MOHAN BABU UNIVERSITY

Sree Sainath Nagar, Tirupati – 517 102

SCHOOL OF ENGINEERING

M.Tech. - Machine Design

CURRICULUM AND SYLLABUS

(For 2022-23 Admitted Students)

FULLY FLEXIBLE CHOICE BASED CREDIT SYSTEM (FFCBCS)

MOHAN BABU UNIVERSITY

Vision

To rise as one of the greatest hubs of innovation and entrepreneurship in the country, wherein students empower themselves with the best of knowledge, unleash their potential to the fullest, and soar high to attain a brighter future for themselves and the nation.

Mission

- To provide relevant knowledge founded on the spirit of curiosity, compassion, courage and commitment.
- To uphold novelle wings of leadership and excellence under expert mentors who guide students towards wisdom and knowledge.
- To create a dynamic learning environment that empowers learners with the right blend of passion and purpose to build a glorious tomorrow.

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

To be a premier Centre of Excellence in the field of Mechanical Engineering by synergizing teaching, learning and research to produce competent Mechanical Engineers for the society.

MISSION

- Impart quality education to create globally competitive mechanical engineers for multicultural and multidisciplinary environments through the contemporary curriculum.
- Develop and maintain the state of art research facilities to enable the faculty and students to address the evolving needs of industry and society.
- Create and maintain a collegial, supportive, and diverse environment that encourages students, faculty, and staff to achieve to the best of their abilities.
- Instil entrepreneurial spirit in students through a multifaceted approach.
- Foster problem solving, leadership, teamwork skills, and the value of commitment, quality and ethical behavior in the students.

M.Tech. - Machine Design

PROGRAM EDUCATIONAL OBJECTIVES

After few years of graduation, the graduates of M. Tech. Machine Design Program would have

PEO 1. Pursued research studies in the core or allied areas.

PEO 2. Successful entrepreneurial or technical career in the core or allied areas of Machine Design.

PEO 3. Adapted evolving technologies in the field of interest by participating in continuing education programs for lifelong learning.

PROGRAM OUTCOMES

On successful completion of the Program, the graduates of M. Tech. Machine Design will be able to:

PO1. Demonstrate mastery of knowledge in Machine Design and other allied areas of the program.

PO2. Design, analyze and simulate mechanical components and systems.

PO3. Select and apply appropriate modern software tools, techniques and resources to model, analyze and design mechanical systems.

PO4. Independently carry out research to deliver solutions for complex problems in the area of Machine Design.

PO5. Communicate effectively in written and oral formats.

PO6. Ability to continuously engage in life-long learning to enhance knowledge and competence.

M.Tech. - Machine Design

Basket Wise - Credit Distribution

Sl. No.	Baskets	Credits (Min.- Max.)
1	SCHOOL CORE	31-34
2	PROGRAM CORE	21-24
3	PROGRAM ELECTIVE	12-18
4	UNIVERSITY ELECTIVE	6
	TOTAL CREDITS	**Min. 70**

School Core (31-34 Credits)

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
		L	T	P	S	C	
22MM201402	Applied Statistics	3	-	-	-	3	-
22EE201001	Research Methodology	3	-	-	-	3	-
22EE201002	Innovation and Intellectual Property Rights	2	-	-	-	2	-
22ME211001	Internship	-	-	-	-	2	-
22ME209001	Project Work Phase - I	-	-	-	-	10	-
22ME210001	Project Work Phase - II	-	-	-	-	14	-
Mandatory Courses (Min. 4 Credits to be earned, Earned Credits will not be considered for CGPA)							
22AI207601	Statistics with R	2	-	-	-	2	-
22LG207601	Technical Report Writing	2	-	-	-	2	-
22MG207601	Project Management	2	-	-	-	2	-
22MG207602	Essentials of Business Etiquettes	2	-	-	-	2	-

Program Core (21-24 Credits)

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
		L	T	P	S	C	
22ME201001	Advanced Machine Design	3	-	-	-	3	-
22ME201002	Advanced Solid Mechanics	3	-	-	-	3	-
22ME201003	Experimental Stress Analysis	3	-	-	-	3	-
22ME201004	Advanced Mechanical Vibrations and Diagnostics	3	-	-	-	3	Experimental Stress Analysis
22ME201005	Advanced Finite Element Analysis	3	-	-	-	3	-
22ME201006	Advanced Optimization Techniques	3	-	-	-	3	-
22ME205001	Design Practice Lab -I	-	-	3	-	1.5	-
22ME205002	Numerical Simulation Lab	-	-	3	-	1.5	-
22ME205003	Design Practice Lab -II	-	-	3	-	1.5	-
22ME205004	Optimization Techniques Lab	-	-	3	-	1.5	-

Program Elective (12 - 18 Credits)

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
		L	T	P	S	C	
22ME201007	Advanced Composite Technologies	3	-	-	-	3	-
22ME201008	Design of Pressure Vessels	3	-	-	-	3	-
22ME201009	Experimental Techniques and Data Analysis	3	-	-	-	3	-
22ME201010	Fracture and fatigue Analysis	3	-	-	-	3	-
22ME201011	Industrial Robotics and Expert Systems	3	-	-	-	3	-
22ME201012	Mechanical Measurements and Controls	3	-	-	-	3	-
22ME201013	Product Design	3	-	-	-	3	-
22ME201014	Theory of Plasticity	3	-	-	-	3	-
22ME201015	Tribology in Design	3	-	-	-	3	-
22ME201016	AI and ML for Mechanical Systems	3	-	-	-	3	-
22ME201017	Computational Fluid Dynamics	3	-	-	-	3	-
22ME201018	Computer Aided Geometric Design	3	-	-	-	3	-
22ME201019	Experimental Modal Analysis	3	-	-	-	3	-
22ME201020	Mechatronics	3	-	-	-	3	-
22ME201021	Multi Body Dynamics	3	-	-	-	3	-
22ME201022	Quality Concepts in Design	3	-	-	-	3	-
22ME201023	Vehicle Dynamics	3	-	-	-	3	-
22ME201024	3D Printing	3	-	-	-	3	-

University Elective (6 Credits)

Course Code	Title of the Course	Lecture	Tutorial	Practical	Project based Learning	Credits	Pre-requisite
		L	T	P	S	C	
22AI201701	Business Analytics	3	-	-	-	3	-
22CM201701	Cost Management of Engineering Projects	3	-	-	-	3	-
22CE201701	Disaster Management	3	-	-	-	3	-
22SS201701	Value Education	3	-	-	-	3	-
22SS201702	Pedagogy Studies	3	-	-	-	3	-
22LG201701	Personality Development through Life Enlightenment Skills	3	-	-	-	3	-

Note:

1. If any student has chosen a course or equivalent course from the above list in their regular curriculum then, he/she is not eligible to opt the same course/s under University Elective.
2. The student can choose courses from other disciplines offered across the schools of MBU satisfying the pre-requisite other than the above list.

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22EE201001	**RESEARCH METHODOLOGY**	3	-	-	-	3

Pre-Requisite --

Anti-Requisite --

Co-Requisite --

COURSE DESCRIPTION:

The course is developed for the students' to understand the underlying concepts of research methodology and a systematic approach for carrying out research in the domain of interest. The course is emphasised on developing skills to recognise and reflect the strength and limitation of different types of research; formulation of the research hypothesis and its systematic testing methods. The course also emphasises on interpreting the findings and research articulating skills along with the ethics of research.

COURSE OUTCOMES: *After successful completion of the course, students will be able to:*

CO1. Demonstrate the underlying concepts of research methodology, types of research and the systematic research process.

CO2. Demonstrate the philosophy of research design, types of research design and develop skills for a good research design.

CO3. Demonstrate the philosophy of formulation of research problem, methods of data collection, review of literature and formulation of working hypothesis.

CO4. Analyse the data and parametric tests for testing the hypothesis.

CO5. Interpret the findings and research articulating skills along with the ethics of research.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	-	3	-	-
CO2	-	-	-	3	-	-
CO3	-	-	-	3	-	-
CO4	-	-	-	3	-	-
CO5	-	-	-	-	3	-
Course Correlation Mapping	**-**	**-**	**-**	**3**	**3**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO RESEARCH METHODOLOGY (08 Periods)

Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research.

Module 2: RESEARCH DESIGN (08 Periods)

Research design—Basic Principles, Need of research design, Features of good design, Important concepts relating to research design, Different research designs, Basic principles of experimental designs, Developing a research plan.

Module 3: RESEARCH FORMULATION (08 Periods)

Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem – Data collection – Primary and secondary sources; Critical literature review – Identifying gap areas from literature review; Hypothesis— Types of hypothesis, Development of working hypothesis.

Module 4: ANALYSIS OF DATA AND HYPOTHESIS TESTING (14 Periods)

Quantitative Tools: Testing and Significance of Measures of Central Tendency, Dispersion; correlation, Principles of least squares—Regression; Errors-Mean Square error, Mean absolute error, Mena absolute percentage errors.
Testing of Hypothesis: Hypothesis Testing Procedure, Types of errors, Parametric testing (t, z and F), Chi-Square Test as a Test of Goodness of Fit; Normal Distribution- Properties of Normal Distribution; Analysis of Variance.

Module 5: INTERPRETATION AND REPORT WRITING (07 Periods)

Interpretation: Meaning of interpretation; Techniques of interpretation; Precautions in Interpretation.
Report Writing –Significance, Different Steps, Layout, Types of reports, Mechanics of Writing a Research Report, Precautions in Writing Reports; Research ethics—Plagiarism, Citation and acknowledgement.

Total Periods: *45*

EXPERIENTIAL LEARNING

1. Should conduct a survey based on a hypothesis, analyze the data collected and draw the inferences from the data.

2. Should review the literature on the given topic and should identify the scope/gaps in the literature and develop a research hypothesis.

