MOHAN BABU UNIVERSITY

SreeSainath Nagar, Tirupati – 517 102

SCHOOL OF ENGINEERING

M. Tech - Machine Design

CURRICULUM AND SYLLABUS

(From 2025-26 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.
- Instill 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	
25MM201403	Applied Statistics and Queuing Theory	3	-	-	-	3	-
25EE201001	Research Methodology	3	-	-	-	3	-
25EE201002	Innovation and Intellectual Property Rights	2	-	-	-	2	-
25ME211001	Internship	-	-	-	-	2	-
25ME209001	Project Work Phase - I	-	-	-	-	10	-
25ME210001	Project Work Phase - II	-	-	-	-	14	-
Mandatory Courses (Min. 4 Credits to be earned, Earned Credits will not be considered for CGPA)							
25CB207601	Essentials of Cyber Security *	2	-	-	-	2	-
25AI207601	Statistics with R	2	-	-	-	2	-
25MG207601	Project Management	2	-	-	-	2	-
25MG207602	Essentials of Business Etiquette	2	-	-	-	2	-
25LG207601	Technical Report Writing	2	-	-	-	2	-

*Compulsory Course

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	
25ME201001	Advanced Machine Design	3	-	-	-	3	-
25ME201002	Advanced Solid Mechanics	3	-	-	-	3	-
25ME201003	Experimental Stress Analysis	3	-	-	-	3	-
25ME201004	Advanced Mechanical Vibrations and Diagnostics	3	-	-	-	3	Experimental Stress Analysis
25ME201005	Advanced Finite Element Analysis	3	-	-	-	3	-
25ME201006	Advanced Optimization Techniques	3	-	-	-	3	-
25ME205001	Design Practice Lab -I	-	-	3	-	1.5	-
25ME205002	Numerical Simulation Lab	-	-	3	-	1.5	-
25ME205003	Design Practice Lab -II	-	-	3	-	1.5	-
25ME205004	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	
25ME201007	Advanced Composite Technologies	3	-	-	-	3	-
25ME201008	Design of Pressure Vessels	3	-	-	-	3	-
25ME201009	Experimental Techniques and Data Analysis	3	-	-	-	3	-
25ME201010	Fracture and fatigue Mechanics	3	-	-	-	3	-
25ME201011	Industrial Robotics and Expert Systems	3	-	-	-	3	-
25ME201012	Mechanical Measurements and Controls	3	-	-	-	3	-
25ME201013	Product Design	3	-	-	-	3	-
25ME201014	Theory of Plasticity	3	-	-	-	3	-
25ME201015	Tribology in Design	3	-	-	-	3	-
25ME201016	AI & ML for Mechanical Systems	3	-	-	-	3	-
25ME201017	Computational Fluid Dynamics	3	-	-	-	3	-
25ME201018	Computer Aided Geometric Design	3	-	-	-	3	-
25ME201019	Experimental Modal Analysis	3	-	-	-	3	Advanced Mechanical Vibrations
25ME201020	Mechatronics	3	-	-	-	3	-
25ME201021	Multibody Dynamics	3	-	-	-	3	-
25ME201022	Quality Concepts in Design	3	-	-	-	3	-
25ME201023	Vehicle Dynamics	3	-	-	-	3	-
25ME201024	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	
25AI201701	Business Analytics	3	-	-	-	3	-
25AI201702	Ethics for AI	3	-	-	-	3	-
25CM201701	Cost Management of Engineering Projects	3	-	-	-	3	-
25CE201701	Disaster Management	3	-	-	-	3	-
25SS201701	Value Education	3	-	-	-	3	-
25SS201702	Pedagogy Studies	3	-	-	-	3	-
25LG201701	Personality Development through Essential Life Skills	3	-	-	-	3	-
25ME201701	Entrepreneurship and Innovation Management	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
25MM201403	APPLIED STATISTICS AND QUEUING THEORY	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course Covers a detailed discussion on the concepts of Time series analysis components, growth curves and their fitting and dispersion and also discussion on seasonal variations. This course also examines Queuing Theory.

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

CO1. Demonstrate the knowledge on the time series and its components and different models in time series.

CO2. Apply knowledge on AR, MA, ARMA, ARIMA models in time series and analysis.

CO3. Demonstrate the knowledge on the variable and attribute charts in quality control.

CO4. Solve the single channel Queuing models related to various engineering fields.

CO5. Identify the steady-state solutions for Queuing models and M/M/1 and M/M/c models.

CO-PO Mapping Table:

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

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

COURSE CONTENT

Module 1: TIME SERIES (09 Periods)

Time series and its components with illustrations, additive, multiplicative and mixed models. Determination of trend by least squares and moving average methods. Growth curves and their fitting with reference to Modified exponential, Gompertz and Logistic curves. Determination of seasonal indices by ratio to trend method.

Module 2: MODELS FOR TIME SERIES DATA (09 Periods)

Autocovariance and autocorrelation functions, stationary processes, Moving average (MA) processes, Auto Regressive (AR) processes, Auto Regressive and Moving Average (ARMA) processes. Auto Regressive Integrated and Moving Average (ARIMA) processes.

Module 3: STATISTICAL QUALITY CONTROL (09 Periods)

Importance of SQC in industry. Statistical basis of she wart control charts. Construction of control charts for variables and attributes (p, np charts) and their Interpretation. Control charts for attributes (c and u charts with fixed sample sizes) and their Interpretation.

Module 4: QUEUING THEORY (09 Periods)

Introduction to Queuing Models, Characteristics of Queuing Models, Single Channel Queuing Theory, Solution to Single Channel Queuing Models, Application of Queuing Theory.

Module 5: QUEUING MODELS (09 Periods)

Specifications and effectiveness measures. Steady state solutions of M/M/1 and M/M/c models with associated distributions of queue length and waiting time. Steady-state solutions of M/Ek/1 and Ek/M/1 queues.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Forecast AMAZON Stock price data for one year using Time series model.
2. Forecasting Future Sales using ARIMA Model.
3. Customers arrive at a one window drive through pharmacy according to a Poisson distribution with a mean of 10 per hour. The service time per customer is exponential with a mean of 5 minutes. There are 3 spaces in front of the window, including that for the car being served. Other arriving cars can wait outside these 3 spaces. The pharmacy is interested in answering the following questions:
4. What is the probability that an arriving customer can enter one of the 3 spaces in front of the window?
5. What is the probability that an arriving customer will have to wait outside the 3 spaces?
6. What is the probability that an arriving customer has to wait?
7. How long is an arriving customer expected to wait before starting service?

RESOURCES

TEXT BOOKS:

1. VK Kapoor and SC Gupta, Fundamentals of applied statistics ,4th edition, Sultan Chand & Sons,2014
2. Hamdy A. Taha, Operations Research – An Introduction, 10thedition, Pearson Education, 2019.

REFERENCE BOOKS:

1. Mukhopadhyay. parimal, Applied Statistics, 2nd edition, Books and Allied Pvt. Ltd,2011
2. Brockwell, P.J. and Davis, R.A, Introduction to Time Series and Forecasting, 2nd edition Springer.2003.
3. Chatfield, C, Time Series Forecasting,1st edition, Chapman & Hall,2000
4. U. Narayana Bhat, "An Introduction to Queuing Theory: Modelling and Analysis in Applications" 1stedition , Spriger,2015

VIDEO LECTURES:

1. https://nptel.ac.in/courses/103106123
2. https://nptel.ac.in/courses/111104137

WEB RESOURSES:

1. http://www.iitg.ernet.in/skbose/qbook/qbook.html

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
25EE201001	**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	-	-	3	-	-
CO2	-	2	-	3	-	-
CO3	-	-	2	3	-	-
CO4	-	-	-	3	-	2
CO5	-	-	-	-	3	2
Course Correlation Mapping	**3**	**2**	**2**	**3**	**3**	**2**

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, and 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 RESOURSES

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/

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
25EE201002	**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:

Course 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 Mapping	**3**	**-**	**2**	**-**	**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: TRADESECRETS (06 Periods)

Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, and 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.

(Note: It's an indicative one. The course instructor may change the activities and shall be reflected in the course handout.)

RESOURSES

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. NeerajP. & 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 RESOURSES

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/)

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
25ME211001	**INTERNSHIP**	-	-	-	-	2

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Expose students to the industrial environment; Create competent professionals for the industry; sharpen the real time technical / managerial skills required at the job; Gain professional experience and understand engineer's responsibilities and ethics; Familiarize with latest equipment, materials and technologies; Gain exposure to technical report writing; Gain exposure to corporate working culture

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

CO1. Analyze latest equipment, materials and technologies that are used in industry to solve complex engineering problems following relevant standards, codes, policies and regulations.

CO2. Analyze safety, health, societal, environmental, sustainability, economical and managerial factors considered in industry in solving complex engineering problems.

CO3. Perform individually or in a team besides communicating effectively in written, oral and graphical forms on practicing engineering.

