jackson, Burd Thomson - Object Oriented Analysis & Design. Thomson Course Technology.
4. Mike O'Docherty - Object-Oriented Analysis and Design: using UML. Wiley Publication
5. Joseph Schmuilers - Teach Yourself UML in 24 Hours. Sams publishing.

Program:	M. Tech. (Construction Management)				Semester : II	
Course :	Contracts, Tendering & Arbitration (Open Elective-II)				Code : MCI2602A	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior knowledge of: None

Course Objectives:

1. To equipped with knowledge of contracts system.
2. To study principles and specifications for making tender documents
3. To learn basic principles of Arbitration in the context of various construction aspects.

Course Outcomes:

After learning the course, the students should be able to:

1. Adopting the ethical knowledge for making construction contracts & Tenders.
2. Prepare Tendering documents as per conditions of contract.
3. Exhibit concept of Arbitration to resolution of disputes in construction projects.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Construction Contracts:** Indian Contract Act (1872): Definition of the contract as per the ACT. Valid, Voidable, Void contracts, Objectives of the act. Introduction: To law, Indian legal system, Laws governing structure & Working of Construction Organization Firms, Laws of Tort.	7
2.	**Construction Contract Documents:** Evaluation of contract documents, need for documents, present stage of national and international contract documents, types of construction contracts, roles and functions of parties to the contract. Contract Formation.	8
3.	**Stages in Contracting:** Preparation of tender documents estimating, pre - qualification, bid evaluation, award of contract, project financing and contract payments, contracts close out and completion.	7
4.	**Arbitration:** Comparison of Actions and Laws - Agreements, subject matter-Violations- Appointment of Arbitrators-Conditions of Arbitrations-Powers and duties of	8
	Total	30

Text Books:

1. Civil Engineering Contracts and Estimates - B.S.Patil – Universities Press- 2006 Edition,reprinted in 2009.
2. The Indian Contract Act (9 of 1872), 1872- Bare Act- 2006 edition, Professional Book Publishers.
3. The Arbitration and Conciliation Act,(1996), 1996 (26 of 1996)- 2006 Edition, professional Book Publisher.

Reference Books:

1. Law of contract Part I and Part II, Dr. R.K. Bangia- 2005 Edition, Allahabad Law Agency.
2. Arbitration, Conciliation and Alternative Dispute Resolution Systems- Dr. S.R. Myneni- 2004 Edition, reprinted in 2005- Asia Law House Publishers.
3. The Workmen_s Compensation Act, 1923 (8 of 1923) Bare Act- 2005- Professional Book Publishers.
4. Standard General Conditions for Domestic Contracts- 2001 Ministry Of Statistics and Program Implementation, Government of India.
5. FIDIC Document (1999).
6. Dispute Resolution Board foundation manual-www.drbf.org. 30 Edition

Program:	M. Tech. (Civil) Construction Management				Semester : II	
Course :	Total Quality Management (Open Elective-II)				Code : MCI2602B	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
2	2	2	20	--	30	50

Prior knowledge of:

a. TQM & MIS at UG Level
b. Awareness of Quality Construction Aspects …….are essential

Course Objectives:

1. To **understand** the need of QM in construction and **apply** necessary tools to achieve
2. To **apply** necessary trainings for the effective utilization of resources
3. To **apply** effectively the eight principles of ISO for quality processes in construction
4. To **apply** Six Sigma tool for TQM in construction project

Course Outcomes:

After learning the course, the engineers should be able to:

1. Understand and apply the TQM philosophy in construction
2. Able to use effectively QC tools.
3. Apply ISO principles for effective Quality processes in construction
4. Able to apply Six Sigma effectively.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Concepts of Quality** A) Definition of quality as given by Deming, Juran, Crosby, difference between Quality control, Quality Assurance (QA/QC). Total quality control (TQC) and Total Quality Management (TQM), Need for TQM in construction industry. Organization necessary for implementation of quality, Quality manual-Contents, data required, preparation, responsibility matrix, monitoring for quality-PDCA Cycle. Quality aspects in every phase in the life cycle of Construction project.	7
2.	**Quality Control Tools** Histogram, Pareto diagram, Fish-bone diagram, Quality control chart-Testing required for quality control of construction material used in RCC Work- destructive and Non destructive Test (NDT). Statistical Quality Control-Necessity, Benchmarking.	8
3.	**Study of ISO 9004- Quality System Standards.** Purpose of ISO Standards. Difference between ISO 9001 and ISO 9004. Certification process for ISO 9001. Certification bodies involved. Eight Principles of ISO-Basic meaning, applying these principles for an effective quality process in the organization. Management support and commitment necessary for achieving implementation for quality system standards. **Development** of quality circles, quality inspection team, inspection reports, monitoring and control, 360_ feedback for quality.	8
4.	**A) Six Sigma** Definition of six sigma, evolution – Historical aspects, probability distribution Six sigma ratings, Six sigma training, six sigma as an effective tool in TQM. **B) Application of Six Sigma** i) RCC Work in building (ii) Assessment of overall construction process from concept to completion of a construction project.	7
	Total	30