3. Should study a case, formulate the hypothesis and identify an appropriate testing technique for the hypothesis.

4. Study an article and submit a report on the inferences and should interpret the findings of the article.

RESOURCES

TEXT BOOKS:

1. C.R. Kothari, Research Methodology: Methods and Techniques, New Age International Publishers, 2nd revised edition, New Delhi, 2004.
2. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. *An introduction to Research Methodology*, RBSA Publishers.

REFERENCE BOOKS:

1. R. Panneerselvam, Research Methodology, PHI learning Pvt. Ltd., 2009.
2. Singh, Yogesh Kumar. *Fundamental of research methodology and statistics*. New Age International, 2006.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/121106007
2. https://onlinecourses.nptel.ac.in/noc22_ge08/preview
3. https://www.youtube.com/watch?v=VK-rnA3-41c

Web Resources:

1. https://www.scribbr.com/category/methodology/
2. https://leverageedu.com/blog/research-design/
3. https://prothesiswriter.com/blog/how-to-formulate-research-problem
4. https://www.formpl.us/blog/hypothesis-testing
5. https://www.datapine.com/blog/data-interpretation-methods-benefits-problems/
6. https://leverageedu.com/blog/report-writing/

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME201004	**ADVANCED MECHANICAL VIBRATIONS AND DIAGNOSTICS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: To provide the fundamental analytical and numerical tools for analysis and modelling of vibration phenomena in discrete and continuum SDOF and MDOF linear systems. Learning of advanced analytical tools and methods for experimental identification of system parameters using recorded data, i.e., frequency domain parameter identification methods.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyse the causes and effects of vibrations in mechanical systems and identify discrete and continuous systems.

CO2. Evaluate mode shapes of multi degree vibration systems using eigen values and eigen vectors.

CO3. Develop governing equations motion for nonlinear and random vibrations.

CO4. Apply various numerical methods to resolve the problems of multi degree vibration systems.

CO5. Analyse and measure the sound level, intensity and power values using Acoustic Analysers, Dosimeter.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	3	-	-
CO2	3	3	2	3	-	-
CO3	3	3	3	2	-	-
CO4	2	2	3	2	-	-
CO5	2	3	3	3	-	-
Course Correlation Mapping	**3**	**3**	**3**	**3**	-	-

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION ***(10 Periods)***

Relevance of and need for vibrational analysis; Basics of SHM, Mathematical modelling of vibrating systems, Discrete and continuous systems, single, degree freedom systems, free and forced vibrations, damped and undamped systems.

Module 2: MULTI DEGREE FREEDOM SYSTEMS ***(09 Periods)***

Free and forced vibrations of millidegree freedom systems in longitudinal, torsional, and lateral modes, Matrix methods of solution, normal modes, Orthogonality Principle, Energy methods, Eigen values and Eigen vectors

Module 3 CONTINUOUS SYSTEMS ***(08 Periods)***

Torsional vibrations, Longitudinal vibration of rods, transverse vibrations of beams, Governing equations of motion, Natural frequencies and normal modes, Energy methods; Introduction to nonlinear and random vibrations.

Module 4 NUMERICAL METHODS **(09 Periods)**

Rayleigh's, Stodola's, Matrix iteration, Rayleigh, Ritz Method and Holzer's methods.

Module 5 NOISE MEASUREMENT AND CONTROL ***(09 Periods)***

Sound Level Meters, Intensity Level Meters, Octave Band Filters Acoustic Analysers, Dosimeter, Measurement of Sound Power, Impact of noise on humans, Weighting, Noise control strategy, sound absorption and insulation.

Total Periods: 45

EXPERIENTIAL LEARNING:

1. Determination of Natural Frequencies & Modal analysis of Machine Components, Equipments to be used: FFT Analyzer, with Impact Hammer or Exciter, Necessary Transducers etc.
2. Problems of Numerical Methods of Vibrations. Assignment on solving vibration problems using MATLAB.

Complete Details will be provided in CHO.

RESOURCES:

TEXT BOOKS:

1. W. T. Thomson and Marie Dillon Dahleh, *Theory of Vibration with Applications,* Pearson Education, 5th Edition, London, 2007.
2. S. S. Rao, *Mechanical Vibrations*, Pearson Education Inc., 5th Edition, USA, 2011.
3. N.C. Nigam, S. Narayan, *Applications of random vibrations*, Narosa Publishing House, New Delhi 1994

REFERENCE BOOKS:

1. V. P. Singh, *Mechanical Vibrations,*DhanpatRai& Company Pvt. Ltd. 3rd Edition, New Delhi 2014.
2. S. Graham Kelly –*Mechanical Vibrations,* Schaum's Outline Series, Tata McGraw Hill, Special Indian Edition, London ,2011.
3. Leonanrd Meirovitch, *Elements of Vibrations Analysis,* Tata McGraw Hill, Special Indian Edition, London ,2011.

VIDEO LECTURES:

1. https://archive.nptel.ac.in/courses/112/103/112103111/

WEB RESOURCES:

1. https://www.iare.ac.in/sites/default/files/lecture_notes/MV_LECTURE_NOTES.pdf
2. https://edurev.in/studytube/Mechanical,Vibrations,Engineering,Mechanics/c8f8b0ad,33cf,444c,b4a2,7e042a30be97t

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME201002	**ADVANCED SOLID MECHANICS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The course is designed to give fundamental knowledge of stress, strain, stress – strain relations, theories of failure and energy methods. Also, provide a firm foundation to the mechanics of deformable solids which will enable the student to analyse and solve a variety of strength-related design problems encountered in engineering practice.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyse various stress components in isotropic and anisotropic materials.

CO2. Analyse the components of strains and it invariants.

CO3. Apply the yield criterions to elasticity and plasticity problems.

CO4. Analyse the axisymmetric problems and stress components in various applications.

CO5. Develop mathematical models of composite materials under different failure criteria's.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	-	-	1	-
CO2	3	3	2	-	1	-
CO3	3	3	-	-	1	-
CO4	2	3	2	-	1	-
CO5	3	3	-		1	-
Course Correlation Mapping	**3**	**3**	**3**	**-**	**1**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: ANALYSIS OF STRESS ***(10 Periods)***

Body Force, Surface Force and Stress Vector, Principal Stresses, Stress Invariants, Principal Planes are Orthogonal, The State of Stress Referred to Principal Axes, The State of Pure Shear, Decomposition into Hydrostatic and Pure Shear States, The Plane State of Stress.

Module 2: ANALYSIS OF STRAIN ***(10 Periods)***

Deformations, Change in Length of a Linear Element—Linear Components, Rectangular Strain Components- The State of Strain at a Point, Interpretation Shear Strain Components, Cubical Dilatation, Principal Axes of Strain and Principal Strains, Plane State of Strain, Compatibility Conditions, Strain Deviator and its Invariants.

Module 3 YIELD CRITERIA AND INTRODUCTION TO IDEALLY PLASTIC SOLID ***(09 Periods)***

Yield Criteria*:* Theories of Failure, Significance of the Theories of Failure, Use of Factor of Safety in Design, a note on the use of Factor of Safety.
Plastic Solid : Ideally Plastic Solid, Stress Space and Strain Space, General Nature of the Yield Locus, Yield Surfaces of Tresca and Von Mises, Prandtl–Reuss Equations, Saint Venant–Von Mises Equations.

Module 4 AXISYMMETRIC PROBLEMS **(08 Periods)**

Thick-Walled Cylinder Subjected to Internal and External Pressures—Lame's Problem, Stresses in Composite Tubes—Shrink Fits, Stresses Due to Gravitation, Rotating Disks of Uniform Thickness, Rotating Shafts and Cylinders.

Module 5 INTRODUCTION TO COMPOSITE MATERIALS ***(08 Periods)***

Stress–Strain Relations, Basic Cases of Elastic Symmetry, Ply Stress and Ply Strain, Failure Criteria of Composite Materials, Pressure Vessels, Transverse Stresses.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Analysed and collect the stress distribution in an automobile crank shaft subjected to various speeds.
2. Evaluate the young's modulus of the metal matrix composite and Laminated matrix composite material.

   Complete Details will be provided in CHO.

RESOURCES

TEXT BOOKS:

1. L. S. Srinath, *Advanced mechanics of solids*, *Tata McGraw-Hill Publishing co. ltd, Second edition, London, 2003.*
2. S. P. Timoshenko, Strength of materials, CBS Publishers, third edition, Vols. 1 & 2, India, 2002.

REFERENCE BOOKS:

1. *S. P. Timoshenko and J N Goodier, Theory of elasticity, McGraw Hill International ,third edition, London, 1970.*
2. G. E. Dieter, *Mechanical metallurgy*, Mc-Graw Hill, third edition, London, 1988.
3. E. P. Popov,*Engineering mechanics of Solids*, Prentice Hall, Second edition, , India, 1998.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/107106080
2. https://nptel.ac.in/courses/107106088

WEB RESOURCES:

1. https://handbook.unimelb.edu.au/2020/subjects/mcen90029#:~:text=The%20goal%20of%20Advanced%20Solid,they%20have%20not%20seen%20before.
2. https://www.brown.edu/Departments/Engineering/Courses/En1750/Notes/notes.html

PROGRAM ELECTIVE

Course code	Course Title	L	T	P	S	C
22ME201007	**ADVANCED COMPOSITE TECHNOLOGIES**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The objective for this course is to understand the mechanics of composite materials. This understanding will include concepts such as anisotropic material behaviour strength theories, micro mechanics and the analysis of laminated composites. The students will undertake a design project involving application of fibre reinforced composites. Failure Criterion for a laminate, design of a laminated composite, static analysis of laminated plates.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Apply different types of manufacturing processes in the preparation of composite materials

CO2. Analyse the two-dimensional angle lamina composite strengths by using various failure theories.