CO-PO Mapping Table:

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

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

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
25ME209001	**PROJECT WORK PHASE -I**	-	-	-	-	10

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Identification of topic for the project work; Literature survey; Collection of preliminary data; Identification of implementation tools and methodologies; Performing critical study and analysis of the topic identified; Time and cost analysis; Implementation of the project work; Preparation of thesis and presentation.

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

CO1. Design and develop advanced machine components, systems, or processes to address complex engineering and allied problems in machine design using modern tools, analytical techniques, and simulations, while adhering to relevant standards, codes, policies, safety regulations, and latest technological developments

CO2. Consider societal needs, human health, safety, environmental impact, sustainability, economics, and project management principles while addressing complex engineering and allied problems in machine design.

CO3. Work effectively as an individual or as a member/leader in a multidisciplinary team, and communicate clearly in written, oral, and graphical forms on machine design systems, processes, and projects.

CO-PO Mapping Table:

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

Correlation Level: 3-High; 2-Medium; 1-Low

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
25ME210001	**PROJECT WORK PHASE -II**	-	-	-	-	10

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Identification of topic for the project work; Literature survey; Collection of preliminary data; Identification of implementation tools and methodologies; Performing critical study and analysis of the topic identified; Time and cost analysis; Implementation of the project work; Preparation of thesis and presentation.

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

CO1. Design and develop advanced machine components, systems, or processes to address complex engineering and allied problems in machine design using modern tools, analytical techniques, and simulations, while adhering to relevant standards, codes, policies, safety regulations, and latest technological developments

CO2. Consider societal needs, human health, safety, environmental impact, sustainability, economics, and project management principles while addressing complex engineering and allied problems in machine design.

CO3. Work effectively as an individual or as a member/leader in a multidisciplinary team, and communicate clearly in written, oral, and graphical forms on machine design systems, processes, and projects.

CO-PO Mapping Table:

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

Correlation Level: 3-High; 2-Medium; 1-Low

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
25CB207601	**ESSENTIALS OF CYBER SECURITY**	2	-	-	-	2

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed discussion on Cyber Security Fundamentals, Cyber Security Fundamentals, Attacker techniques and motivations, Fraud techniques, Threat infrastructure, Exploitation, Malicious code, Defense and analysis techniques, Intrusion detection techniques

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

CO1. Understanding the fundamental concepts of cyber security concepts

CO2. Identify the pattern of launching attacker and fraud techniques to reduce risk and impact of cyber-attacks.

CO3. Identify the vulnerabilities using the SQL injection and web exploitation techniques in a system for securing data.

CO4. Apply code obfuscation techniques to prevent any unauthorized party from accessing logic of an application

CO5. Apply honey pots and malicious code-naming techniques to defend against attacks in memory.

CO-PO Mapping Table:

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

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

COURSE CONTENT

Module 1: CYBER SECURITY FUNDAMENTALS **(05 Periods)**

Network Security Concepts: Information assurance fundamentals, Basic cryptography, Symmetric encryption, Public key encryption, The Domain Name System (DNS), Firewalls, Virtualization, and Radio-Frequency Identification.

Module 2: ATTACKER TECHNIQUES **(07 Periods)**

Attacker techniques and motivations: Anti forensics, proxy usage, Tunneling techniques: HTTP, DNS, ICMP, Intermediaries, Steganography and other concepts, Detection and prevention.

Fraud techniques: Phishing, smishing, vishing and mobile malicious code, rogue antivirus, click fraud.

Threat infrastructure: Botnets, Fast Flux, Advanced Fast Flux.

Module 3: EXPLOITATION **(06 Periods)**

Shellcode, Integer overflow vulnerabilities, Stack based buffer overflows, Format string vulnerabilities, SQL injection, Malicious PDF files, Race conditions, Web exploit tools, DoS conditions, Brute force and dictionary attacks.

Module 4: MALICOUS CODE **(06 Periods)**

Worms, viruses, Evading detection and elevating privileges: obfuscation, Virtual Machine obfuscation Persistent software techniques, Token kidnapping, Virtual machine Detection, Rootkits, Spyware, Attacks against privileged user accounts and escalation of privileges, Stealing information and Exploitation.

Module 5: DEFENSE AND ANALYSIS TECHNIQUES **(06 Periods)**

Importance of memory forensics, Capabilities of memory forensics, Memory analysis frameworks, Dumping physical memory, Installing and using volatility, Finding hidden processes, Volatality analyst pack.

Honeypots, Malicious code naming, Automated malicious code analysis systems, Intrusion detection techniques

Total Periods:30

EXPERIENTIAL LEARNING

1. Observe the firewall settings on your personal computer or smartphone.
    - What configurations are enabled?
    - How does this firewall protect your device from threats?
2. Compare phishing, smishing, and vishing using real-life examples. Which of these do you think people are most vulnerable to, and why?
3. Research a recent DoS attack in the news.
    - What services were affected?
    - What preventive measures could have reduced the impact?
4. Explore your antivirus software logs.
    - What types of threats were blocked recently?
    - Were any of them worms, viruses, or spyware?
5. Reflect on the importance of intrusion detection systems (IDS).
    - How does an IDS differ from a firewall?
    - Why are both needed in an organisation's security framework?

RESOURCES

TEXT BOOKS:

1. James Graham, Richard Howard, Ryan Olson, "Cyber Security Essentials", CRC Press, 2011.
2. Chwan-Hwa(john) Wu,J. David Irwin, "Introduction to Cyber Security", CRC Press T&F Group.

REFERENCE BOOKS:

1. Nina Godbole and SunitBelpure, "Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley publications.
2. B.B.Gupta, D.P.Agrawal, HaoxiangWang, "Computer and Cyber Security: Principle s, Algorithm, Applications, and Perspectives", CRC Press, ISBN 9780815371335, 2018.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/106106129
2. https://www.coursera.org/professional-certificates/ibm-cybersecurity-analyst

WEB RESOURSES

1. https://www.interpol.int/en/Crimes/Cybercrime
2. https://www.geeksforgeeks.org/ethical-hacking/cyber-security-tutorial/
3. https://owasp.org/www-project-top-ten/
4. https://www.netacad.com/courses/cybersecurity-essentials?courseLang=en-US

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
25AI207601	**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 the scope of inference through the computation of confidence intervals. The topics covered in the course 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 and Statistical 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 investigate the distribution of data.

CO-PO Mapping Table:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
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, and 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 MLB Attend (Using R) 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 RESOURSES

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/

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
25MG207601	**PROJECT MANAGEMENT**	2	-	-	-	2

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: To understand the importance of decision-making while implementing any project and interpret and discuss the results of qualitative and quantitative analysis

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

CO1. Understand the basic introduction to project management

CO2. Apply the methods of project identification and selection.

CO3. Understand project allocation methods and evaluation.

CO4. Analyse the techniques for project time, review, and cost

CO5. Understand the factors of risk and quality of a project.

CO-PO Mapping Table:

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

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

COURSE CONTENT

Module 1: INTRODUCTION (05 Periods)

Concept of project management, project definition and key features of projects, project life cycle phases, typical project management issues, basic project activities

Module 2: PROJECT IDENTIFICATION AND SELECTION (06 Periods)

Identification and screening (brainstorming, strength and weakness in the system, environmental opportunities and threats), Project evaluation methods- Payback period, Net present value, Internal rate of return and project evaluation under uncertainty.

Module 3: PROJECT RESOURCE MANAGEMENT (07 Periods)

Scheduling resources, resource allocation methods, project crashing and resource leveling, working of systems, design of systems, project work system design, project execution plan, project procedure manual project control system, planning scheduling and monitoring

Module 4: TIME AND COST MANAGEMENT (05 Periods)

Time Management-Network diagram, forward and backward pass, critical path, PERT and CPM, AOA and AON methods, tools for project network, Cost management-earned value method

Module 5: RISK AND QUALITY MANAGEMENT (07 Periods)

Risk identification, types of risk, risk checklist, risk management tactics, risk mitigation and contingency planning, risk register, communication management, Quality assurance and quality control, quality audit, methods of enhancing quality

Total Periods: 30

EXPERIENTIAL LEARNING

1. Refer to any video lecture on project evaluation methods and give a brief seminar using PPT

2. Select any company wherein you will get the details of activities and time and draw the project network diagram and submit a report.

3.

Activity	Predecessor Activity	Normal Time (Weeks)	Crash Time (Weeks)	Normal Cost (Rs.)	Crash Cost (Rs.)
A	-	4	3	8,000	9,000
B	A	5	3	16,000	20,000
C	A	4	3	12,000	13,000
D	B	6	5	34,000	35,000
E	C	6	4	42,000	44,000
F	D	5	4	16,000	16,500
G	E	7	4	66,000	72,000
H	G	4	3	2,000	5,000

Determine a crashing scheme for the above project so that the total project time is reduced by 3 weeks.

4. Collect any case study that discusses the process of probability calculation of success of the project and submit a report.

RESOURCES

TEXT BOOKS:

1. R.Panneerselvam and P.Senthil Kumar (2013), Project Management, PHI Learning Private Limited.
2. Prasanna Chandra (2014), Projects: Planning, Analysis, Selection, Financing, implementation, and Review.