Text Books:

1. Quality Control and Total Quality Management by P.L.Jain- Tata McGraw Hill Publ.Company Ltd 2.
2. Total Engineering Quality Management – Sunil Sharma – Macmillan India Ltd.
3. 3.Total Project Management – The Indian Context - P.K.Joy Macmillan India Ltd.

Reference Books:

1. International Standards Organization – ISO 9001 and ISO 9004
2. Mantri Handbook – A to Z of Construction – Mantri Publications
3. Juran_s Quality Handbook – Joseph M. Juran, A. Blanton. Godfrey – Mcgraw Hill International Edition (1998)
4. Management Information Systems – Gordon B. Davis, Margrethe H. Olson – Tata McGraw Hill Publ. Co.

Program:	M. Tech. (Civil Engineering)	Semester : II
Course :	Operations Research (Open Elective-II)	Code : MCI2602C

Teaching Scheme			Evaluation Scheme			
Lecture	Hour s	Credit	IE 1	IE2	ETE	Total
2	2	2	20	-	30	50

Prior knowledge of:

a. Applied Mathematics Including Calculus and
b. Linear Algebra, Calculus-Based Probability/Statistics…….are essential

Course Objectives: This course aims at enabling students,

1. To familiarize with concepts and techniques of Linear and Nonlinear Programming Problems.
2. To derive feasible and optimal solution for Transportation and Assignment Problem.
3. To apply various methods to select and execute various optimal strategies using decision theory.
4. To construct network diagrams with single and three time estimates of activities involved in the project.

Course Outcomes: After learning the course, the students should be able to:

1. Model and solve Linear and Nonlinear Programming Problems.
2. Model & Solve profit maximization Transportation and Assignment Problem.
3. Apply various methods to select and execute various optimal strategies using decision theory.
4. Calculate Project schedule and expected completion time for the project.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Introduction to Operations Research** Introduction, operations research approach to problem solving, Models and Modelling in operations research, Advantages, Methods for solving operations research models, Methodology of operations research, Advantages. **Linear Programming** Introduction, Structure of Linear programming Model, Advantages, Limitations, Assumptions and Applications of Linear programming, Guidelines for Model Formulation, Solving Linear programming problems using Graphical Method and Simplex Method	7
2.	**Transportation and Assignment Problems** Mathematical Models of Transportation Problem, The Transportation Algorithm, Methods for Finding Initial Solution, Test for Optimality. Mathematical Models of Assignment Problem, Solution Methods of Assignment Problem.	8
3.	**Decision Theory and Games Theory** Steps of Decision-Making Process, Types of Decision- Making Environment, DecisionMaking Under Uncertainty, Games Theory: Introduction, Two Person Zero Sum Games, Pure Strategies (Minimax and Maximin Principles): Games with Saddle Point, Mixed Strategies: Games without Saddle Point, The Rules of Dominance, Solution Methods of Games without Saddle Point.	7
4.	**Project Management** Introduction, Basic Difference between PERT and CPM, Phases of Project Management, PERT/CPM Network Components and Precedence Relationships, Critical Path Analysis. Project scheduling with uncertain activity times, Estimation of project completion time.	8
	Total	**30**

Text Books:

1. J K Sharma, "Operations Research: Theory and Applications" , Trinity Press 5th Edition ISBN No. 9789350593363.
2. Frederick S. Hillier, Gerald Lieberman, "Introduction to Operations Research, McGraw Hill", 6th Edition ISBN No.0071139893.