CO3. Analyse the problems on macro mechanical behaviour of Composites

CO4. Analyse the problems on micromechanical behaviour of Composites

CO5. Design and Analyse the laminated composites.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	3	-	-
CO2	3	3	3	3	-	-
CO3	3	3	2	3	-	-
CO4	2	3	3	2	-	-
CO5	2	3	3	3	-	-
Course Correlation Mapping	**3**	**3**	**3**	**3**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO COMPOSITE MATERIALS (10 Periods)

Introduction to Composite Materials: Definition, classification & brief history of composite materials; Constituent of composite materials: Reinforcements, Matrix, Coupling agents, coatings & fillers; Reinforcements: Introduction, Glass Fibers, Boron Fibers, Carbon Fibers, Organic Fibers, Ceramic Fibers, Whiskers, Other Non-oxide Reinforcements, Comparison of Fibers; Matrix Materials**:** Polymers, Metals and Ceramic Matrix Materials.

Module 2: FAILURE THEORIES OF TWO-DIMENSIONAL ANGLE LAMINA (09 Periods)

Engineering Constants of an Angle Lamina, Invariant form of stiffness and compliance matrices for an angle lamina, 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.

Module 3 MACROMECHANICAL ANALYSIS OF A LAMINA (08 Periods)

Introduction, Definitions: Stress, Strain, Elastic Moduli, Strain Energy. Hooke's Law for Different Types of Materials, Hooke's Law for a Two-Dimensional Unidirectional Lamina, Plane Stress Assumption, Reduction of Hooke's Law in Three Dimensions to Two Dimensions, Relationship of Compliance and Stiffness Matrix to Engineering Elastic Constants of a Lamina.

Module 4 MICROMECHANICAL ANALYSIS OF A LAMINA (09 Periods)

Introduction, Volume and Mass Fractions, Density, and Void Content, Evaluation of the Four Elastic Moduli, Strength of Materials Approach, Semi-Empirical Models ,Elasticity Approach, Elastic Moduli of Lamina with Transversely Isotropic Fibers, Ultimate Strengths of a Unidirectional Lamina, Coefficients of Thermal Expansion, Coefficients of Moisture Expansion Micromechanical Analysis of Laminates: Introduction , Laminate Code , Stress–Strain Relations for a Laminate, In-Plane and Flexural Modulus of a Laminate , Hygrothermal Effects in a Laminate, Warpage of Laminates, hybrid laminates.

Module 5 FAILURE, ANALYSIS, AND DESIGN OF LAMINATES (09 Periods)

Introduction, Special Cases of Laminates, Failure Criterion for a Laminate, Design of a Laminated Composite, static analysis of laminated plates

Total Periods: 45

EXPERIENTIAL LEARNING

1. Fabrication/analysis of Fiber reinforced composite material from Bamboo, Flex and Glass Fiber.
2. Fabrication/analysis of Glass Hybrid Fibres Epoxy Composite Material using Hand Layup Method

   Complete details will be provided in CHO.

RESOURCES

TEXT BOOKS:

1. Isaac and M Daniel, *Engineering Mechanics of Composite Materials*, Oxford University Press,*1st edition,* India, 1994.
2. Bhagwan D. Agarwal, Lawrence J. Broutman, K. Chandra shekhara, *Analysis and performance of fibre Composites*, Wiley- Interscience, 4thEdition, New York, 2017.
3. Autar K. Kaw, *Mechanics of Composite Materials*, CRC publications, 2nd Edition,India, 2006.

REFERENCE BOOKS:

1. Robert M. Jones, *Mechanics of Composite Materials*, CRC Press, 2nd Edition, Florid*a,* 2015.
2. L. R. Calcote, *Analysis of Laminated Composite Structures*, Van Nostrand Rainfold, 1st edition, NewYork, 1969.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/112104168
2. https://archive.nptel.ac.in/courses/112/104/112104229/

WEB RESOURCES:

1. https://www.academia.edu/36174281/Lecture_Notes_on_Composite_Materials
2. https://web.eng.fiu.edu/wangc/EGN3365-16.pdf

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME201015	**TRIBOLOGY IN DESIGN**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Tribology deals with friction, wear, and lubrication. This course will approach tribology in terms of both the science of basic mechanisms, and the technologies of design, manufacture and maintenance.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1 Analyse friction, wear, lubrication and their interactions for a given application

CO2 Identify tribological performance parameters on Tribological components

CO3 Identify the type of failures in metallic, ceramic and polymeric surfaces

CO4 Analyze the design and select appropriate tribo components for a given application

CO5 Apply the principles of surface engineering for different applications of tribology.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	3	-	-
CO2	3	2	3	2	-	-
CO3	3	3	2	3	-	-
CO4	2	3	3	2	-	-
CO5	2	3	3	3	-	-
Course Correlation Mapping	**3**	**3**	**3**	**3**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO TRIBOLOGY (10 Periods)

Historical background, practical importance, and subsequent use in the field. Lubricants: Types and specific field of applications. Properties of lubricants; viscosity, its measurement, effect of temperature and pressure on viscosity, lubrication types, standard grades of lubricants, and selection of lubricants.

Module 2: FRICTION AND WEAR (09 Periods)

Friction: Origin, friction theories, measurement methods, friction of metals and non-metals. Rolling Friction, Source of Rolling Friction, Stick slip motion, laws of Friction.

Wear: Classification and mechanisms of wear, delamination theory, debris analysis, testing methods and standards. Mechanism of sliding wear of metals, Ceramics and Polymers, Wear mechanisms- Abrasive wear, Adhesive, Abrasive wear situations, tribo-chemical reactions, Corrosive wear, Surface Fatigue wear situations, Fracture wear, fretting, erosion, Estimation of wear rate.

Module 3 LUBRICANTS (08 Periods)

Introduction, effect and necessity of lubrication, Lubrication types, properties, Requirements of Lubricants, Testing methods, Hydrodynamic Lubrication, Elasto-hydrodynamic lubrication, Boundary Lubrication, solid and semi-solid lubricants, Solid Lubrication, Hydrostatic Lubrication.

Module 4 SURFACE TOPOGRAPHY (09 Periods)

Geometric Characteristics of Surfaces, Computation of Surface Parameters-Mean, Ten point average, CLA methods, Load bearing curve Film Parameters for Different Lubrication Regimes, Transition Between Lubrication Regimes, Health and safety aspects of lubricants.

Module 5 SURFACE ENGINEERING AND BEARING MATERIALS (09 Periods)

Scope of surface engineering, Surface modifications, Transformation Hardening, Surface fusion, Thermochemical processes, Surface coatings, Plating and anodizing, Fusion Processes, Vapour Phase processes, Chemical vapour deposition.

Bearing materials: selection of bearing materials, metal bearings, Non-metal bearings.

Total Periods: 45

EXPERIENTIAL LEARNING

1. To delineate the behaviour of interacting surfaces-associated practices, and mainly emphasizes on phenomenon of friction, wear and lubrication.
2. Experiments performed on various industrial materials in dry or lubricating conditions with the increase of lubricating oil temperature for measuring frictional wear, coefficient of friction, etc. under various load conditions.

   Complete details will be provided in CHO.

RESOURCES

TEXT BOOKS:

1. B. Bhushan, *Introduction to Tribology*, John Wiley & Sons, Inc., 2nd edition, New York, 2002
2. Prasanta Sahoo, *Engineering Tribology*, PHI Learning Private Ltd, New Delhi, 2011
3. Williams J.A, *Engineering Tribology,* Oxford Univ. Press, India, 2001.

REFERENCE BOOKS:

1. Majumdar B.C, *Introduction to bearings*, S. Chand & Co., Wheeler publishing,India, 1999.
2. Andras Z. Szeri, *Fluid film lubrication theory and design*, Cambridge University press, Delware, 1998.
3. Cameron A, *Basic lubrication theory*, Ellis Horwood Ltd., 2002.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/112102014
2. https://archive.nptel.ac.in/courses/112/102/112102015/

WEB RESOURCES:

1. https://ocw.mit.edu/courses/2-800-tribology-fall-2004/pages/lecture-notes/
2. https://www.ocw.mit.edu/courses/2-800-tribology-fall-2004/resources/lecture-notes/

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME205002	**NUMERICAL SIMULATION LAB**	-	-	3	-	1.5

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed introduction to the fundamental principles of current technologies and their translation to engineering practice. The course emphasizes hands-on programming in MATLAB and application to several domains This course implements MATLAB program to plot the internal forces, namely, the axial forces, shearing force and bending moment as functions.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Develop MAT LAB programs for simple and complex engineering problems.

CO2. Interpret the output graphical plots for the given governing equation

CO3. Apply the MATLAB programming to real time applications.

CO4. Determination of polynomial using method of Least Square Curve Fitting.

CO5. Use of MATLAB to solve simple problems in vibration, Mechanism Simulation using multi body dynamic software

CO-PO-PSO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	-	-	-
CO2	3	3	3	-	-	-
CO3	3	3	-	-	-	-
CO4	2	3	3	-	-	-
CO5	3	3	3	-	1	2
Course Correlation Mapping	**3**	**3**	**3**	**-**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

EXPERIENTIAL LEARNING

List of Experiments:

1. Introduction to MATLAB program
2. MATLAB program to plot the internal forces, and bending moment.
3. Thermal stress analysis of piston using MATLAB program
4. Formulation of ideal and real gas equations.
5. Using MATLAB program plot the function of one variable and two variables
6. Multi body dynamic analysis through MATLAB program
7. MATLAB program for Eulers equation of motion
8. MATLAB program for curve fitting.
9. Dynamics and vibration analysis using MATLAB program
10. MATLAB program to plot the resultant acceleration and the variation of acceleration program
11. Write a MATLAB program to plot the ratio of m/f as a function of crank angle α from 0 to 180 degrees. Given a = 50 mm and a = 150 mm. Determine the value of crank angle α for which the ratio m/f is maximum and the corresponding value of m/f.
12. Write MATLAB script for plotting the magnitude of the frequency response of a system with rotating unbalanced masses.

RESOURCES

REFERENCES:

1. Rao. V. Dukkipati , ATLAB for ME Engineers , New age Science, 1st Edition, India 2008.
2. Agam Kumar Tyagi, MATLAB and Simulink for Engineers, Oxford University Press 1st Edition, USA, 2012.
3. S.S.Rao, Vibration Problems, CRC press, 4 th Edition, Florid*a,* 2014.