REFERENCE BOOKS:

1. A Guide to the Project Management Body of Knowledge: (PMBOK Guide) by Project Management Institute, 2013.
2. Gopala Krishnan & Rama Murthy, A Text book of Project Management, McMillan India.
3. S. Choudhary (2004), Project Management, Tata McGraw Hill Publication.

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc19_mg30/preview
2. https://archive.nptel.ac.in/courses/110/104/110104073/

WEB RESOURSES

1. https://www.pmi.org/about/learn-about-pmi/what-is-project-management
2. https://www.manage.gov.in/studymaterial/PM.pdf

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
25MG207602	**ESSENTIALS OF BUSINESS ETIQUETTE**	2	-	-	-	2

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course develops the concept of business etiquette and the proper etiquette practices for different business scenarios. It builds student awareness of professional conduct and cultural sensitivity, preparing them to navigate diverse global environments with confidence, respect, and appropriate etiquette for every scenario.

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

CO1. To understand the concept of Etiquette.

CO2. Develop life skills or etiquette in order to succeed in corporate culture.

CO3. Present oneself with finesse and making others comfortable in a business

CO4. Adopt behaviors consistent with standard workplace expectations

CO5. Demonstrate an understanding of professionalism in terms of workplace behaviors and work place relationships.

CO-PO Mapping Table

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

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

COURSE CONTENT

Module 1: INTRODUCTION TO ETIQUETTE (06 Periods)

Introduction to etiquette, benefits- Business etiquette – ABCs of etiquette- Manners, poor manners and good manners- - Role of good manners in business –Professional conduct and personal spacing.

Module 2: CLASSIFICATION OF ETIQUETTE (06 Periods)

Telephone Etiquette - Email etiquette - Dining Etiquette - Dress Etiquette, - Online chat etiquette - Virtual Etiquette - Work place Etiquette

Module 3: MULTI-CULTURAL ETIQUETTE (06 Periods)

Inclusivity and Diversity - cultural awareness –cultural sensitivity - Adaptability and Flexibility - Inter-cultural communication - Ethical Considerations -Taboos and practices

Module 4: WORKPLACE COURTESY AND BUSINESS ETHICS (06 Periods)

Workplace Courtesy - Business Ethics - Hierarchy and Protocol - Developing good relations with peers, superiors, subordinates - Offering compliments and criticism-Preventing Sexual Harassment - Conflict Resolution Strategies

Module 5: NEW ISSUES IN ETIQUETTE &WORKPLACE SUCCESS (06Periods)

Ethical Issues in Business Etiquette - Cultural Differences and their Effects on Business Etiquette - Sexual Etiquette in the Workplace - Preventing Sexual Harassment-Professionalism - Interpersonal relations- Following Company Policy for Business Etiquette

Total Periods: 30

EXPERIENTIAL LEARNING

1. Role play activity in Telephone etiquette practices.
2. As a new employee, how do you follow workplace courtesies?
3. Group presentation of Etiquette in different countries.
4. Imagine you are a supervisor and explain your subordinates the importance of business etiquette.
5. You came to know that one of male employees in your company sexually harassed a female employee. As a boss of a company, how do you handle the situation and suggest steps to prevent sexual harassment at work place.

RESOURCES

TEXT BOOK:

1. Dhanavel, S.P. English and Soft Skills. Hyderabad: Orient Black Swan, 2021.
2. Pachter Barbara &Cowie Denis (2013) Essentials of Business Etiquette, New York: McGraw Hill Education.

REFERENCE BOOKS:

1. 2. Fox Sue (2010) Business Etiquette for Dummies, New Jersey: Wiley Publications.
   3. Kumar Suresh E, Shreehari P, Savithri J (2010) Communication Skills and Soft Skills: An Integrated Approach, Chennai: Pearson Education.
2. Stephen P. Robbins and Timothy A. Judge, Organizational Behaviour, Prentice Hall, Delhi, 16th edition, 2014.
3. Kumar Suresh E, Shreehari P, Savithri J (2010) Communication Skills and Soft Skills: An Integrated Approach, Chennai: Pearson Education.

VIDEO LECTURES:

1. https://in.video.search.yahoo.com/yhs/search?fr=yhs-sz-002&ei=UTF-8&hsimp=yhs-002&hspart=sz&param1=2723087361&p=cultural+awareness+%E2%80%93cultural+sensitivity+video&type=type80160-2362144563#id=8&vid=11d76fd8f4c9b5419344ccfd30f291c1&action=click
2. https://in.video.search.yahoo.com/yhs/search?fr=yhs-sz-002&ei=UTF-8&hsimp=yhs-002&hspart=sz&param1=2723087361&p=cultural+awareness+%E2%80%93cultural+sensitivity+video&type=type80160-2362144563#id=9&vid=ea7c85dbd21b03e8dec303c23c6bcb7b&action=view

WEB RESOURSES:

1. https://theengine.biz/wp-content/uploads/2020/12/Business-Etiquette-ebook.pdf
2. https://insights.si/wp-content/uploads/hunt-chaney-l.-i-st.-clair-martin-j.-2007.-the-essential-guide-to-business-etiquette.pdf
3. https://www.scribd.com/document/732526337/Types-of-Business-Etiquette-and-its-Importance

SCHOOL CORE

Course Code	Course Title	L	T	P	S	C
25LG207601	**TECHNICAL REPORT WRITING**	2	-	-	-	2

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course deals with preparing effective technical documents for both written and digital media, with particular emphasis on technical memos, problem-solving and decision-making reports, and organizational, product-support, and technical-information webs.

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

CO1. Demonstrate knowledge of Technical Report Writing and structures with a scientific attitude.

CO2. Analyze the process of writing in preparing effective reports.

CO3. Demonstrate styles of writing for Publication in a Scientific Journal.

CO4. Apply the process of referencing and editing techniques for effective communication in written documents.

CO5. Analyze the strategies in the technical report presentation.

CO-PO Mapping Table:

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

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

COURSE CONTENT

Module 1: INTRODUCTION TO TECHNICAL REPORT WRITING (06 Periods)

Concepts of Technical Report, Types of Reports, Planning Technical Report Writing, Components of a Technical Report, Report Writing in Science and Technology, Selecting and Preparing a Title, Language Use

Module 2: PROCESSOF WRITING (06 Periods)

Writing the 'Introduction', Writing the 'Materials and Methods, Writing the Findings/Results, Writing the 'Discussion', Preparing and using "Tables'.

Module 3: STYLE OF WRITING (06 Periods)

Preparing and using Effective 'Graphs', Citing and Arranging References, Writing for Publication in a Scientific Journal.

Module 4: REFERENCING (06 Periods)

Literature citations,, Bibliographical data according to ISO standards, Citations in the text, Copyright, and copyright laws, the text of the Technical Report, Using a word processing and desktop publishing (DTP) systems, Document or page layout, hints on editing Typographic details, Cross-references.

Module 5: PRESENTATION (06 Periods)

Presentation with appropriate pointing, Dealing with intermediate questions, Review and analysis of the presentation, Rhetoric tips from A to Z.

Total Periods: 30

EXPERIENTIAL LEARNING

1. Prepare a report on technologies of modern times that enriched the originality of research works and their impacts on society concerning plagiarism.
2. Make PowerPoint presentations on the various style of writing academic reports.
3. Error-free Reports are so important for successful communication and sharing of information. Prepare a detailed chart on proofreading techniques to make a report effective and error-free.
4. Design a logo for a company and write down the copy-right laws for that.
5. Read research articles from any international journal of science and technology and differentiate research writing from other academic and non-academic writings.
6. Write an organizational memo Include a heading, introduction, and summary at the beginning of your memo, and present the details of your discussion in a logical order. Use headings and topic or main-idea sentences to clarify the organization.
7. Prepare an appraisal report on the staff performance of your company.
8. Prepare a PowerPoint presentation on the annual performance report of a company.
9. Critically review and write a report on any one of the recently released products.
10. Read the newspaper and write a detailed report about the content coverage and analyse the factors for the popularity of the newspaper.

RESOURCES

TEXTBOOK:

1. RC Sharma Krishna Mohan, "Business Correspondence and Report" McGraw-Hill Publishing. Writing," Tata Company Limited, New Delhi", 3rd Edition, 2005 (reprint).

2. Patrick Forsyth, "How to Write Reports and Proposals", THE SUNDAY TIMES (Kogan Page), New Delhi, Revised 2ndEdition, 2010.

REFERENCE BOOKS:

1. John Seely, "The Oxford Writing & Speaking", Oxford University Press, Indian Edition

2. Anne Eisenberg, "A Beginner's Guide to Technical Communication", McGraw-Hill Education (India) Private Limited, New Delhi, 2013.