Reference Books:

1. Gerald Lieberman, "Operations Research: An Introduction", PHI, 9th Edition, ISBN No. 978- 9332518223.
2. Gupta Prem Kumar and Hira D.S, "Problems in Operations Research", S. Chand, ISBN No.978- 8121909686.
3. Wayne L. Winston, "Operations Research Applications and Algorithms", Cengage Learning, 4th Edition, 1987
4. P Sankara Iyer, "Operations Research", Sigma Series, TMH, 1st Edition, ISBN No.978-0070669024.

Program:	M. Tech. (Artificial Intelligence and Data Science)				Semester: II	
Course :	Python for Data Science (Open Elective-II)				Code : MDS2602A	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	-	30	50

Prior knowledge of:

a. Python basics
b. .Statistical and numerical methods…….are essential

Course Objectives:

1. Apply various Python data structures to effectively manage various types of data.
2. Explore various steps of data science pipeline with role of Python
3. Design applications applying various operations for data cleansing and transformation.
4. Use various data visualization tools for effective interpretations and insights of data.

Course Outcomes: After learning the course, the students should be able to:

1. Gain an in-depth understanding of data science processes and the basics of statistics.
2. Explain the essential concepts of Python programming.
3. Perform high-level mathematical computations.
4. Perform data analysis and manipulation.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Overview of Python and Data Structures:** Basics of Python including data types, variables, expressions, objects and functions. Python data structures including String, Array, List, Tuple, Set, Dictionary and operations them	**6**
2.	**Data Science and Python:** Discovering the match between data science and python: Outlining the core competencies of a data scientist, Linking data science, big data, and AI, Understanding the role of programming, Creating the Data Science Pipeline, Preparing the data, Performing exploratory data analysis, Learning from data, Visualizing, Obtaining insights and data products, Understanding Python's Role in Data Science, Introducing Python's Capabilities and Wonders: Why Python?, Grasping Python's Core Philosophy, Contributing to data science, Discovering present and future development goals, Working with Python, Getting a taste of the language, Understanding the need for indentation, Working at the command line or in the IDE, Performing Rapid Prototyping and Experimentation, Considering Speed of Execution, Visualizing Power, Using the Python Ecosystem for Data Science, Accessing scientific tools using SciPy, Performing fundamental scientific computing using NumPy, Performing data analysis using pandas, Implementing machine learning using Scikit-learn, Going for deep learning with Keras and TensorFlow, Plotting the data using matplotlib, Creating graphs with NetworkX, Parsing HTML documents using Beautiful Soup.	**9**
3.	**Data Visualization:** Visualizing Information: Starting with a Graph, Defining the plot, Drawing multiple lines and plots, Saving your work to disk, Setting the Axis, Ticks, Grids, Getting the axes, Formatting the axes, Adding grids, Defining the Line Appearance, Working with line style, Using colors, Adding markers, Using Labels, Annotations, and Legends, Adding labels, Annotating the chart, Creating a legend.	**7**
4.	**Data Wrangling:** Wrangling Data: Playing with Scikit-learn, Understanding classes in Scikit-learn, Defining applications for data science, Performing the Hashing Trick, Using hash functions, Demonstrating the hashing trick, Working with deterministic selection, Considering Timing and Performance, Benchmarkin, with,timeit, Working with the memory profiler, Running in Parallel on Multiple Cores, Performing multicore parallelism, Demonstrating multiprocessing.	**8**
	Total	**30**

Text Book

1. Python for data science for dummies 2nd Edition, John Paul Mueller, Luca Massaron, Wiley
2. Programming through Python, M. T. Savaliya, R**. K. Maurya**, G. M. Magar, STAREDU Solutions
3. Pandas for everyone :Python Data Analysis, Daniel Y. Chen, Pearson

Reference Book

1. Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools Davy Cielen, Arno D.B. Meysman, Mohamed Ali

Program:	M. Tech. (Artificial Intelligence & Data Science)				Semester : II	
Course :	Introduction to Neural Networks (Open Elective-II)				Code : MDS2602B	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
2	2	2	20	-	30	50

Prior knowledge of :

a. Linear Algebra
b. Mathematics……..are essential

Course Objectives:

1. The main objective of this course is to provide the student with a basic understanding of neural networks fundamentals
2. Program the related algorithms and Design the required and related systems

Course Outcomes: After learning the course, the students should be able to:

1. Demonstrate ANN structure and activation Functions
2. Define foundations and learning mechanisms and state-space concepts
3. Identify structure and learning of perceptions
4. Explain Feed forward, multi-layer feed forward networks and Back propagation algorithms
5. Analyze Radial Basis Function Networks, Regularization and RBF networks
6. Explain the Self Organizing Map