SOFTWARE/TOOLS:

1. Matlab-2014, LabVIEW and Scilab

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=IjBsQs0FAhY
2. https://www.youtube.com/watch?v=6mv0LpEhrKU

Web Resources:

1. http://www.tutorialspoint.com/matlab/
2. https://in.mathworks.com/products/matlab.html
3. https://www.iare.ac.in/sites/default/files/lab1/IARE_CTL%20MANUAL.pdf
4. https://www.mathworks.com/academia/courseware/teaching-mechanical-engineering-with-matlab-and-simulink.html

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME205001	**DESIGN PRACTICE LAB - I**	-	-	3	-	1.5

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The practical implementation of FEM in solving the engineering problem using commercial available software will be provided with this course. This course enables and educate the learners to adopt finite element method algorithm

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Apply concepts of 3D modeling of solid parts and their drawings.

CO2. Formulate finite elements like bar, truss and beam elements for linear static structural analysis.

CO3. Solve static and dynamic problems using FEM.

CO4. Develop finite element model for fatigue analysis.

CO5. Apply finite element simulation tool to solve practical thermal problems

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	-	1	2
CO2	3	3	3	-	1	2
CO3	3	3	-	-	1	2
CO4	2	3	3	-	1	2
CO5	3	3	3		1	2
Course Correlation Mapping	**3**	**3**	**3**	**-**	**1**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

EXPERIENTIAL LEARNING

List of Experiments conducted in this laboratory:

I Modelling and Drafting of machine parts, Die casts and sheet metal.

- **a** Prepare the solid model 1 of given figure with required dimensions in isometric representation
- **b** Prepare the Sheet metal part 1 of given figure with required dimensions in isometric representation
- **c** Prepare the Die cast part 1 of given figure with required dimensions in isometric representation

II Concept of Mesh generation (1D, 2D and 3D) and Sensitivity analysis

- **a** Generated 1-D mesh for given Simply Supported, Cantilever and Over hanging beams
- **b** Generation of 2D mesh for Sheet metal part and extract the mid-mesh. Check quality of mesh (Skegness, Jacobean, Aspect ratio) and eliminate errors. Reduce triangular elements to 5%.
- **c** Generation of 3D mesh for given part. Check quality of mesh (Skegness, Jacobean, Aspect ratio).

III Static and dynamic analysis through Finite element modelling of mechanical problems using ANSYS

- **a** Determination of deflection and stresses in 2D trusses and beams
- **b** Determination of deflections component and principal and Von-Mises stresses in simple 3D plane and axisymmetric components

IV Fatigue analysis and comparison with respect to static and dynamic analysis.

- **a** Fatigue analysis of connecting rod of an IC engine
- **b** Dynamic analysis of Aeroplane wind under dynamic forcing condition

V Stead state and transient thermal analysis using ANSYS workbench.

- **a** Conductive heat transfer Analysis of plane and axisymmetric components.
- **b** Convective heat transfer Analysis of 2D components

RESOURCES

REFERENCES:

1. Gokhale, Nitin S. Practical finite element analysis. Finite to infinite, 2008th edition India,2020.
2. Goutham Pohit, Goutham Ghosh, Machine Drawing with Auto CAD, Pearson, 1st Edition,London, 2004.
3. User manuals of ANSYS package Version 9.0

SOFTWARE/TOOLS:

1. CATIA, Pro-E, HYPERMESH, ANSYS,ABAQUSetc

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=TK4MX_42UU4
2. https://youtu.be/DXhpDia5RPk
3. https://www.proetutorials.com/

Web Resources:

1. https://lab.vanderbilt.edu/vumacs/
2. https://youtu.be/UqLOEgJleZk
3. https://youtu.be/jF1PSYXEVfs
4. https://youtu.be/0X6NrzyNVvk

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22AI201701	**BUSINESS ANALYTICS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course emphasizes on the basic concepts of Business Analytics. It covers the basic excel skills, Excel look up functions for database queries in business analytics. By the end of this course students will acquire basic knowledge to implement statistical methods for performing descriptive, predictive and prescriptive analytics.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Understand the basic concepts and models of Business Analytics

CO2. Select Suitable basic excel function to perform analytics on spread sheets.

CO3. Apply different statistical techniques and distributions for modeling the data

CO4. Develop user-friendly Excel applications by using statistical models for effectiveness decision making.

CO5. Analyze the performance of different optimization models used in prescriptive analytics on Binary and Categorical data.

COURSE CONTENT

Module 1: FOUNDATIONS OF BUSINESS ANALYTICS ***(9 Periods)***

Introduction, What is Business Analytics, Evolution of Business Analytics, Scope of Business Analytics, Data for Business Analytics, Applications of Business Analytics, Models in Business Analytics, Problem Solving with Analytics.

Module 2: ANALYTICS ON SPREADSHEETS ***(09 Periods)***

Basic Excel Skills, Excel Functions, Using Excel Lookup Functions for Database Queries, Spreadsheet Add-Ins for Business Analytics.
Visualizing and Exploring Data: Data Visualization, Creating Charts In Microsoft Excel, Other Excel Data Visualization, Statistical Methods For Summarizing Data, Exploring Data Using Pivot tables.

Module 3: DATA MODELING ***(09Periods)***

Basic concepts of Probability, Random Variables and Probability Distributions, Continuous Probability Distributions.
Statistical Sampling, Estimation population parameters, Sampling Error, Sampling Distributions, Hypothesis Testing, ANOVA, Chi Square Test.

Module 4 Predictive analytics ***(09 Periods)***

Trend lines And Regression Analysis, Modeling Relationships And Trends In Data, Simple Linear Regression, Multiple Linear Regression, Building Good Regression Models,
Strategies for predictive decision modeling, implementing models on spreadsheets, spreadsheet applications in business analytics, developing user-friendly excel applications, analysing uncertainty and model assumptions, model analysis using analytic solver platform

Module 5 Prescriptive analytics ***(09Periods)***

Linear Models: Building Linear Models, Implementing Linear Optimization Models On Spreadsheets, Graphical Interpretation Of Linear Optimization, Linear Optimization Models for prediction and Insight.
Integer Models: Solving models with Integer Variables, Integer Optimization Models with Binary Numbers
Decision Analysis: Formulating Decision Problems, Decision Strategies Without Outcome Probabilities, Decision Trees With Outcome Probabilities, Decision Trees.

Total Periods: 45

EXPERIENTIAL LEARNING

1. **Diabetic Prediction:**

   The National Institute of Diabetes and Digestive and Kidney Diseases has a created a dataset. The objective of the dataset is to diagnostically predict whether or not a patient has diabetes, based on certain diagnostic measurements included in the dataset. Several constraints were placed on the selection of these instances from a larger database. In particular, all patients here are females at least 21 years old of Pima Indian heritage. The datasets consists of several medical predictor variables and one target variable, Outcome. Predictor variables includes the number of pregnancies the patient has had, their BMI, insulin level, age, and so on. Build a machine learning model to accurately predict whether or not the patients in the dataset have diabetes or not?

2. Solve the house price prediction problem using **Linear regression analysis** method. Optimize the parameters of the regression function using gradient descent method.

3. Visualize the decision tree built for solving Heart disease prediction problem and measure the impurity of nodes created via **Decision Tree Analysis**.

   Dataset:https://www.kaggle.com/arviinndn/heart-disease-prediction-uci dataset/data

4. The data set baby boom (Using R) contains data on the births of 44 children in a one-day period at a Brisbane, Australia, hospital. Compute the skew of the wt variable, which records birth weight. Is this variable reasonably symmetric or skewed?

5. Visualize the **Distribution of data** with different feature scaling methods on online news popularity dataset for article word count.

   Dataset:https://www.kaggle.com/datasets/deepakshende/onlinenewspopularity

6. **Human Activity Recognition System:**

   The human activity recognition system is a classifier model that can identify human fitness activities. To develop this system, you have to use a smart phone dataset, which contains the fitness activity of 30 people which is captured through smart phones. This system will help you to understand the solving procedure of the **Multi-classification problem**.

RESOURCES

TEXT BOOKS:

1. James Evans, *Business Analytics*, Pearson Education,2nd Edition, 2017.

REFERENCE BOOKS:

1. Marc J.Schniederjans, *Business Analytics*, Pearson Education,2015
2. Camm,Cochran, *Essentials of Business Analytics*, cenage learning,2015

VIDEO LECTURES:

1. https://nptel.ac.in/courses/110105089
2. https://archive.nptel.ac.in/courses/110/107/110107092/
3. https://nptel.ac.in/courses/110106050

Web Resources:

1. https://www.proschoolonline.com/certification-business-analytics-course/what-is-ba
2. https://michael.hahsler.net/SMU/EMIS3309/slides/Evans_Analytics2e_ppt_01.pdf
3. https://www.guru99.com/business-analyst-tutorial-course.html

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22EE201002	**INNOVATION AND INTELLECTUAL PROPERTY RIGHTS**	2	-	-	-	2

Pre-Requisite --

Anti-Requisite --

Co-Requisite --

COURSE DESCRIPTION:

The course is designed to provide comprehensive knowledge to the students regarding the general principles of innovation and intellectual property rights, significance of innovation and steps for innovation, Concept and Theories, Criticisms of Intellectual Property Rights, International Regime Relating to IPR. The course provides an awareness on how to protect ones unique creation, claim ownership, knowledge of what falls under the purview of someone's rights and what doesn't, and safeguard their creations and gain a competitive edge over the peers.