VIDEO LECTURES:

1. https://vimeo.com/143714818

2. https://digitalmedia.sheffield.ac.uk/media/002.+The+Anatomy+of+a+Technical+Report/1_u8wntcge

WEB RESOURSES:

1. http://www.resumania.com/arcindex.html

2. http://www.aresearchguide.com/writing-a-technical-report.htm

3. http://www.sussex.ac.uk/ei/internal/forstudents/engineeringdesign/studyguides/tec report writing

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
25ME201001	**ADVANCED MECHINE 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. Analyze the static failure for ductile and brittle materials.

CO3. Design machine components using techniques like stress life approach, Strain life approach and Fracture mechanics approach.

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:

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			
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: 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 3: ADVANCED FATIGUE CHARACTERIZATION AND LIFE ESTIMATION (09 Periods)

Stress-Life(S-N) Approach: S-N curves, Statistical nature of fatigue Test data, General SN behavior, Mean stress effects, Different factors influencing S-N behaviour, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using S- N approach. Strain-Life (ε-N)approach: Monotonic stress-strain behavior, Strain controlled test methods, Cyclic stress-strain behavior, Strain based approach to life estimation, Determination of strain life fatigue properties, Mean stress effects, Effect of surface finish, Life estimation by ε-N approach.

Module 4: FRACTURE MECHANICS AND NOTCH ANALYSIS (08 Periods)

LEFM Approach: LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation. Notches and their effects: Concentrations and gradients in stress and strain, S-N approach for notched membranes, mean Stress effects and Haigh diagrams, Numerical examples.

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 RESOURSES:

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
25ME201002	**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, Advanced stress analysis in anisotropic and functionally graded materials.

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, Digital Image Correlation (DIC) techniques for strain measurement (Intro level)

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

Yield Criteria: Theories of Failure, Significance, Use of Factor of Safety in Design, Ideally Plastic Solid, Stress Space and Strain Space, Yield Locus, Yield Surfaces of Tresca and Von Mises, Prandtl–Reuss Equations, Saint Venant–Von Mises Equations, Introduction to non-linear material models in FEM, - Overview of damage mechanics and ductile failure prediction.

Module 4: AXISYMMETRIC PROBLEMS (08 Periods)

Thick-Walled Cylinder—Lame's Problem, Composite Tubes—Shrink Fits, Stresses Due to Gravitation, Rotating Disks, Shafts, and Cylinders, FEM-based modeling of axisymmetric structures using software (demo/tutorial-based), Design of pressure vessels in aerospace and biomedical applications.

Module 5: INTRODUCTION TO COMPOSITE MATERIALS (08 Periods)

Stress–Strain Relations, Elastic Symmetry, Ply Stress and Strain, Failure Criteria, Pressure Vessels, Transverse Stresses, Bio-composites and nano-reinforced composites, Composite mechanics under cryogenic and high-temperature environments, Introduction to sustainability in composite selection.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Use of simulation tools (ANSYS/ABAQUS) to model stress distribution in structural components.
2. Conducting tensile tests on bio-composites and metal matrix composites.
3 Mini project: Stress–strain behavior of additively manufactured (3D printed) parts.

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.
3. Bower, A. F. (2010). Applied Mechanics of Solids, CRC Press
4. Robert M. Jones, Mechanics of Composite Materials, CRC Press, 2nd Edition, 2014

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.
4. Ugural, A. C., & Fenster, S. K. (2012). Advanced Strength and Applied Elasticity, Pearson

VIDEO LECTURES:

1. https://nptel.ac.in/courses/107106080
2. https://nptel.ac.in/courses/107106088
3. https://nptel.ac.in/courses/112106268 (Advanced Solid Mechanics – IIT Madras)
4. https://nptel.ac.in/courses/112104320 (Mechanics of Composite Materials – IIT Kanpur)

WEB RESOURSES:

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
3. https://ocw.mit.edu/courses/mechanics-of-materials
4. https://compositesworld.com – Latest in composites

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
25ME201003	**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. Learn to measure structural vibrations, pressure, and airflow using transducers, plotters, and wind tunnel systems.

CO3. Identify structural distress causes, crack behavior, and apply diagnostic tools for damage assessment and demolition control.

CO4. Explore non-destructive testing methods like rebound hammer and ultrasonics to evaluate structural integrity without damage.

CO5. Apply model analysis principles and similitude laws to simulate, study, and interpret structural behaviour accurately.

CO-PO Mapping Table:

Course 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: MEASUREMENT OF VIBRATION AND WIND FLOW (08 Periods)

Measurement of Vibration- Vibration Galvanometers- Vibrometer-Characteristics of Structural vibration- Pressure gauges Velocity transducers- Seismic transducers – Linear Variable Differential Transformer- Cathode ray oscilloscope – X Y Plotter- Wind Tunnels- Flow meters- Venturimeter- Digital Data Acquisition systems.

Module 3: DISTRESS MEASUREMENT AND CONTROL (10 Periods)

Diagnosis of distress in structures-Cracks in structures-Formation of cracks- Types of cracks-Causes of cracks- Crack measurement- Monitoring and measurement of crack movement- Corrosion of reinforcement in RCC- Half cell-Construction and use-Damage assessment-Controlled blasting for demolition.

Module 4: N.D.T. METHODS (08 Periods)

Load testing on structures-In situ load testing-Ultimate load testing-Rebound hammer-Principle and Applications-Limitations Ultrasonic testing- Principles and Applications-Brittle coating- Principle and Applications- Stress coat- All Temp Comparison of brittle coatings- Evaluation of the coating.

Module 5: MODEL ANALYSIS (10 Periods)

Model laws- Laws of similitude-Model materials- Model testing- Necessity for Model analysis-Advantages- Applications Types of similitude- Scale effect in Models- Indirect model study- Direct model study- Limitations of model investigations Structural problems that may demand model studies- Usage of influence lines in model studies.

Total Periods: 45

EXPERIENTIAL LEARNING

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

RESOURCES

TEXT BOOKS:

1. Dally J.W. and Riley W.F., "Experimental stress Analysis", McGraw Hill, Inc. New York, 1991.
2. Srinath L.S. et al, "Experimental Stress Analysis", Tata McGraw Hill Publishing Co. Ltd., New Delhi,1984.
3. Rangan C.S., "Instrumentation – Devices and Systems", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1983.

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, New Delhi, 1996.
4. Sirohi R.S., Radhakrishna H.C., "Mechanical Measurements", New Age International Pvt. Ltd., 1997.

VIDEO LECTURES:

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

WEB RESOURSES

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
25ME201004	**ADVANCED MECHANICAL VIBRATIONS AND DIAGNOSTICS**	3	-	-	-	3

Pre-Requisite Experimental Stress Analysis

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, Vibration isolation principles in automotive suspensions and dynamic response of aerospace panels and MEMS-based sensor elements.

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, Dynamic behavior analysis of rotor-bearing systems, engine mounts, and vibration control in aerospace landing gear using MDOF modelling.

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, Application to continuous structures in automotive frames, aircraft wings, and micro-scale vibrating cantilevers used in MEMS devices; Introduction to nonlinear and random vibrations.

Module 4: NUMERICAL METHODS (09 Periods)

Rayleigh's method; Stodola's method; Matrix iteration method; Rayleigh-Ritz Method; Holzer's method; Numerical formulation and solution of vibration problems in rotating components, drive shafts, and composite aerospace structures using MATLAB and Python.

Module 5: NOISE MEASUREMENT AND CONTROL (09 Periods)

Sound Level Meters, Intensity Level Meters, Octave Band Filters Acoustic Analysers, Dosimeter, Measurement of Sound Power, and Impact of noise on humans, Weighting, Noise control strategy, sound absorption and insulation. Application to cabin noise control in automobiles, engine compartment acoustic insulation, and MEMS-based acoustic noise sensing systems.

Total Periods: 45

EXPERIENTIAL LEARNING:

1. Determination of Natural Frequencies & Modal analysis of Machine Components, Equipment's 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.
3. Complete Details will be provided in CHO.
4. Building and testing a cantilever MEMS beam setup using Arduino + vibration sensors.

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
4. Balakumar Balachandran & Edward Magrab, Vibrations, Cengage Learning, 2nd Edition, 2018.
5. Inman, D. J., Engineering Vibration, Pearson, 4th Edition, 2014.

REFERENCE BOOKS:

1. V. P. Singh, Mechanical Vibrations, Dhanpat Rai& 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.
4. William J. Bottega, Engineering Vibrations: Theory and Applications, CRC Press, 2014
5. S. S. Rao, Applied Numerical Methods for Engineers and Scientists, Pearson, 2004

VIDEO LECTURES:

1. https://archive.nptel.ac.in/courses/112/103/112103111/
2. https://nptel.ac.in/courses/112105249
3. https://nptel.ac.in/courses/112104140
4. https://ocw.mit.edu/courses/mechanical-engineering/2-003sc-engineering-dynamics-fall-2011/

WEB RESOURSES:

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
3. https://www.mathworks.com/help/vibration – MATLAB tutorials and toolboxes for vibration analysis.
4. https://asme.org – Articles and case studies on vibration control in machines and structures.