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Introduction to Neural Networks:** Introduction and ANN Structure, Biological neurons and artificial neurons. Model of an ANN. Activation functions used in ANNs. Typical classes of network architectures.	6
2.	**Mathematical Foundation** Mathematical Foundations and Learning mechanisms. Re-visiting vector and matrix algebra, State-space concepts, Concepts of optimization, and Error-correction learning. Memory-based learning, Hebbian learning. Competitive learning.	8
3.	**Perceptrons** Single-layer perceptrons, Structure and learning of perceptrons, Pattern classifier, introduction and Bayes' classifiers, Perceptron as a pattern classifier, Perceptron convergence. Limitations of a perceptrons.	7
4.	**Feed Forward and Backpropagation NN:** Feed forward ANN, Structures of Multi-layer feed forward networks. Back propagation algorithm, Back propagation - training and convergence, Functional approximation with back propagation. Practical and design issues of back propagation learning	9
	Total	30

Text Books:

1. Introduction to Artificial Neural Systems, Jacek Zurada, West Publishing Company
2. Simon Haykin, "Neural Networks: A comprehensive foundation", Second Edition, Pearson Education Asia.
3. Satish Kumar, "Neural Networks: A classroom approach", Tata McGraw Hill, 2004

Reference Books:

1. Neural Networks: A Systematic Introduction, Raúl Rojas, 1996
2. Pattern Recognition and Machine Learning, Christopher Bishop, 2007

MOOC Courses-

1. Deep Learning Part-I, Swayam Prof.Mitesh M. Khapra
2. Neural Networks and Deep Learning, Coursera, Andrew Ng
3. Deep Learning for Computer Vision, Prof. Vineeth N Balasubramanian

Program:	M. Tech Mechanical (Design Engineering)				Semester : II	
Course :	Skill Development Lab - II (Soft Skills and English Aptitude)				Code: M_2101	
Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	TW	PR	OR	Total
2	2	2	50	--	-	50

Course Objectives:

1. To facilitate holistic growth
2. To make the students aware about the significance of Soft Skills and English Aptitude
3. To develop the ability of effective communication through individual and group activities
4. To expose students to right attitude and behavioral aspects and build the same through various activities

Course Outcomes:

After learning the course the students should be able to:

1. Express effectively through verbal/oral communication skills
2. Prepare for group discussions/meetings/interviews and presentations
3. Operate effectively in multi-disciplinary and heterogeneous teams through the knowledge of team work, inter personal relationships, conflict management and leadership activities

Guidelines :

1. Total experiments to be conducted are Six **out of eight**
2. **Total : 6 experiments 12 hours**

Detailed Syllabus:

Skill Development Lab (ANY Five)

Expt	Description	Duration, (H)
1.	**Group Discussion:** Make students aware of proper and globally accepted ethical way to handle work, colleagues and clients. Develop group communication skills. Learn to speak up one's opinion in a forum. Cultivate the habit of presenting solution-driven analytical arguments making them contributors in any team.	3
2.	**Public Speaking:** Any one of the following activities may be conducted: **1. Prepared speech** (Topics are given in advance, students get 10 minutes to prepare the speech and 5 minutes to deliver.) **2. Extempore speech** (Students deliver speeches spontaneously for 5 minutes each on a given topic)	3
3.	**Writing An Article On Any Social Issue:** Build writing skills, improve language and gain knowledge about how to write an article/ report	3
4.	**Reading and Listening skills:** The batch can be divided into pairs. Each pair will be given a article by the facilitator. Each pair would come on the stage and read aloud the article one by one. After reading by each pair, the other students would be asked questions and needful corrections in the article. The facilitator can evaluate the students for reading and listening skills.	3
5.	**Debate On Current Affairs/ Social Relevance Topics:** Cultivate the habit to present forceful arguments while respecting the opponent's perspective and enhance verbal skills.	3
6.	**Telephonic etiquettes:** To teach students the skills to communicate effectively over the phone. Students will be divided into pairs. Each pair will be given different situations, such as phone call to enquire about job vacancy, scheduling a meeting with team members, phone call for requesting of urgent leave from higher authorities. Students will be given 10 min to prepare. Assessment will be done on the basis of performance during the telephone call.	3
7.	**Email etiquettes:** To provide students with an in-depth understanding of writing formal emails.	3
8.	**Mock interviews:** Guide students and conduct mock interviews	3
	Total	15

Text Books:

1. B. Mitra, Personality Development and Soft Skills
2. *S. Lucas,The Art of Public Speaking*

Reference Books:

1. M. Weaver, Empowering Employees Through Basic Skills
2. G. Ratigan, Aced: Superior Interview Skills to Gain an Unfair Advantage to Land Your DREAM JOB!