COURSE OUTCOMES: *After successful completion of the course, students will be able to:*

CO1. Understand the significance of innovation and steps for innovative thinking, and the concepts of intellectual property right and avenues for filling intellectual property rights.
CO2. Understand the legislative practices and protocols for acquisition of trademark and the judicial consequences for violating laws of trademark protection.
CO3. Understand the legislative practices and protocols for acquisition of copyrights and the judicial consequences for violating laws of copyrights protection.
CO4. Understand the fundamentals of patent laws, legislative practices and protocols for acquisition of trade secrets and the judicial consequences for violating laws of trade secrets protection.
CO5. Understand the latest developments and amendments in protection and filling of intellectual rights at international level.

CO-PO Mapping Table:

Learning Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	--	--	--	2	3
CO2	3	--	2	--	2	3
CO3	3	--	2	--	2	2
CO4	3	--	2	--	2	2
CO5	3	--	2	--	2	2
Course Correlation Level	**3**	**--**	**2**	**3**	**3**	**3**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: Introduction to Innovation and IPR (06 Periods)

Innovation: Difference between Creativity and Innovation – Examples of innovation; Being innovative; Identify Blocks for creativity and innovation – overcoming obstacles; Steps for Innovation

Intellectual property rights: Need for intellectual property rights (IPR); types of intellectual property- Design, Geographical Indication; International organizations, agencies and treaties.

Module 2: Trademarks (06 Periods)

Introduction to trademark, Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting and evaluating trade mark, trade mark registration processes.

Module 3: Law of Copyrights (06 Periods)

Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law.

Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer.

Module 4: Trade Secrets (06 Periods)

Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation.

Unfair competition: Misappropriation right of publicity, false advertising.

Module 5: New Development of Intellectual Property (06 Periods)

New developments in: trade mark law, copy right law, patent law, intellectual property audits. International overview on intellectual property; international - trade mark law, copy right law, international patent law, international development in trade secrets law.

Total Periods: *30*

Topics for self-study are provided in the lesson plan.

EXPERIENTIAL LEARNING

1. Should conduct a survey based on the real scenario, where IPR is misused or unethically used and present an article.
2. Prepare an article on the registration processes of IPR practically (copy right/trade mark/ patents).
3. Should study a case of conflict on trademarks/patents and should produce an article mentioning the circumstances and remedial measures.

4. Prepare an article on the latest development in the international intellectual property rights.
5. Refining the project, based on the review report and uploading the text

TEXT BOOKS:

1. Deborah, E. Bouchoux, *Intellectual property: The law of Trademarks, Copyright, Patents, and Trade Secrets,* Cengage learning, 4th Edition, 2013.
2. Prabuddha Ganguli, *Intellectual property right - Unleashing the knowledge economy*, Tata McGraw Hill Publishing Company Ltd.
3. Tom Kelley & Jonathan Littman: *The Art of Innovation*, Profile Books Ltd, UK, 2008

REFERENCE BOOKS:

1. Neeraj P., & Khusdeep D. Intellectual Property Rights. India, IN: PHI learning Private Limited. 1st Edition 2019.
2. Nithyananda, K V. Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited. 2019
3. Edward debone; *How to have Creative Ideas*, Vermilon publication, UK, 2007.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/110105139
2. https://www.youtube.com/watch?v=bEusrD8g-dM
3. https://www.youtube.com/watch?v=LS7TTb23nzU

Web Resources:

1. Subramanian, N., & Sundararaman, M. (2018). *Intellectual Property Rights – An Overview*. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf
2. World Intellectual Property Organisation. (2004). *WIPO Intellectual property Handbook*. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf
3. Cell for IPR Promotion and Management (http://cipam.gov.in/)
4. World Intellectual Property Organisation (https://www.wipo.int/about-ip/en/)
5. Office of the Controller General of Patents, Designs & Trademarks (http://www.ipindia.nic.in/)

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME201001	**ADVANCED MACHINE DESIGN**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The objective of the course is to review of failure theories, fatigue design methods, fundamentals of Fracture mechanics and application to fatigue crack growth, Stress-life and strain-life approaches, notches and their effects, fatigue from variable amplitude loading, spectrum loading, cumulative damage theories, cycle counting methods, statistical aspects of fatigue.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Design mechanical components by selecting a suitable material and failure criteria.

CO2. Analyse the static failure for ductile and brittle materials.

CO3. Evaluate fatigue life of mechanical components for ductile and brittle materials.

CO4. Analyze and predict the fracture strength of mechanical components under Different fracture modes.

CO5. Design mechanical components involving contacts avoiding the surface failures.

CO-PO Mapping Table:

Learning Outcomes	`Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	-	-	-
CO2	3	3	3	-	-	-
CO3	3	3	-	-	-	-
CO4	2	3	3	-	-	-
CO5	3	3	3			
Course Correlation Mapping	**3**	**3**	**3**	**-**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: Material selection for design ***(10 Periods)***

Engineering Design process and the role of materials; Materials classification and their properties; Types of Material Failure – Elastic & Plastic Deformation, Creep deformation, Fatigue fracture under static and impact loading, Fatigue under cyclic loading; Design and Materials Selection – Iterative and Stepwise nature design, Safety factors, Prototype and Component Testing, Service Experience; Fundamentals of Plasticity.

Module 2: Review of fundamental concepts ***(09 Periods)***

Load analysis - 2D and 3D static load analysis; Case studies of static load analysis - Bicycle hand brake lever, Bicycle with pedal arm, Plier-wrench; Understanding of static failure for ductile and brittle materials; Comparison of experimental data with failure theories; Significance of the theories of failure; Importance of factor of safety in design; Design case studies – Bracket.

Module 3 Static failure theories ***(10 Periods)***

Failure of Ductile Materials Under Static Loading - The von Mises-Hencky or Distortion-Energy Theory, The Maximum Shear-Stress Theory, The Maximum Normal-Stress Theory, Comparison of Experimental Data with Failure Theories; Failure of Brittle Materials Under Static Loading - Even and Uneven Materials, The Coulomb-Mohr Theory, The Modified-Mohr Theory; Case Studies in Static Failure Analysis, Bicycle Brake Lever Failure Analysis.

Module 4 Fatigue failure theories **(08 Periods)**

Introduction to fatigue; Fatigue failure models; Fatigue life; Estimation of theoretical fatigue strength; Correction factors to the theoretical fatigue strength; Stress concentration; Cumulative damage and life exhaustion; Effect of mean stress on the fatigue failure; Designing for fully reversed uniaxial stresses; Designing for fluctuating uniaxial stresses.

Module 5 Design for failure prevention: ***(08 Periods)***

Surface Geometry; Mating surfaces; Friction; Surface failures - Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue wear; Static and Dynamic Contact stresses – Spherical contact, Cylindrical contact and General contact, Design Case Studies – Ball bearing, Cylindrical roller bearing, Cam-follower contact.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Develop the Simulink model and analyses the performance at various Design input conditions. (Use MATLAB)
2. SCI lab implementation for fatigue problems to resolve the design equations.

RESOURCES

TEXT BOOKS:

1. Robert L Norton , Machine design an integrated approach, Pearson Education, Second edition, 2009.
2. Richard G. Budynas, J Keith Nisbett, Shigley's Mechanical Engineering Design, McGraw Hill, Ninth edition, 2011.

REFERENCE BOOKS:

1. Mechanical properties of engineered materials, Wolé Soboyejo, Marcel Dekker, Inc., 2002.
2. Elements of Fracture Mechanics, Prashant Kumar, McGraw Hill Education (India) Private Limited, 2014.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=nqhyCzrFp1s
2. https://www.youtube.com/watch?v=0PeJHv7nuIw

Web Resources:

1. RGPV Notes - www.rgpvnotes.in
2. https://lecturenotes.in/subject/2755/advance-machine-design-amd/note
3. https://www.pdfprof.com/PDF_Image.php?idt=10147&t=28
4. https://www.newtondesk.com/machine-design-handwritten-study-notes/

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME201003	**EXPERIMENTAL STRESS ANALYSIS**	3	-	-	-	3

Pre-Requisite **-**

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

The course covers the fundamental aspects of experimental stress analysis that includes exhaustive treatment of the most versatile techniques like photoelasticity and strain gauges and a brief introduction to the emerging techniques like digital image correlation. In addition, it also provides the fundamental aspects of different experimental techniques such as Moiré, Brittle and Birefringent Coatings.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyse complex engineering problems related to plan stress & strain of rigid bodies with compatibility conditions.

CO2. Apply brittle coating technique for cracks for effective solutions.

CO3. Analyze moire fringes to plane displacement & slope measurements.

CO4. Analyze engineering problems related to birefringent coating for effective solutions by stress separation methods.

CO5. Apply principles to measure photo elasticity behaviour in materials.

CO-PO Mapping Table:

Learning Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	-	-
CO2	3	3	2	2	-	-
CO3	3	3	2	2	-	-
CO4	3	3	2	2	-	-
CO5	3	3	2	2	-	-
Course Correlation Mapping	**3**	**3**	**2**	**2**	**-**	**-**

Correlation Levels: **3: High;** **2: Medium;** **1: Low**

COURSE CONTENT

Module 1: INTRODUCTION & STRAIN MEASUREMENT METHODS ***(09 Periods)***

Introduction: Theory of Elasticity, Plane stress and plane strain conditions, Compatibility conditions. Three-dimensional stress strain relations.
Strain Measurement Methods: Various types of strain gauges, Electrical Resistance strain gauges, semiconductor strain gauges, strain gauge circuits, effect of poission ratio strain gauge results, measurements of residual strain general applications.

Module 2: BRITTLE COATING METHOD ***(08 Periods)***

Introduction, coating stresses, failure theories, brittle coating crack patterns, crack detection, ceramic based brittle coatings, and resin based brittle coatings, test procedures for brittle coatings analysis, calibration procedures, analysis of brittle coating data.

Module 3 MOIRE METHODS ***(10 Periods)***

Introduction, mechanism of formation of Moire fringes, the geometrical approach to Moire-Fringe analysis, the displacement field approach to Moire-Fringe analysis, out of plane displacement measurements, out of plane slope measurements, sharpening and multiplication of Moire-Fringes, experimental procedure and techniques.