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
25ME201005	**ADVNACED FINITE ELEMENT ANALYSIS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Behaviour of mechanical components under complex environment can be analysed using advanced FEM. It deals with the finite element formulation of one dimensional problems, like trusses and beams, two dimensional problems with constant triangles, axisymmetric solids subjected to axisymmetric loading, two dimensional isoparametric elements and time dependent problems.

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

CO1. Apply the principle of variational techniques in seeking solutions to problems related to springs, bars, and beams.

CO2. Derive the expressions for elemental characteristics equation.

CO3. Compute strain and stress using the concept of global stiffness matrix in bars, stepped bars, and tapered plates.

CO4. Develop mathematical model of composite walls subjected to external and internal temperatures.

CO5. Analyse the dynamic response of the externally excited systems.

CO-PO Mapping Table:

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

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

COURSE CONTENT

Module 1: FUNDAMENTALS OF FEM (10 Periods)

Introduction to FEM, basic concepts, historical background, applications of FEM, general description, comparison with other numerical methods, variational approach, Galerkin's method. Co-ordinates, basic element shapes, interpolation function, Virtual energy principle, Rayleigh–Ritz method. Properties of stiffness matrix, treatment of boundary conditions, solution of system of equations, shape functions and characteristics, Basic equations of elasticity, strain-displacement relation. Introduction to Error Estimation and Mesh Refinement Techniques.

Module 2: ONE DIMENSIONAL PROBLEMS & NONLINEAR ANALYSIS TECHNIQUES (09 Periods)

1-D Structural Problems: Axial bar element – stiffness matrix, load vector, temperature effects. Quadratic shape functions and problems. Analysis of Trusses: Plane Trusses and Space Truss elements. Introduction to nonlinear FEM for 1D problems, material and geometric nonlinearity basics. Adaptive Meshing in 1D analysis.

Module 3: ADVANCED 2D/3D AND CONTACT ANALYSIS (08 Periods)

2-D Problems: CST, LST, force terms, Stiffness matrix and load vectors, boundary conditions. Isoparametric elements – quadrilateral element, shape functions – Numerical Integration. Finite element modelling of Axi-symmetric solids subjected to Axi-symmetric loading with triangular elements. 3-D Problems: Tetrahedron element – Jacobean matrix – Stiffness matrix. Higher Order Elements for 2D & 3D Problems. Contact Analysis basics.

Module 4: THERMAL ANALYSIS (10 Periods)

Heat Transfer Analysis: Introduction to modes of heat transfer, steady state heat transfer and governing differential equation pertaining to conduction with and without heat generation. Concepts of boundary conditions in heat transfer, derivation of elemental properties of 1-D heat element. Numerical problems related to temperature distribution in composite walls. Transient Heat Transfer. Basics of Thermo-mechanical Coupled Analysis.

Module 5: DYNAMIC & EXPLICIT ANALYSIS METHODS (08 Periods)

Dynamic considerations, Dynamic equations – consistent mass matrix – Eigen Values, Eigen vector, natural frequencies – mode shapes – modal analysis. Introduction to Explicit Dynamics. Crash and Impact Analysis basics.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Consider a conventional study chair, measure the actual dimensions and create 3D model using CAD software. Carry out the static structural analysis using ANSY work bench.
2. Create a three dimensional model of three floor building or a water head tank and carry out the dynamic analysis in ANSYS. Justify the results with analytical results.

RESOURCES

TEXT BOOKS:

1. R D Cook, D S Malkus and M E Plesha, Concepts and Applications of Finite Element Analysis, 3d ed., John Wiley, New York, 1989.
2. Chandrupatla, Tirupathi Belegundu, Ashok.D Introduction to finite elements in engineering, 4th Edition, Publications: New Delhi Pearson 2015.

REFERENCE BOOKS:

1. O C Zienkiewicz and R L Taylor, the Finite Element Method, 3d ed. McGraw-Hill, 1989.
2. K J Bathe, Finite Element Procedures in Engineering Analysis, Prentice-Hall, Englewood Cliffs, NJ, 1982.
3. J N Reddy, An introduction to the Finite Element Method, McGraw – Hill, New York, 1993.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/112106130
2. https://nptel.ac.in/courses/112104193

WEB RESOURSES:

1. https://www.twi-global.com/technical-knowledge/faqs/finite-element-analysis
2. https://www.techtarget.com/searchsoftwarequality/definition/finite-element-analysis-FEA

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
25ME201006	**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:

Course 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: Lo**

COURSE CONTENT

Module 1: FOUNDATIONS OF MATHEMATICAL OPTIMIZATION & MODELING (08 Periods)

Introduction to Optimization: Definition, importance, classifications, Formulation of optimization problems in engineering design, Types of objective functions and constraints (linear, nonlinear, equality, inequality), Convex vs. non-convex problems – importance in convergence, Feasible region, global vs. local optimum, saddle points, Case studies: Real-life formulation examples from mechanical systems (design, manufacturing, energy systems).

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, Applications of gradient methods in machine learning models, 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 MAT lab/ 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 RESOURSES:

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

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
25ME205001	**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 modelling 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. Modeling in 3D of machine tool parts like gear details, machine tool beds, tailstocks and assembly drawings of machine tools like lathe machine components, power drives, jigs & fixtures, power presses etc using ProE.

b. Use of various types of surfaces in 3D modeling, animation features and other editing entities in machine tool assemblies in ProE.

c. Tool path generation, Part Programing – G & M code development for machining operations using ProE Physical interpretation of machining features and tool geometries.

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. Kinematic and dynamic simulation of various mechanisms in machines, process simulation like Pro-Cast, Pro-Mould and other machining feature

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 RESOURSES:

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

PROGRAM CORE

Course Code	Course Title	L	T	P	S	C
25ME205002	**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 problem sin vibration, Mechanism Simulation using multibody dynamic software

CO-PO 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**	**-**	**1**	**2**

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, Florida,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 RESOURSES

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
25ME205003	**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:

Course 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 using multiple pivot points.
- **b.** Determine natural frequency of simple pendulum using both analytical and FFT-based methods.
- **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 cantilever beam with end mass – effect on damping and mode shape.
- **c.** Estimation of frequency of damped forced vibration using DAQ and FFT.
- **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.** Rotor balancing using multi-plane computerised 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 study on inversions with simulation (MATLAB/ADAMS) for various four-bar mechanisms.
- **b.** Dynamic analysis of Aeroplane wind under dynamic forcing condition
- **c.** Critical speeds of shafts with varying stiffness and boundary conditions using FFT.
- **d.** Analysis of machine vibration, signature, using FFT analyzer.

V USE OF CODING IN ANALYSIS.

- **a.** Kinematics of a planar open-loop 3-link system using MATLAB/Scilab.
- **b.** Inverse dynamics of planar system with external force inputs.
- **c.** Forward dynamics of 2R planar robotic arm using Simulink or 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 RESOURSES:

1. https://mdmv-nitk.vlabs.ac.in/exp/exp-simply-supported-beam-nitk/ orXeff4
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
25ME205004	**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:

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	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
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 an ANFIS program using MATLAB software to find the optimization parameters.
12. Implement teaching learning-based algorithm for various design problems.
13. Application of RSM using DoE.
14. Topology Optimization using MATLAB or Fusion 360

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, Fusion360.

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 RESOURSES:

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

PROGRAM ELECTIVE

Course code	Course Title	L	T	P	S	C
25ME201007	**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 fiber 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. Analyse and design 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. Modern green composites, sustainability, and recent applications in aerospace and biomedical fields.

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. Hydrothermal stresses and strains in a lamina: hygrothermal stress–strain relationships for a unidirectional lamina, hygrothermal stress–strain relationships for an angle lamina, hgyro thermal stress-strain relations for real-world performance modeling under moisture and temperature variations.

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, Modern interpretation using simulation data with FEM outputs.

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, laminate code development, and software-aided design practices.

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, AI-aided laminate design and sustainability-focused composite selection strategies.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Fabrication/analysis of Fiber reinforced composite material from Bamboo, Flex and Glass Fiber.
2. Use of simulation tools to compare stress-strain behavior of hybrid and traditional composites
3. Fabrication/analysis of Glass Hybrid Fibres Epoxy Composite Material using Hand Layup Method
4. Mini-project on laminated plate design and validation with real-time moisture and thermal variations

RESOURCES

TEXT BOOKS:

1. Isaac and M Daniel, Engineering Mechanics of Composite Materials, Oxford University Press, 1994.
2. Bhagwan D. Agarwal, Lawrence J. Broutman, K. Chandra shekhara, Analysis and performance of fibre Composites, Wiley- Interscience, New York, 4th Edition, 2017.
3. Autar K. Kaw, Mechanics of Composite Materials, CRC publications, 2nd Edition, 2006.
4. M.W. Hyer, Stress Analysis of Fiber-Reinforced Composite Materials, DES tech Publications, 2009

REFERENCE BOOKS:

1. Robert M. Jones, Mechanics of Composite Materials, CRC Press, 2nd Edition, 2015.
2. L. R. Calcote, Analysis of Laminated Composite Structures, Van Nostrand Rainfold, New York, 1969.
3. Daniel Gay, Composite Materials: Design and Applications, CRC Press, 3rd Ed, 2014

VIDEO LECTURES:

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

WEB RESOURSES:

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
25ME201008	**DESIGN OF PRESSURE VESSELS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides information on stresses in pressure vessel and its application, ASME code for pressure vessel design, supports design for pressure vessel, design consideration in pressure vessel, piping design for pressure vessel.