Audit Course-II Syllabus

Program:	M.Tech. (Design Engineering)			Semester :	I and II	
Course :	Audit Courses (Semester I and II)			Code :	M_1961 M_2962	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
1	1	--	--	--	--	--

Guidelines:

4. **The audit courses are common to all M.Tech Courses.**
5. **Students can select any audit course from list of audit courses for semester I and II**
6. **These are non-credit courses but mandatory to comply the submission of the semester.**

LIST OF AUDIT COURSES
(Common to M.Tech and MCA programs)

	SEM-II
M_2962A	Team Building & Leadership
M_2962B	English for Research writing
M_2962C	Disaster Management

Program	M.Tech(All Branches)/MCA				Semester: II	
Course:	Team Building & Leadership (Audit Courses-II)				Code: M_2962A	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE 1	IE 2	ETE	Total
1	1	-	--	--	--	--

Course Objectives:

1. Develop and strengthen interpersonal skills
2. Become familiar with and discuss different leadership models.
3. Familiarize students with the characteristics of team building.

Course Outcomes:

After learning the course, the students should be able to:

1. Use leadership and teamwork knowledge to develop projects.
2. To develop the capacity to work collaboratively in a team

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Leadership:** Will and motivation, Personal leadership, self-knowledge, and self-control, using power responsibly and respectfully: the leader as a team-builder, Ability to plan future actions and transmit that vision to others. Taking the initiative and stimulate others. What the word "leader" means, Types of leadership, Traditional, legal, and legitimate leader. Categories: autocratic, democratic, charismatic, paternalistic, authentic, spiritual, dictatorial, etc.	6
2.	**Team work** Why is teamwork important? The evolution from group to team: development stages. Advantages and disadvantages of teamwork. How to determine roles in a team. Traditional vs. virtuoso teams, forming effective and balanced teams, Strengthening teams within the organization. Creating a friendly and collaborative environment. Strategies to develop the team's mission, vision, values, and objectives. Shared objectives vs. personal motivation. Distinguishing purpose and tasks in the team. Encouraging participation. Creating team identity, creating high-performing teams.	6
	Total	12

Text Books

1. Stephen Covey, The Seven Habits of Highly Effective People, Free Press, 1989.
2. Ronald A. Heifetz, Leadership without Easy Answers, Belknap Press, 1994.
3. Michael E. Porter, Competitive Strategy, Free Press, 1980.

Reference Books:

1. John Kotter, Leading Change: Why Transformation Efforts Fail,
2. Ikujiro Nonaka, The Knowledge-Creating Company
3. Michael West, The Secrets of Successful Team Management, Chap. 2, "Self-Management," pgs. 32-61

Program	M.Tech(All Branches)/MCA				Semester: II	
Course :	English For Research Paper Writing (Audit Courses-II)				Code : M_2962B	
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE1	IE2	ETE	Total
1	1	-	--	--	--	--

Course Objectives:

1. Understand that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title
4. Ensure the good quality of paper at very first-time submission

Course Outcomes:

After learning the course the students should be able to:

1. Develop the ability to plan and prepare and research papers and reports
2. Write a research article, review article, thesis chapter and other related academic research text effectively

Detailed Syllabus:

Unit	Description	Duration (H)
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness, Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Writing the Introduction, Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	6
2	Key skills needed: Title, Abstract, Introduction, Review of the Literature, Methods, Results, Discussion, Conclusions, Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission	6
	Total	12

Text Books:

1. Dey R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press

Reference Books:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book .
3. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

Program	M.Tech(All Branches)/MCA			Semester: II		
Course :	Disaster Management (Audit Courses-II)			Code : M_2962C		
Teaching Scheme			Evaluation Scheme			
Lecture	Hours	Credit	IE-1	IE2	ETE	Total
1	1	-	--	--	--	--

Course Objectives:

1. To orient engineers about various natural and manmade disasters.
2. To teach the concept of Disaster management and measures to be taken at different stages of disaster
3. Management. To provide insight about global, national and regional level scenario of disaster management.