Module 4 BIREFRINGENT COATINGS **(08 Periods)**

Introduction, Coating stresses and strains, coating sensitivity, coating materials, application of coatings, effects of coating thickness, Fringe-order determinations in coatings, stress separation methods.

Module 5 PHOTOELASTICITY ***(10 Periods)***

Photo elasticity: Photo elasticity, Polariscope, Plane and circularly polarized light, Bright and dark field setups, Photo elastic materials, Isochromatic fringes, Isoclinics.
Three Dimensional Photo elasticity : Introduction, materials, locking in model deformation, machining cementing and slicing 3-D models, slicing the model and interpretation of the resulting fringe patterns, effective stresses, shear-difference method in 3-D, applications of the Frozen-stress and scattered-light method.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Analyze the mechanical stresses in materials by using strain gauges.
2. Conduct experiments on samples by using photoelasticity method, moire technique and coating methods for various applications and conditions.

RESOURCES

TEXT BOOKS:

1. Freddi, Olmi, Cristofolini, *Experimental stress analysis for materials and structures*, Springer, 2015.
2. J.W. Dally and W.F. Riley, *Experimental Stress Analysis*, McGraw Hill Education, 2014.

REFERENCE BOOKS:

1. *J. L. Meriam and L. G. Kraige, Engineering Mechanics: Statics Vol. 1, Dynamics Vol. 2, John Wiley & Sons Ltd., 5th Edition, 2008.*
2. *U.C. Jindal, Experimental stress analysis, Pearson Publishers, 1st edition, 2018.*
3. *Sadhu Singh, Experimental stress analysis, Khanna Publishers, 2017.*
4. *J.Srinivas, Stress analysis-An introduction to experimental techniques, Narosa Publishers 2015.*

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc21_me02/preview.

Web Resources:

1. https://courses.washington.edu/me354/lab/photoelas.pdf
2. https://home.iitm.ac.in/kramesh/ESA.html

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME201006	**ADVANCED OPTIMIZATION TECHNIQUES**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

This course cover the topic of Optimization from its fundamentals. It will start with an overview of real analysis and convexity. With this base it will cover Integer programming, classical optimization, and numerical programming. Genetic algorithms and programs for Multi-Objective Decision Making problems. In addition, it also provides the applications of optimization in design and manufacturing systems.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Model and solve unconstrained optimization problems.

CO2. Apply Classical and Numerical techniques for real life Problems.

CO3. Apply genetic algorithm and Programming techniques for real life problems.

CO4. Analyze various complex problems by using multi-objective decision approaches.

CO5. Design and solve complex problems using evolutionary algorithms to optimize the parameters.

CO-PO Mapping Table:

Learning Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	-	-
CO2	3	3	2	3	-	-
CO3	3	3	2	3	-	-
CO4	3	3	2	3	-	-
CO5	3	3	2	3	-	-
Course Correlation Mapping	**3**	**3**	**2**	**3**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION ***(08 Periods)***

Integer programming, cutting plane method and branch and bound technique, mixed integer programming

Module 2: CLASSICAL & NUMERICAL OPTIMIZATION TECHNIQUES ***(10 Periods)***

Classical optimization techniques: Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions.
Numerical methods for optimization: Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method.

Module 3 GENETIC ALGORITHM (GA) ***(09 Periods)***

Genetic algorithm (GA): Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA.
Genetic Programming (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, solving differential equations using GP.

Module 4 MULTI-OBJECTIVE DECISION MAKING **(09 Periods)**

Introduction to goal programming, Non-dominated front, multi–objective GA, Non-dominated sorted GA, convergence criterion, Applications of multi-objective problems. Introduction to Analytical hierarchical process, analytical network process.

Module 5 APPLICATIONS OF OPTIMIZATION IN DESIGN AND MANUFACTURING SYSTEMS: ***(09 Periods)***

Some typical applications like optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam, optimization of springs and gears, general optimization model of a machining process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Solve conventional problems in Genetic algorithm.
2. Analyze the mechanical problems by using MATlab/ Scilab program language.

RESOURCES

TEXT BOOKS:

1. Singiresu S Rao*, Engineering Optimization: Theory and Practice*, New Age International, 3rd Edition, 2013.
2. A.Ravindran, K.M.Ragsdell, G.V.Reklaitis, *Engineering Optimization: Methods and applications*, Wiley India Pvt. Ltd., 2nd Edition 2006.
3. Dan Simon, *Evolutionary Optimization Algorithms*, John Wiley & Sons, 2013.

REFERENCE BOOKS:

1. C. Mohan and Kusum Deep, *Optimization Techniques*, New Age International Publishers, 1st edition, 2010.
2. Hamdy A. Taha, *Introduction to Operations Research*, PHI, 10th edition, 2017.
3. Kalyanmoy Deb , *Multi-Objective Optimization using Evolutionary Algorithms*, Wiley Publishers, 2010.
4. D.E.Goldberg , *Genetic algorithms in Search, Optimization, and Machine learning* , Addison-Wesley Publishers, 13th edition, 1989.

VIDEO LECTURES:

1 https://onlinecourses.nptel.ac.in/noc21_me10/preview

Web Resources:

1. https://nptel.ac.in/courses/105108127
2. https://archive.nptel.ac.in/content/storage2/courses/105108127/pdf/Module_1/M1L3slides.pdf

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME201012	**MECHANICAL MEASUREMENTS AND CONTROLS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The purpose of this course is to enable the students to provide insights to mechanical measurements and instruments associated with it. It is also focused on the controllers and its implementation in the various applications. The course is mainly aimed to provide details of measurements and controlling aspects.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate the methods of measurement, measurement systems both the analog and digital standards along with the errors.

CO2. Demonstrate various temperature measurement sensors based on classification and working.

CO3. Demonstrate various pressure measurement sensors based on classification and working.

CO4. Demonstrate various strain gauges based on classification and working.

CO5. Demonstrate the fundamentals of control systems like open loop and closed loop.

CO-PO Mapping Table:

Learning Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	-	-	1	-
CO2	3	3	2	-	1	2
CO3	3	3	-	-	1	-
CO4	2	3	2	-	1	2
CO5	3	3	-		1	-
Course Correlation Mapping	**3**	**3**	**3**	**-**	**1**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: CONCEPTS OF MEASUREMENT ***(10 Periods)***

Methods of measurements-the generalized measurement system-calibration-types of input quantities analog and digital measurements-standards –dimensions and units of measurements treatment ofuncertainties-nomenclature of terms in measurement-errors and classification of errors-single test data –variable sample and replicated test data-treatment of uncertainties propagation of uncertainty.

Module 2: MEASUREMENT OF TEMPERATURE ***(09 Periods)***

Sensors and transducers-primary and secondary transducers-classification of first stage devices variableresistance transducers-variable inductance elements-the differential transformer-variable reluctance transducers-capacitive transducers-piezo electric and photo electric transducers measurement oftemperature-liquid in glass thermometers - pressure thermometers-resistance thermometers-lead wirecompensation –thermoelectric thermometers-laws of thermocouples-lead wires for thermocouples –ambient temperature compensation -pyrometers-total radiation and optical pyrometers-infrared pyrometers.

Module 3 MEASUREMENT OF PRESSURE AND FLOW RATE ***(08 Periods)***

Measurement of pressure-bourdon tube pressure gauge-calibration of bourdon tube pressure gauge elastic diaphragms-corrugated diaphragms-strain gauge pressure cells-bulk modulus gauge-the McLeod gauge –thermal conductivity gauges and ionization gauges.
Measurement of flow rate-classification of flow meters-obstruction flow meters-variable area flow meters-turbine type flow meters-thermal flow meters magnetic flow meters-ultrasonic flow meters.

Module 4 STRAIN GAUGE AND MISCELLANEOUS MEASUREMENTS (10 Periods)

Measurement of strain-electrical resistance strain gauges-bonded and unbounded strain gauges metallic resistance strain gauges-gauge factors-specifications and installation of factors for strain gauges-bridges with two and four arms sensitive to strain-calibration of strain gauges strain gauge rosettes-measurement of humidity-hair hygrometers-measurement of PH-PH meters-measurement of air pollution-Orsat apparatus-nuclear instrumentation-Geiger Muller counter-scintillation counter**.**

Module 5 BASICS OF CONTROL SYSTEM THEORY ***(08 Periods)***

Control systems-open and closed loop control systems-servomechanisms and regulators-control system fundamentals-block diagrams-block diagram reduction-simple problems signal flow graphs Masons gain formula-mathematical models of control systems-stability of control systems-Routh and Hurwitz stability criteria.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Use strain gauge and acquire the displacement of a cantilever beam. Consider it as aeroplane wing and find the damping of it.
2. Use temperature sensors and anemometer to measure the flow inside tube with continuous measurement of temperature.

RESOURCES

TEXT BOOKS:

1. Thomas .G. Beckwith, Lewis Buck and Roy D Maragani- *Mechanical Measurements* Narosa, 5th Ed. publishing house-2000,
2. NagoorKani ,A, *Control Systems*, RBA Publicatrions-2000

REFERENCE BOOKS:

1. Holman J P, *Experimental methods for Engineers*, TataMCGraw Hill publishers 2000.
2. Benjamin C KUO ,Faridgolnaraghi ,*Automatic control Systems* –John Wiley and Sons 2002.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/112107242
2. http://nptel.ac.in/courses/106106127/

Web Resources:

1. https://www.ni.com/en-in/solutions/electronics/mechanical-component-and-durability-test.html
2. https://uca.edu/psychology/files/2013/08/Ch10-Experimental-Design_Statistical-Analysis-of-Data.pdf

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
22ME201013	**PRODUCT DESIGN**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides the Competitor and costumer – behaviour analysis, activity of concept generation, Structured approaches, Five step Method, variety component standardization, Assessing the need for industrial design, Cost estimation in design.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Demonstrate knowledge on strategic importance of product development

CO2. Develop various methods To comprehend technological analysis and experiment design.

CO3. Demonstrate knowledge on Point out product architecture, industrial design and robust design.