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

CO1. Analyse the different types of stresses and their effects in pressure vessel.

CO2. Design pressure vessel as per the standards.

CO3. Design base plate and supports as per the standards.

CO4. Design circular ring, collapse of thick walled cylinders under external pressure conditions.

CO5. Analyse the piping layout and the stresses acting on it.

CO-PO Mapping Table:

Course 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 Mapping	**3**	**-**	**2**	**-**	**2**	**2**

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

COURSE CONTENT

Module 1: STRESSES IN PRESSURE VESSEL (09 Periods)

Introduction to stresses in pressure vessel and its application to shells and end closures, stresses in circular plate, Thermal stresses, Perforated plates: Stress concentration factors for multi-hole patterns, Stresses in plate having the circular hole due to bi-axial loading, Advanced creep models (Norton-Bailey, θ-projection method), excessive elastic deformation, plastic instability, brittle, rupture and creep.

Module 2: PRESSURE VESSEL DESIGN CODE (09 Periods)

Introduction to ASME code for pressure vessel design, Pressure vessel and related components design using ASME codes; Design of nozzle

Module 3: SUPPORTS DESIGN FOR PRESSURE VESSEL (09 Periods)

Design of base plate and support lugs, Advanced support lug design: Nonlinear contact analysis. Types of anchor bolt, its material and allowable stresses, Design of saddle supports. Composite material supports for cryogenic applications

Module 4: DESIGN CONSIDERATION IN PRESSURE VESSEL (09 Periods)

Buckling phenomenon, Elastic Buckling of circular ring and cylinders under external pressure, collapse of thick walled cylinders or tubes under external pressure, Effect of supports on elastic buckling of cylinders, Buckling of functionally graded cylinders. Design of circumferential stiffness, Buckling under combined load.

Module 5: PIPING DESIGN FOR PRESSURE VESSEL (09 Periods)

Flow diagram, Piping layout and piping stress analysis, Flexibility factor and stress intensification factor, Design of piping as per B31.1 piping code, Piping components: bends, tees bellows and valve, Additively manufactured piping components. Types of piping supports and the behavior, Hydrogen embrittlement considerations in modern piping. Introduction to piping Codes and Standards.

Total Periods: 45

EXPERIENTIAL LEARNING

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

1. A study on the pressure vessel design, structural analysis and pressure test of a 6000 m depth-rated for unmanned underwater vehicle.
2. Design and Analysis of Vertical Pressure Vessel using ASME Code and FEA Technique for food processing industry.
3. **CASE STUDIES/ ARTICELS:**

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

RESOURCES

TEXT BOOKS:

1. John F.Harvey, Van no strand, "Theory and design of modern Pressure Vessels" Reihold company, New York.
2. A S Tooth, J Spence, "Pressure Vessel Design Concepts and Principles", CRC Press, 2012.

REFERENCE BOOKS:

1. Dennis R. Moss, Michael M. Basic, "Pressure Vessel Design , Elsevier Science, 2012
2. Henry H.Bednar, P.E, "Pressure Vessel Design Hand Book", C.B.S. Publishers, New Delhi.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=Z1J97IpFc2k
2. https://www.youtube.com/watch?v=OqRJh5X5Ox8

WEB RESOURSES:

1. https://info.thinkcei.com/think-tank/pressure-vessel-design
2. https://iopscience.iop.org/article/10.1088/1757-899X/923/1/012020

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25ME201009	**EXPERIMENTAL TECHNIQUES AND DATA ANALYSIS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The course is designed with the objective of giving complete concepts of experimental technique used in mechanical engineering. Through these techniques the behaviour of the system can be represented in the form of data. Later the methods of analysis and accessing acquired data would be reviled to the learners through this course contents.

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

CO1. Demonstrate the knowledge on various experimental methods.

CO2. Demonstrate experimental techniques for static and transient problems.

CO3. Apply analytical methods for nonlinear problems and solve it.

CO4. Demonstrate the knowledge on data types and DOE.

CO5. Apply statistical techniques to data modelling.

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**	**2**	**-**	**1**	**-**

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

COURSE CONTENT

Module 1: EXPERIMENTAL METHODS (10 Periods)

Electrical Filter Circuits, Digital Recording and Manipulation of Signals, Electrical Resistance Strain Gages, Advanced Wheatstone and Full-Bridge Strain Gage Circuits, Motion and Force, Digital Recording and Analysis of Images, Speckle Pattern Interferometry, Holographic Interferometry, Photoelasticity.

Module 2: STATIC PROBLEMS AND TRANSIENT PROBLEMS WITH TIME DATA (09 Periods)

Force Identification Problems, Whole-Field Displacement Data, Strain Gages, Traction Distributions, Nonlinear Data Relation, and Deconvolution using Sensitivity Responses, Experimental Studies, and Scalability Issues: Recursive Formulation, Split Hopkinson Pressure Bar (SHPB) for High-Strain Rate Testing, Identifying Localized Stiffness and Mass, Implicit Parameter Identification.

Module 3: NONLINEAR PROBLEMS (08 Periods)

Static Inverse Method, Nonlinear Structural Dynamics, Nonlinear Elastic Behaviour, Elastic-Plastic Materials, Nonlinear Parameter Identification, Dynamics of Cracks, Finite Element Model Updating using Experimental Data.

Module 4: DATA and DESIGN OF EXPERIMENTS (10 Periods)

Data: Types of Data, Population Parameters and Sample Statistics, Symmetry of the Binomial Distribution, Interval/Ratio Data: Mean, Standard Deviation, Introduction to Probability, Simple Probability, Conditional Probability, Probability Density Function and Cumulative Distribution Function.

DOE: Types of Experiments, Experiment Design Factors, Experiment Design Protocol and Examples, Taguchi Methods and Orthogonal Arrays.

Module 5: STATISTICAL ANALYSIS (08 Periods)

The Sampling Distribution of the Mean, Bootstrap Method for Confidence Interval Estimation, The Standard Normal Distribution, The Z-test, Hypothesis Testing Using 1-Sample Statistics, Falsification, The Double-Negative: The Null Hypothesis, The Consequences of Being Wrong: Confidence Intervals for the One-sample Z-test.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Construct a DOE matrix for optimizing a rectangular box using two or more variables, applying basic modelling and Taguchi or factorial design principles.
2. Perform a Z-test on a real or lab dataset using MINITAB or Design Expert, and interpret results including confidence intervals using classical or bootstrap methods.

RESOURCES

TEXT BOOKS:

1. James F. Doyle, Modern experimental stress analysis, John Wiley & Sons Ltd, 2004.
2. James A. Middleton, Experimental Statistics and Data Analysis for Mechanical and Aerospace Engineers, CRC Press, 2022.

REFERENCE BOOKS:

1. Kobayashi, A.S., Handbook on Experimental Mechanics, VCH Publishers, New York, 1993.
2. Box, G.E, Hunter, J.S, & Hunter W.G.. Statistics for experimenters. Wiley Hoboken, NJ, USA (2005).

VIDEO LECTURES:

1. http://nptel.ac.in/courses/106102064
2. http://nptel.ac.in/courses/106106127/

WEB RESOURSES:

1. https://nap.nationalacademies.org/read/4917/chapter/4
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
25ME201010	**FRACTURE AND FATIGUE MECHANICS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The course is designed to implement the theoretical knowledge about the mechanical behaviour of material, particularly focusing on fracture mechanics and fatigue characteristics to understand, assess and overcome failure. Both the linear-elastic as well elastic-plastic fracture mechanisms will be discussed. This will be followed by discussing the characteristics and mechanisms of fatigue cracks initiation and propagation.

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

CO1. Understand fracture origins, stress analysis, Griffith's theory, NDT methods, and crack problem solutions

CO2. Analyze the problems on linear elastic fracture mechanics of structures.

CO3. Understand crack growth criteria, energy concepts, EPFM parameters, CTOD, J-integral, and fracture stability.

CO4. Formulate lifetimes of components for optimal failure and fatigue conditions.

CO5. Develop Ashby charts for various materials under creep conditions.

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	3	3	-	-
CO4	3	3	3	3	-	-
CO5	3	3	3	3	-	-
Course Correlation Mapping	**3**	**3**	**3**	**3**	**-**	**-**

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

COURSE CONTENT

Module 1: FRACTURE MECHANICS PRINCIPLES (09 Periods)

Introduction and historical review, sources of micro and macro cracks. Stress concentration due to elliptical hole, strength ideal materials, and Griffith's energy balance approach. Fracture mechanics approach to design. NDT and Various NDT methods used in fracture mechanics, numerical problems. The Airy stress function, complex stress function, solution to crack problems, effect of finite size, special cases, and elliptical cracks.