Course Outcomes:

After learning the course the students should be able to:

1. Learn different disasters and measures to reduce the risk due to these disasters.
2. Learn institutional frame work for disaster management at national as well as global level.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Introduction** – Hazard and Disaster. Concepts of Hazard, Vulnerability, Risks. Different Types of Disaster : A) Natural Disaster: such as Flood, Cyclone, Earthquakes, Landslides etc B) Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea, Rail & Road), Structural failures(Building and Bridge), War & Terrorism etc. Slow Disasters (famine, draught, epidemics) and Rapid Onset Disasters(Air Crash, tidal waves, Tsunami) Causes, effects and practical examples for all disasters.	6
2.	**Natural disasters**- Earthquakes, Tsunami, Floods, Drought, Landslides, Cyclones and Volcanic eruptions. Their case studies. Coastal disasters. Coastal regulation Zone. **Disaster Prevention and Mitigation**. Refugee operations during disasters, Human Resettlement and Rehabilitation issues during and after disasters, Inter-sectoral coordination during disasters, Models in Disasters. **Disaster Management** : Role of Government, International and NGO Bodies. Role of IT in Disaster Preparedness Role of Engineers on Disaster Management.	6
	Total	12

Reference Books:

1. Pandey, M., 2014. Disaster Management, Wiley India Pvt. Ltd., 240p.
2. Tushar Bhattacharya, Disaster Science and Management, McGraw Hill Education (India) Pvt. Ltd
3. Jagbir Singh, Disaster, Management: Future Challenges and Opportunities, K W Publishers Pvt. Ltd.
4. J.P. Singhal, Disaster Management, Laxmi Publications
5. C. K. Rajan, Navale Pandharinath, Earth and Atmospheric Disaster Management : Nature and Manmade, B S Publication
6. Shailesh Shukla, Shamna Hussain, Biodiversity, Environment and Disaster Management, Unique Publications

Text Books:

1. Disaster Administration and Management, Text & Case studies- SL Goel-Deep and Deep Publications
2. Disaster Management- G.K Ghosh-A.P.H. Publishing Corporation
3. Disaster management – S.K.Singh, S.C. Kundu, Shobha Singh A – 119, William Publications, New Delhi.
4. Disaster Management – Vinod K Sharma- IIPA, New Delhi,1995
5. Encyclopedia of Disaster Management- Goel S.L. - Deep and Deep Publications, New Delhi, 2006.

Course Syllabus

Semester-III

Program:	M. Tech. (Mechanical) – Design Engineering				Semester: III	
Course :	Dissertation Phase – I [Company/ In-house project]				Code : MMD3702	
Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	IE2	TW	OR	Total
20	20	10	--	100	100	200

Prior knowledge of:

1. Basic knowledge of Mechanism and Machine Design,
2. Mechanical system design,
3. Basics of Analysis software,
4. MATLAB programming……are essential

Course Objectives:

1. To understand the product/process development including budgeting.
2. To plan for various activities of the major project and channelize the work towards product /process development.
3. To enable students to apply the knowledge about research design and methods to develop their project.
4. To inculcate research culture in students for their technical growth.

Course Outcomes:

After learning the course the students should be able to:

1. Understand, plan and execute an original Project work with appreciable research outcomes.
2. To integrate theory and practice in relation to the identified area of study.
3. To demonstrate research skills in the chosen area of study.
4. Prepare good quality technical report based on the project.
5. Publish good quality paper in reputed journal and present their work in reputed conferences.

Guidelines :

1. Individual student need to design and demonstrate project under the guidance of allocated guide.
2. Sponsored Project or Project Internship is acceptable considering postgraduate scope.
3. The physical / soft model and validation of results is compulsory.
4. Project Report-1 should be submitted as a compliance of term work associated with subject.
5. At least 2 paper publications are expected as research outcome of Project Stage-I (Conference or reputed journal) and 40% of planned project work should be completed for submission of Dissertation Phase-I
6. Total Duration: 120 hours are contact hours with guides and for reviews; 120 hours are expected to be spend by students to satisfy all project requirements and implementations.