CO4. Demonstrate knowledge on Investigate the customer requirement and survey of problems.

CO5. Demonstrate knowledge on performance of the product for reliability and cost.

CO-PO Mapping Table:

Learning Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	-	-	-
CO2	3	2	3	-	-	-
CO3	3	2	3	-	-	-
CO4	3	2	3	-	-	-
CO5	3	2	3	-	-	-
Course Correlation Mapping	**3**	**2**	**3**	**-**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION TO PRODUCT DESIGN ***(09 Periods)***

Need for IPPD – strategic importance of product development – integration of customer, designer, material supplier and process planner, Competitor and costumer – behaviour analysis.
Understanding customer – promoting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specification.

Module 2: CONCEPT GENERATION AND CONCEPT SELECTION ***(09 Periods)***

Concept Generation: Activity of concept generation, Structured approaches, Five step Method: clarify, Search Externally and internally, explore systematically, reflect on the solutions and processes.
Concept selection: Integral part of Product design process, methodology, benefits.

Module 3 PRODUCT ARCHITECTURE, INDUSTRIAL DESIGN AND ROBUST DESIGN ***(09 Periods)***

Product Architecture: Implication, Product change, variety component standardization, Product performance, manufacturability.
Industrial Design: Assessing the need for industrial design, impact design process Integrate design process, assessing the quality of industrial design.
Robust Design: Introduction, various steps in robust design.

Module 4 DEVELOPMENT OF ENGINEERING SPECIFICATIONS ***(09 Periods)***

Development of engineering specifications: Steps in development of engineering specification, identification of customer\s requirements, Quality Functional Deployment (QFD)

Module 5 PRODUCT EVALUATION ***(09 Periods)***

Product Evaluation: Importance and goals of performance evaluation, robust design, sensitivity analysis, Cost estimation in design, design for reliability, design for environment and maintenance.

Total Periods: 45

EXPERIENTIAL LEARNING
The following is the sample. Faculty shall frame according to the course domain.

1. Take a product from a market redesign.

CASE STUDIES/ ARTICELS:

Contemporary relevant case studies/Articles will be provided by the course instructor at the beginning.

RESOURCES

TEXT BOOKS:

1. Kari T. Ulrich and Steven D. Eppinger, *Product Design and Development* ,McGraw Hill International Editions. 2015.
2. David G. Ullman, *The Mechanical Design Process*,McGraw Hill, New York,4th edition,2011.

REFERENCE BOOKS:

1. George E. Dieter, *Engineering Design*, McGraw Hill Education, New Delhi, 4th edition,2013.
2. A. K. Chitale, R. C. Gupta, *product design and manufacturing*, PHI Learning, 6th edition,2014.

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc21_me83/preview
2. https://www.coursera.org/lecture/creative-design-prototyping-testing/introduction-to-product-design-and-development-Rcy11

Web Resources:

1. https://www.blur.design/design/product-design
2. https://www.toools.design/best-product-design-tools

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
22ME205003	**DESIGN PRACTICE LAB -II**	-	-	3	-	1.5

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The Machine Dynamics Laboratory basically involves experimental exposure to working principles of machinery. All the theoretical aspects of different types of machinery covered in the regular lectures will be realized through experimentation. Also, the comparison of the experimental results and the theoretical calculation will converse.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Evaluate the natural frequency of the undamped vibrating system.

CO2. Evaluate the vibration parameters of damped free and forced vibrating system.

CO3. Assessment of the unbalance and balanced rotors.

CO4. Evaluate the critical speed of shaft and analysis inversion of mechanism.

CO5. Analyze the kinematics of mechanism using modern software's.

CO-PO Mapping Table:

Learning Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	-	1	-
CO2	3	3	3	-	1	-
CO3	3	3	3	-	1	-
CO4	2	3	3	-	1	-
CO5	3	3	3		1	
Course Correlation Mapping	**3**	**3**	**3**	**-**	**1**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

EXPERIENTIAL LEARNING

List of Experiments conducted in this laboratory:

I Un-damped System

- **a** Determine natural frequency of compound pendulum.
- **b** Determine natural frequency of simple pendulum system
- **c** Estimation of the frequency of un-damped force vibration of a spring mass system

II Damped System

- **a** Damped Free Vibrations of Two Degree Freedom System: Coupled Pendulum
- **b** Vibrations of Continuous System: A Cantilever Beam
- **c** Estimation of the frequency damped force vibration of a spring mass system
- **d** Determine the frequency response curve under different damping conditions for single degree freedom system of vibration
- **e** Tuning of Dynamic Absorber

III Balancing of systems

- **a** Balancing of Rotors: Rotor Balancing Machine
- **b** Balancing of Reciprocating Machines: Balancing a Twin Cylinder Engine (A Locomotive Engine)

IV Analysis of mechanism and critical speed of shafts.

- **a** Case studies on mechanisms and inversions
- **b** Dynamic analysis of Aeroplane wind under dynamic forcing condition
- **c** Critical speeds of shafts with hinged and fixed end conditions
- **d** Analysis of machine vibration, signature, using FFT analyser.

V Use of coding in analysis.

- **a** Kinematics of a planar open-loop system using MATLAB/Scilab
- **b** Inverse dynamics of planar open-loop systems using MATLAB/Scilab
- **C** Forward dynamics of planar open-loop systems using MATLAB/Scilab
- **d** Kinematics of a planar closed-loop system using MATLAB/Scilab

RESOURCES

REFERENCES:

1. Singiresu S. Rao. Mechanical Vibrations, Addison-Wesley Longman Incorporated, (1990).
2. Chandramouli Padmanabhan,Marie Dillon Dahleh,William T. Thomson. Theory of Vibrations with Applications, Pearson Education, (2008).
3. V. Ramamurthi. Mechanical Vibration Practice and Noise Control, Narosa Publishing House, (2012).
4. Haym Benaroya and Mark L. Nagurka. Mechanical Vibration, CRC Press, (2010).

SOFTWARE/TOOLS:

1. MATLAB
2. SciLab

VIDEO LECTURES:

1. https://mdmv-nitk.vlabs.ac.in/exp/exp-rotating-unbalance-nitk/videos.html
2. https://youtu.be/6LJwNQ-4fds

Web Resources:

1. https://mdmv-nitk.vlabs.ac.in/exp/exp-simply-supported-beam-nitk/
2. https://www.vlab.co.in/participating-institute-nitk-surathkal
3. https://www.vlab.co.in/broad-area-mechanical-engineering

PROGRAM CORE

Course code	Course Title	L	T	P	S	C
22ME205004	**OPTIMIZATION TECHNIQUES LAB**	-	-	3	-	1.5

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Introduction to optimization techniques using both linear and non-linear programming. The focus of the course is on convex optimization though some techniques such as multi-objective decision making, Grey Relational Analysis model using Minitab, Taguchi-Based Design of Experiments, artificial neural network, ANFIS. After an adequate introduction to DOE techniques, students will learn to frame engineering minima maxima problems in the framework of optimization problems.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1 Apply optimization Techniques such as multi-objective decision making, Analytical Hierarchical process for engineering problems.

CO2 Apply optimization methods such as Grey Relational Analysis model using Minitab for engineering problems.

CO3 Apply optimization methods such as Taguchi, ANOVA and artificial neural network with back propagation for engineering problems.

CO4 Analyse and optimize mechanical element parameters by using genetic algorithm.

CO5 Use of MATLAB to solve simple problems in vibration, Mechanism Simulation using multi body dynamicsoftware.

CO-PO Mapping Table:

Learning Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	3	-	-
CO2	3	3	3	3	-	-
CO3	3	3	2	3	-	-
CO4	2	3	3	3	-	-
CO5	3	3	3	3		
Course Correlation Mapping	**3**	**3**	**3**	**3**	**-**	**-**

Correlation Levels: 3: High; 2: Medium; 1: Low

EXPERIENTIAL LEARNING

List of Experiments conducted in this laboratory:

1 Introduction to modelling and optimization techniques.
2 Develop a multi-objective decision making by using Analytical Hierarchical process (AHP).
3 Implement linear regression and multi-regression for a set of data points using Minitab statistical software.
4 Build, verify and visualize a Grey Relational Analysis model using Minitab statistical software.
5 Draw the correlation graph on dataset and visualize giving an overview of relationships among data of design problems by using Taguchi technique.
6 Application of Taguchi-Based Design of Experiments for Friction stir Welding.
7 Plot the correlation plot set of datasets and visualize giving an overview of relationships among data of Helical Springs by using Analysis of covariance variance (ANOVA).
8 Write a program to implement artificial neural network with back propagation.
9 Apply artificial neural network (ANN) applications to solve the bearing related problems.
10 Implement ANN applications to vehicle vibration models.
11 Write a ANFIS program using MATLAB software to find the optimization parameters in wire EDM.
12 Implement teaching learning-based algorithm for various design problems.
13 Solving Cantilever beam problem by using genetic algorithm.
14 Write a program to optimum spur gear design by using genetic algorithm.

RESOURCES

REFERENCES:

1. S.S. Rao, "Optimization Theory and Applications", Second Edition, New Age International (P) Limited Publishers, 1995.
2. Agam Kumar Tyagi, "MATLAB and Simulink for Engineers", Oxford University Press 1st Edition, 2012.
3. Kalyanmoy Deb, "Optimization for Engineering Design Algorithms and Examples", Prentice Hall of India, New Delhi, 2004.
4. M. Asghar Bhatti, "Practical Optimization Methods: with Mathematics Applications", Springer Verlag Publishers, 2000.