Module 2: LINEAR ELASTIC FRACTURE MECHANICS (09 Periods)

Linear Elastic Fracture Mechanics (LEFM): Three loading modes and the state of stress ahead of the crack tip, stress concentration factor, stress intensity factor and the material parameter the critical stress intensity factor.

The effect of Constraint: Define plane stress and plane strain and the effect of component thickness. The plasticity at the crack tip and the principles behind the approximate derivation of plastic zone shape and size. Limits on the applicability of LEFM.

Module 3: CRACK RESISTANCE AND STABILITY (09 Periods)

The energy release rate, and criteria for crack growth. The crack resistance (R curve), compliance, J integral, tearing modulus and stability. Elastic Plastic Fracture Mechanics (EPFM): Fracture beyond general yield. The crack-tip opening displacement, the use of CTOD criteria, and experimental determination of CTOD. Parameters affecting the critical CTOD, use of J integral, and limitation of J integral.

Module 4: FATIGUE (09 Periods)

Definition of terms used to describe fatigue cycles, High Cycle Fatigue, Low Cycle Fatigue, mean stress R ratio, strain and load control. S-N curves. Goodman's rule and Miners rule. Micro mechanisms of fatigue damage, fatigue limits and initiation and propagation control, leading to a consideration of factors enhancing fatigue resistance. Total life and damage tolerant approaches to life prediction.

Module 5: CREEP DEFORMATION (09 Periods)

The evolution of creep damage, primary, secondary and tertiary creep. Micro-mechanisms of creep in materials and the role of diffusion. Ashby creep deformation maps. Stress dependence of creep – power law dependence. Comparison of creep performance under different conditions – extrapolation and the use of Larson-Miller parameters. Creep-fatigue interactions. Examples.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Create an Ashby creep chart with simulation software or traditional ways to comprehend material creep deformation.
2. Use S-N curve analysis to examine materials under low- and high-cycle fatigue situations.

RESOURCES

TEXT BOOKS:

1. Dowling, Norman E. Mechanical behavior of materials: engineering methods for deformation, fracture, and fatigue, Pearson, 4th edition, 2012.
2. Hull, Derek, and David J. Bacon, Introduction to dislocations, Butterworth-Heinemann, 5th edition, 2001.

REFERENCE BOOKS:

1. G. E. Dieter, Mechanical Metallurgy, McGraw Hill Education, 3rd edition, 2017.
2. Thomas .G. Beckwith, Lewis Buck and Roy D Maragani- Mechanical Measurements, Narosa
   Publishing house, 2000.
3. Callister, William D., and David G. Rethwisch. Materials science and engineering: an introduction, Vol. 7. New York, John Wiley & Sons, 2007.
4. T.L. Anderson, Fracture Mechanics Fundamentals and Applications, 2nd edition. CRC press, 1995.
5. S. Suresh, Fatigue of Materials, Cambridge University Press, 1998.
6. F.R.N. Nabarro, H.L. deVilliers, The Physics of Creep, Taylor and Francis, 1995.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/113106088
2. https://onlinecourses.nptel.ac.in/noc21_mm27/preview

WEB RESOURSES:

1. https://ocw.mit.edu/courses/2-002-mechanics-and-materials-ii-spring-2004/pages/lecture-notes/

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25ME201011	**INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The purpose of this course is to enable the students to provide insights to principles of Industrials robotics and Expert systems. Offers basic understanding of robot anatomy, kinamatics & dynamics and understanding hydraulic and pneumatic drives. This course involves a cognitive understanding of the process of designing a robot.

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

CO1. Apply kinematics in design of robotics functions and its trajectory motions.

CO2. Identify different types of robot drivers and control mechanisms.

CO3. Analyze sensors, and empathize sensors in Pattern recognition.

CO4. Design robot work cell and control the robots for safe mode functioning.

CO5. Compose robot programming for the applications of artificial intelligence and expert systems in robots.

CO-PO Mapping Table:

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

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

COURSE CONTENT

Module 1: INTRODUCTION AND ROBOT KINEMATICS (09 Periods)

Definition, historical development, robot anatomy, work volume, precision movement, end effectors, sensors; Robot kinematics, direct and inverse kinematics, Manipulator trajectory planning and motion control, robot dynamics, methods for orientation and location of objects,

Module 2: ROBOT DRIVES AND CONTROL (09 Periods)

Motion Conversion: Rotary-to-Rotary, Rotary-to-Linear Motion Conversion, Controlling the Robot motion, Robotic sensory devices, design of drive systems, hydraulic and pneumatic drives, linear and rotary actuators and control valves, electro hydraulic servo valves, electric drives, motors, stepper motors: principles of operation, end effectors: mechanical, vacuum, magnetic and air operated grippers.

Module 3: ROBOT SENSORS (09 Periods)

Transducers and sensors, tactile sensors, proximity and range sensors, sensing joint forces, robotic vision system, imaging components: point, line, planar and volume sensors, image representation, hardware considerations, image grabbing, image processing and analysis, edge enhancement, contrast stretching, band rationing, image segmentation, Pattern recognition, software considerations, training of vision system.

Module 4: ROBOT CELL DESIGN AND APPLICATION (08 Periods)

Robot work cell design and control, safety in robotics, robot cell layouts, multiple robots and machine interference, robot cycle time analysis; Robot applications : current and future-AI in robotics, Industrial application of robots.

Module 5: ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS (10 Periods)

Methods of robot programming, characteristics of task level languages lead through programming methods, motion interpolation; basics and goals of Artificial Intelligence, machine learning, deep learning, neural networks, reinforcement learning, AI techniques, problem representation in AI, problem reduction and solution techniques, application of AI and KBES in robots, diagnostics, predictive maintenance, autonomous navigation.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Model and document any robot control devices and sensors. (MATLAB modelling).
2. Develop and document any Robot cell analyzing the performance at various applications and conditions. (Use MATLAB or open source)
3. "Design and simulate a robotic task (e.g., object sorting or pick-and-place) using an AI-based decision-making system. Implement basic robot programming in a simulation environment (such as ROS, V-REP/CoppeliaSim, or RoboDK), and integrate an AI technique (like a simple neural network or decision tree) to enable the robot to recognize and sort objects based on sensor or image input. Document your process, challenges, and how AI improved robot performance."

RESOURCES

TEXT BOOKS:

1. K.S.Fu, R.C. Gonzalez and C.S.G. Lee, Robotics Control, Sensing, Vision and Intelligence,
   Mc Graw Hill, 1987.
2. Mikell P Groover, Automation, Production Systems and Computer-Integrated Manufacturing, Pearson Education, 2015.

REFERENCE BOOKS:

1. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis, Oxford University Press,
   6th impression, 2010.
2. Richaerd D Klafter, Thomas Achmielewski and MickaelNegin, Robotic Engineering – An integrated Approach, Prentice Hall India, New Delhi, 2001.
3. Timothy Jordanides , Expert Systems and Robotics , Springer –Verlag, Newyork, 1991.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/112105249
2. https://nptel.ac.in/courses/107106090

WEB RESOURCES:

1. https://nptel.ac.in/courses/112101098
2. https://www.coppeliarobotics.com/

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25ME201012	**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. Analyze advanced strain measurement techniques including MEMS and wireless sensors.
CO5. Understand open/closed loop systems, digital control strategies, and PID controller tuning.

CO-PO Mapping Table:

Course 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 Mapping	**3**	**-**	**2**	**-**	**2**	**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 of uncertainties-nomenclature of terms in measurement-errors and classification of errors-single test data –variable sample and replicated test data-**signal conditioning, digital signal processing and data acquisition techniques –** treatment of uncertainties – **propagation of uncertainty using statistical tools.**

Module 2: MEASUREMENT OF TEMPERATURE (09 Periods)

Sensors and transducers – primary and secondary transducers – classification of first stage devices – variable resistance transducers – variable inductance elements – the differential transformer – variable reluctance transducers – capacitive transducers – piezoelectric and photoelectric transducers –measurement of temperature – liquid in glass thermometers – pressure thermometers – resistance thermometers – lead wire compensation – thermoelectric thermometers – laws of thermocouples – lead wires for thermocouples – ambient temperature compensation – pyrometers – total radiation and optical pyrometers –**infrared pyrometers – thermal imaging using IR cameras and thermography.**

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. **Coriolis and vortex flow meters with integrated smart metering systems.**

Module 4: STRAIN GAUGE AND MISCELLANEOUS MEASUREMENTS (10 Periods)

Measurement of strain – electrical resistance strain gauges – bonded and unbonded strain gauges – metallic resistance strain gauges – gauge factors – specifications and installation factors for strain gauges – bridges with two and four arms sensitive to strain – calibration of strain gauges – strain gauge rosettes – **use of MEMS-based sensors for strain and vibration measurement –** measurement of humidity – hair hygrometers – measurement of pH – pH meters – measurement of air pollution – Or sat apparatus – nuclear instrumentation – Geiger Muller counter – **MEMS accelerometers and digital vibration sensors.**

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 – **introduction to Z-domain control systems, digital controllers, and PID tuning using simulation tools.**

Total Periods: 45

EXPERIENTIAL LEARNING

1. Use MEMS accelerometer to capture vibration of a cantilever beam and analyze its dynamic response using FFT.
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. Ogata K., Modern Control Engineering, Pearson, 2010
3. Doebelin E.O., Measurement Systems – Application and Design, McGraw Hill, 2004.