Plan of Activities

Sr. No.	Activity	Duration, H
1.	Week 1, 2 and 3: Guide allotment, applying for sponsorship and project internship, finalization of topic and platform, Planning of the work.	40
2.	Week 4 & 5: Literature review, objectives and methodology Finalization, Review 1 for finalization of topic and objectives.	25
3.	Week 6, 7 & 8: understanding, analytical / numerical calculations and design of components, Review 2 to understand the progress of the project	40
4.	Week 9 & 10: preparation of the experimentation plan and measurement system for experimentation	25
5.	Week 11 & 12: Project Report writing and publication or copyright planning and execution. Demonstration of Project work and Final Review for submission and term work compliances	20
	Total	150

Program:	M. Tech (Mechanical) – Design Engineering	Semester :	III
Course :	Seminar	Code :	MMD3703

Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	IE2	TW	OR	Total
4	4	2	--	50	50	100

Guidelines :

1. Individual student needs to study recent topics in the field of Design Engineering under the guidance of allocated guide.
2. Students can choose topic related to design of mechanical system considering recent trends and its societal importance.
3. The extensive Literature Survey, Mathematical Modeling of particular method and valuable conclusion is expected from seminar study.
4. Seminar Report should be submitted as a compliance of term work associated with subject.
5. At least 1 review paper publication is expected as research outcome of seminar.
6. Total Duration: 24 Contact Hours and 24 Hours should be spent by students on completion of related activities and requirements.

Course Outcomes

1. To acquire the basic skills to for performing literature survey and paper presentation
2. To provide students better communication skills
3. To describe the current topics in the domain of study based on recent publications
4. To be able to write a report

Seminar Activities

Sr. No.	Activity	Duration, (H)
1.	Week 1, 2 & 3: Guide allotment, finalization of topic, Planning of the work. Review-1 conduction	8
2.	Week 4 & 5: Literature review and methodology of the selected topic.	5
3.	Week 6, 7 & 8 : Mathematical model and findings and its analysis Review-2 conduction	8
4.	Week 9 & 10 : Comparison of findings with findings in literature	5
5.	Week 11 & 12: Seminar Report writing and publication or copyright planning Final Review conduction.	4
	Total	24

Program:	M. Tech (Mechanical) – Design Engineering		Semester : III			
Course :	Internship [Company / In-house project]		Code : MMD3801			
Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	IE2	TW	OR	Total
4	4	2	-	100	-	100

Guidelines :

1. Individual student need to attempt for internship with the help of PCCOE T&P cell in the field of Mechanical Design under the guidance of allocated guide.
2. If not get selected for any internships, student can choose extension of mini-project / entrepreneurship opportunity from PCCOE, related to Mechanical design considering recent trends and its societal importance.
3. The idea presentation is expected from the student based on the topic.
4. Internship report should be submitted as a compliance of term work associated with subject.
5. Total Duration: 24 Contact Hours and 24 Hours should be spent by students on completion of related activities and requirements.

Detailed Syllabus:

Internship / In-house / Entrepreneurship activity

Sr. No.	Activity	Duration, (H)
1.	Week 1, 2 and 3: Guide allotment, Application of internships, finalization of topic, Planning of the work. Review-1 conduction	6
2.	Week 4 & 5: Internship/ Mini-project/ Entrepreneurship activity implementation as per requirements	4
3.	Week 6, 7 & 8 : Review-2 of Activities	6
4.	Week 9 & 10: Interaction of Guides with Industry, Poster Presentation	4
5.	Week 11 & 12: Internship Report writing and publication or copyright planning Final Review conduction.	4
	Total	24

Program:	M. Tech. Mechanical (Design Engineering)			Semester :	III	
Course :	MOOCs			Code :	MMD3981	
Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	IE2	TW	OR	Total
4	4	2	-	100	-	100

Guidelines :

1. Individual student needs to register for MOOC course of their interest or Entrepreneurship related trainings.
2. Weekly assignments need to be completed regularly as per requirement of course, which will be considered for internal assessment of course.
3. The certification of course or training is mandatory.
4. Oral presentation of course/ training will be taken at the end of semester
5. Total duration: 24 contact hours and 24 hours should be spent by students on completion of related activities and requirements.

Program:	M. Tech. (Design Engineering)				Semester : III	
Course :	Entrepreneurship				Code: MMD3981	
Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	IE2	TW	OR	Total
4	4	2	-	100	-	100

Prior knowledge of:

a. Any Engineering Graduate with Innovation
b. Design thinking knowledge…….are essential

Course Objectives:

1. To acquaint with Entrepreneurial qualities.
2. To apply entrepreneurship in Engineering Courses.
3. To imbibe Entrepreneurial capabilities in engineering students.