SOFTWARE/TOOLS:

1. Minitab, MATLAB

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=tQBpEFP7t7s&ab_channel=Statistics
2. https://www.youtube.com/watch?v=tA_1aBID2Oc&ab_channel=StatisticsOnline

Web Resources:

1. https://www.iare.ac.in/sites/default/files/lab1/IARE_SOFT_COMPUTING_LAB_MANUAL.pdf
2. https://in.mathworks.com/products/matlab.html
3. https://www.iare.ac.in/sites/default/files/lab1/IARE_CTL%20MANUAL.pdf
4. https://www.mathworks.com/academia/courseware/teaching-mechanical-engineering-with-matlab-and-simulink.html

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
22AI207601	**STATISTICS WITH R**	2	-	-	-	2

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course introduces the basic concepts of statistics using R language. The course also deals with various types of sampling methods and its impact in thescope of inference through the computation of confidence intervals. The topics covered in thecourse also includes descriptive statistics, marginal and conditional distribution, statistical transformations, chi-squared test and ANOVA.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Import, manage, manipulate, structure data files and visualize data using R programming.

CO2. Identify trends and patterns in data using Marginal, Conditional distributions andStatistical transformations.

CO3. Analyse data using sampling and probability distribution methods and compute confidence intervals for statistical inference.

CO4. Apply chi-squared goodness-of-fit test, Pearson's □ 2-statistic and ANOVA to investigatethe distribution of data.

CO-PO Mapping Table:

Learning Outcomes	Program Outcomes						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	-	-	-	-	-
CO2	3	2	-	-	-	-	-
CO3	2	2	-	-	-	-	-
CO4	3	2	-	-	-	-	-
Course Correlation Mapping	3	2	-	-	-	-	-

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: INTRODUCTION ***(05 Periods)***

Data, R's command line, Variables, Functions, The workspace, External packages, Data sets, Data vectors, Functions, Numeric summaries, Categorical data.

Module 2: BIVARIATE AND MULTIVARIATE DATA ***(07 Periods)***

Lists, Data frames, Paired data, Correlation, Trends, Transformations, Bivariate categorical data, Measures of association, Two-way tables, Marginal distributions, Conditional distributions, Graphical summaries, Multivariate data - Data frames, Applying a function over a collection, Using external data, Lattice graphics, Grouping, Statistical transformations.

Module 3 POPULATIONS ***(06 Periods)***

Populations, Discrete random variables, Random values generation, Sampling, Families of distributions, Central limit theorem, Statistical Inference - Significance tests, Estimation, Confidence intervals, Bayesian analysis.

Module 4 CONFIDENCE INTERVALS ***(06 Periods)***

Confidence intervals for a population proportion, p - population mean, other confidence intervals, Confidence intervals for differences, Confidence intervals for the median, Significance test - Significance test for a population proportion, Significance test for the mean (t-tests), Significance tests and confidence intervals, Significance tests for the median.

Module 5 GOODNESS OF FIT ***(06 Periods)***

The chi-squared goodness-of-fit test, The multinomial distribution, Pearson's □ 2-statistic, chi-squared test of independence and homogeneity, Goodness-of-fit tests for continuous distributions, ANOVA - One-way ANOVA, Using *lm* for ANOVA.

Total Periods: 30

EXPERIENTIAL LEARNING

1. The data set baby boom (Using R) contains data on the births of 44 children in a one- day period at a Brisbane, Australia, hospital. Compute the skew of the wt variable, which records birth weight. Is this variable reasonably symmetric or skewed? The variable running. time records the time after midnight of each birth. The command diff(running.time) records the differences or inter-arrival times. Is this variable skewed?
2. An elevator can safely hold 3, 500 pounds. A sign in the elevator limits the passenger count to 15. If the adult population has a mean weight of 180 pounds with a 25-pound standard deviation, how unusual would it be, if the central limit theorem applied, that an elevator holding 15 people would be carrying more than 3, 500 pounds?
3. The data set MLBAttend (UsingR) contains attendance data for Major League Baseball between the years 1969 and 2000. Use lm to perform a t-test on attendance for the two levels of league. Is the difference in mean attendance significant? Compare your results to those provided by t.test.

RESOURCES

TEXT BOOKS:

1. John Verzani, Using R for Introductory Statistics, CRC Press, 2nd Edition, 2014.
2. Sudha G Purohit, Sharad D Gore, Shailaja R Deshmukh, Statistics Using R, Narosa Publishing house, 2nd Edition, 2021.

REFERENCE BOOKS:

1. Francisco Juretig, R Statistics Cookbook, Packt Publishing, 1st Edition, 2019.
2. Prabhanjan N. Tattar, Suresh Ramaiah, B. G. Manjunath, A Course in Statistics with R, Wiley, 2018.

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc21_ma76/preview
2. https://onlinecourses.nptel.ac.in/noc19_ma33/preview
3. https://youtu.be/WbKiJe5OkUU?list=PLFW6lRTa1g83jjpIOte7RuEYCwOJa-6Gz
4. https://youtu.be/svDAkvh6utM?list=PLFW6lRTa1g83jjpIOte7RuEYCwOJa-6Gz
5. https://nptel.ac.in/courses/111104120

WEB RESOURCES:

1. https://www.geeksforgeeks.org/r-statistics/
2. https://www.geeksforgeeks.org/r-programming-exercises-practice-questions-and-solutions/
3. https://www.w3schools.com/r/r_stat_intro.asp
4. https://www.w3schools.com/r/r_stat_intro.asp
5. https://statsandr.com/blog/descriptive-statistics-in-r/

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
22CE201701	**DISASTER MANAGEMENT**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on disaster prone areas in India, repercussions of disasters and hazards, disaster preparedness and management, risk assessment and disaster management.

COURSE OUTCOMES: After successful completion of the course, students will be able to:

CO1. Analyze the vulnerability of an area to natural and man-made disasters/hazards as per the guidelines to solve complex problems using appropriate techniques ensuring safety, environment and sustainability.

CO2. Analyze the causes and impacts of disasters using appropriate tools and techniques and suggest mitigation measures ensuring safety, environment and sustainability besides communicating effectively in graphical form.

CO3. Suggest the preparedness measures using appropriate tools and techniques and suggest mitigation measures ensuring safety, environment and sustainability.

CO4. Analyze the Risk Assessment using appropriate tools and techniques and suggest mitigation measures ensuring safety, environment and sustainability.

CO5. Design disaster management strategies to solve pre, during and post disaster problems using appropriate tools and techniques following the relevant guidelines and latest developments ensuring safety, environment and sustainability besides communicating effectively in graphical form.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	2	2	2	2	2	-	-	-	-
CO2	3	3	-	2	2	2	2	-	-	2	-	-
CO3	3	3	-	2	2	2	2	-	-	-	-	-
CO4	3	3	-	3	2	2	2	-	-	-	-	-
CO5	3	2	3	2	2	2	1	2	-	1	3	2
Course Correlation Mapping	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**-**	**2**	**3**	**2**

Correlation Levels: 3: High; 2: Medium; 1: Low

COURSE CONTENT

Module 1: DISASTER PRONE AREAS IN INDIA ***(09 Periods)***

Introduction: Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types And Magnitude. **Disaster Prone Areas:** Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics.

Module 2: REPERCUSSIONS OF DISASTERS AND HAZARDS ***(09 Periods)***

Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

Module 3: DISASTER PREPAREDNESS AND MANAGEMENT ***(11 Periods)***

Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

Module 4: RISK ASSESSMENT ***(08 Periods)***

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.

Module 5: DISASTER MANAGEMENT ***(08 Periods)***

Disaster management organization and methodology, Disaster management cycle, Disaster management in India – Typical cases and Cost–benefit analysis, Disaster management programs implemented by NGOs and Government of India, Usage of GIS and Remote sensing techniques in disaster management, Leadership and Coordination in Disaster management, Emerging trends in disaster management.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Perform hazard assessment and vulnerability analysis for any nearby town/city and prepare a detailed report of possible impacts of various disasters on environment, infrastructure and development.
2. Prepare a detailed report on the causes and effects of Tsunami that was occurred in the year 2004. Also discuss various advancements in Tsunami warning systems.
3. Identify the major causes of urban floods in cities like Chennai, Hyderabad & Mumbai. Also list various mitigation strategies to reduce the impact of floods.
4. Prepare a detailed report on how various man-made activities are directly/indirectly related to the occurrence of landslides that occurred in recent days in India.
5. Visit AP State Disaster Response and Fire Services Department and record about various methods used by them in mitigating disasters and their management.

RESOURCES

TEXT BOOKS:

1. Sharma V. K., *Disaster Management, Medtech Publishing, 2nd Edition, 2013*.
2. Anand S. Arya, Anup Karanth, and Ankush Agarwal, *Hazards, Disasters and Your Community: A Primer for Parliamentarians*, GOI–UNDP Disaster Risk Management Programme, Government of India, National Disaster Management Division, Ministry of Home Affairs, New Delhi, Version 1.0, 2005

REFERENCE BOOKS:

1. Donald Hyndman and David Hyndman, *Natural Hazards and Disasters*, Cengage Learning, USA, 5th Edition, 2015.
2. *Disaster Management in India,* A Status Report, Ministry of Home Affairs, Govt. of India, May 2011.
3. Rajendra Kumar Bhandari, *Disaster Education and Management: A Joyride for Students, Teachers, and Disaster Managers*, Springer India, 2014.
4. Singh R. B., *Natural Hazards and Disaster Management*, Rawat Publications, 2009.
5. R. Nishith, Singh AK, *Disaster Management in India: Perspectives, issues and strategies,* New Royal book Company.
6. Sahni, PardeepEt.Al. (Eds.), *Disaster Mitigation Experiences And Reflections*, Prentice Hall of India, New Delhi.
7. Goel S. L. , *Disaster Administration And Management Text And Case Studies*, Deep &Deep Publication Pvt. Ltd., New Delhi

VIDEO LECTURES:

1. https://nptel.ac.in/courses/105104183
2. https://www.digimat.in/nptel/courses/video/124107010/L01.html

Web Resources:

1. https://egyankosh.ac.in/handle/123456789/25093
2. https://www.egyankosh.ac.in/handle/123456789/25912
3. https://www.nios.ac.in/media/documents/333courseE/12.pdf
4. https://ndmindia.mha.gov.in/images/public-awareness/Primer%20for%20Parliamentarians.pdf