Course Outcomes:

After learning the course, the students should be able to:

1. Motivate students to think about Entrepreneurship alternative to employment.
2. Registering students for Startup / Udyam registration of MSME.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	Introduction to Entrepreneurship and its importance	5
2.	Achievement Motivation. Case Studies of Indian Entrepreneurs	5
3.	Product Identification, Market Survey	5
4.	Whom to contact for what? Financial Management,	5
5.	Business Planning	5
6.	Project Report preparation	5
	Total	30

Reference Books:

1. Entrepreneurial Development by Vasant Desai, Himalaya publication
2. *Entrepreneurship Development and Small Business Enterprise*. Poornima M. Charantimath. Pearson Education India, 2005
3. *Dynamics* of *entrepreneurial development* and *management* : *Entrepreneurship, project management, finances, programmes,* and *problems*. by *Vasant Desai*.
4. *Course Material by EDII, Ahmedabad*

Experiment List: Project Report preparation for an Enterprise and Udyam Registration.2

Course Syllabus

Semester-IV

Program:	M. Tech (Mechanical) – Design Engineering			Semester :	IV	
Course :	Dissertation Phase – II [Company/ In-house project]			Code :	MMD4704	
Teaching Scheme			Evaluation Scheme			
Practical	Hours	Credit	IE2	TW	OR	Total
24	24	12	-	200	200	400

Prior knowledge of:

a. Basic knowledge of Mechanism and Machine Design,
b. Mechanical system design,
c. Basics of Analysis software,
d. MATLAB programming…….are essential

Course Objectives:

1. To understand the Product Development Process including budgeting.
2. To plan for various activities of the major project and channelize the work towards product development.
3. To build, design and implement real time application using available platforms.
4. To inculcate research culture in students for their technical growth.

Course Outcomes:

After learning the course the students should be able to:

1. Understand, plan and execute an original Project work with appreciable research outcomes.
2. To integrate theory and practice in relation to the identified area of study.
3. To demonstrate research skills in the chosen area of study.
4. Prepare good quality technical report based on the project.
5. Publish good quality paper in reputed journal and present their work in reputed conferences

Guidelines :

1. Semester III major project is to be completed in this semester under the guidance of same project guide.
2. Students need to implement the project using suitable computational tools and /or experimental setups.
3. Final Project Report including all process of project should be submitted as a compliance of term work associated with subject and permission to appear for examination.
4. Total 2 Paper publications are expected as research outcome of Project Stage-I and II (Conference or reputed journal) and 100% of planned project work should be completed for submission of Dissertation Phase-II
5. Total Duration: 144 hours are contact hours with guides and for reviews; 144 hours are expected to be spend by students to satisfy all project requirements and implementations.

Plan of Activities

Sr. No.	Activity	Duration, (H)
1.	Week 1 & 2: 60 % Work should be completed, by fabrication the setup	30
2.	Week 3 & 4: experimentation on the setup, generate and compile the results. Review 1 conduction.	30
3.	Week 5 & 6: Paper Publication should be in process or completed during this week, 80% work should be completed.	30
4.	Week 7 & 8: Compliance of 100 % work. Review -2 will be conducted	30
5.	Week 9 & 10: Department Reviews will be conducted to check the quality of project and requirements fulfillment to permit project submission.	30
6.	Week 11 & 12: Project Report writing and copyright planning and execution. Demonstration of Project work and Final Research Review Committee (RRC) reviews will be conducted for submission and term work compliances	30
	Total	**180**

Program:	M. Tech. (Design Engineering)				Semester : IV	
Course :	MOOCs				Code : MMD4982	
Teaching Scheme/week			Evaluation Scheme			
Practical	Hours	Credit	IE2	TW	OR	Total
4	4	2	-	100	-	100

Guidelines :

1. Individual student needs to register for MOOC course of their interest or Entrepreneurship related training.
2. Week assignment needs to be regularly completed as per requirement of course, which will be considered for internal assessment of course.
3. The certification of course or training is mandatory.
4. Oral and Presentation of course/ training will be taken at the end of semester
5. Total Duration: 24 Contact Hours and 24 Hours should be spent by students on completion of related activities and requirements.