REFERENCE BOOKS:

1. Holman J P, Experimental methods for Engineers, Tata McGraw 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 RESOURSES:

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
25ME201013	**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:

Course 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.

User - centered design principles – Emerging design trends – digital product definition.
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. **Rapid prototyping techniques – role in concept evaluation – case examples of iterative prototyping cycles.**

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.

Human factors in industrial design – ergonomics integration.

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)

Benchmarking against competing products – scenario-based requirement engineering.

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 sustainability and lifecycle impact**.

Total Periods: 45

EXPERIENTIAL LEARNING

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.
3. Norman, D. (2013). The Design of Everyday Things. Basic Books.

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.
3. Pahl, G., Beitz, W. et al. (2007). Engineering Design: A Systematic Approach. Springer.

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 RESOURSES:

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

PROGRAM ELECTIVE

Course code	Course Title	L	T	P	S	C
25ME201014	**THEORY OF PLASTICITY**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: In this course the concept of Plasticity, an important property of solids will be discussed in a comprehensive way. Idealization of physical system, representing the idealized system through mathematical equation and finally finding solution of those equations are the key features that constitute the structure of this course. This course emphasis will be given on both theory and applications.

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

CO1. Apply the principles of theory of elasticity and to solve the compatibility equations.

CO2. Apply the principles of virtual work, and its rate forms, plastic potential and flow rule associated with different yield criteria.

CO3. Derive and apply equations in the theory of plasticity such as incremental stress strain relationships and deformation theory of plasticity.

CO4. Develop stress strain relations and yield criterion for the analysis of structural elements.

CO5. Analyse the anisotropic material behaviour of uniaxial and multi-axial loading.

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	3	3	-	-
CO4	2	3	3	3	-	-
CO5	2	3	3	3	-	-
Course Correlation Mapping	**3**	**3**	**3**	**3**	**-**	**-**

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

COURSE CONTENT

Module 1: FUNDAMENTAL OF ELASTICITY (10 Periods)

Introduces uniaxial behavior modeling, tensors, stress invariants, and elastic energy. Covers Tresca, Von Mises, and Drucker–Prager yield criteria, Stress space visualization tools and industry-used yield loci mapping methods

Module 2: PRINCIPLE OF VIRTUAL WORK AND CRITICAL LOADING (09 Periods)

Explores virtual work, Drucker's postulate, and plastic flow rules. Discusses elastic-plastic strain increments and convexity principles, Applications in 3D printing residual stress prediction and forming simulations.

Module 3: INCREMENTAL STRESS STRAIN RELATIONSHIPS AND DEFORMATION THEORY OF PLASTICITY

(08 Periods)

Prandtl-Reuss models, deformation theory with hardening rules, and mixed hardening, Hybrid material behavior under cyclic loads and computational mechanics insights.

Module 4: STRESS STRAIN RELATIONS AND YIELD CRITERIA (09 Periods)

Stress Strain Relations: Introduction, types of materials, empirical equations, theories of plastic flow, experimental verification of St.Venant's theory of plastic flow, the concept of plastic potential, the maximum work hypothesis, mechanical work for deforming a plastic substance. Flow theories, plastic work, and yield surfaces, Recent experimental techniques for flow curve validation and effective stress/strain visualization.

Module 5: BOUNDING SURFACE THEORY (09 Periods)

Uniaxial and multiaxial loading anisotropic material behaviour. Theroms of limit analysis: Statically admissible stress field and kinematically admissible velocity field. Upper and lower bound theorem's, examples, and problems. Examines uniaxial/multiaxial loading, anisotropy, and theorems of limit analysis, Real-world problems in pressure vessels, structural crash safety, and fatigue applications.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Application of plasticity theories in forming of metals, design of pressure vessels, fatigue analysis, and structural design.
2. Design and application of plasticity in bending of beams, torsion of bars, and partially plastic expansion of thick-walled vessels.
3. Simulation of plastic deformation using FEM-based software tools.
4. Case study analysis on crashworthiness and high strain-rate behavior in automotive and defense components

RESOURCES

TEXT BOOKS:

1. Timoshenko S.P. and Goodier J.N., Theory of Elasticity, Koakusha Publishers, 3rd edition, 1970.
2. Jagabanduhu Chakrabarty, Theory of Plasticity, Butterworth-Heinemann, 3rd edition, 2006.
3. C. R. Calladine, Plasticity for Engineers: Theory and Applications, Wood head publishing, 2010.
4. William F. Hosford, Mechanics of Materials, Cambridge University Press, 3rd Ed, 2019

REFERENCE BOOKS:

1. W.F. Chens and D.J. Han, Plasticity for structural engineers, J. Ross Publishing, 2007.
2. Victor E. Saouma, Mechanics of Materials-II, Fundamentals of Inelastic Analysis, 2002
3. Sadhu Singh, Theory of plasticity, Khanna Publishers, 1990.
4. J. Lemaitre and J.L. Chaboche, Mechanics of Solid Materials, Cambridge University Press, 1990

VIDEO LECTURES:

1. https://nptel.ac.in/courses/105105177
2. http://home.iitk.ac.in/~pmd/me721.html

WEB RESOURSES:

1. https://lecturenotes.in/download/note/34385-note-for-theory-of-elasticity-and-plasticity-tep-by-lukesh-parida
2. https://www.notes4free.in/vtu-notes/vtu-pdf-notes/Theory-of-plasticity-vtu-notes

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25ME201015	**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. 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. Additives in lubricants: Anti-wear, extreme pressure (EP), and friction modifiers. Emerging trends in bio-lubricants and eco-friendly 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. Wear mapping and predictive modeling of wear. Mechanism of sliding wear of metals, Ceramics and Polymers, Wear mechanisms-Nanotribology: Friction and wear at nanoscale, applications in MEMS/NEMS. 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. Magnetic Lubrication and smart lubricants (self-healing, responsive lubricants).solid and semi-solid lubricants, Solid Lubrication, Hydrostatic Lubrication.Tribological challenges in electric vehicles and high-temperature applications.

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. Advanced surface characterization techniques (AFM, 3D profilometry). Transition Between Lubrication Regimes - Role of surface texture in tribological performance (laser texturing, micro-dimpling). 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. Advanced bearing materials (hybrid ceramics, graphene-reinforced composites).

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.

RESOURCES

TEXT BOOKS:

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

REFERENCE BOOKS:

1. Majumdar B.C, Introduction to bearings, S. Chand & Co., Wheeler publishing, 1999.
2. Andras Z.Szeri, Fluid film lubrication theory and design, Cambridge University press, 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 RESOURSES:

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 ELECTIVE

Course Code	Course Title	L	T	P	S	C
25ME201016	**AI & ML FOR MECHANICAL SYTEMS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The course introduces the variety of concepts in the field of artificial intelligence. It discusses the philosophy of AI, and how to model a new problem as an AI problem. In this course we intend to introduce some of the basic concepts of machine learning from a mathematically well motivated perspective.

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

CO1. Apply the core concepts of Mechanical Systems in the context of Industry 4.0

CO2. Apply AI,ML and Deep Learning concepts on Various Mechanical Systems

CO3. Apply the statistical and optimization techniques on Mechanical Systems

CO4. Evaluate the Mechanical System performance using Model evaluation methods

CO5. Analysis of Mechanical Systems implementation by Raspberry Pi

CO-PO 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	2	**-**	**-**	**-**
Course Correlation Mapping	**3**	**3**	**3**	**-**	**-**	**-**

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

COURSE CONTENT

Module 1: ARTIFICIAL INTELLIGENCE (09 Periods)
Brief review of AI history, Problem formulation: Graph structure, Graph implementation, state space representation, search graph and search tree, Search Algorithms: random search, Depth-first, breadth-first search and uniform-cost search. Heuristic: Best first search, A* and AO* algorithm, generalization of search problems. Ontology; Fuzzy; Metaheuristics.

Module 2: MACHINE LEARNING (09 Periods)
Overview of supervised and unsupervised learning; Supervised Learning: Linear Regression, Non-linear Regression Model evaluation methods, Logistic Regression, Neural Networks; Unsupervised Learning: K-means clustering, C-means Clustering. Convolutional Neural Networks (CNN), Pooling, Padding Operations, Interpretability in CNNs, Limitations in CNN. Cases with respect to different mechanical systems.

Module 3: STATISTICAL ANALYSIS (09 Periods)
Relationship between attributes: Covariance, Correlation Coefficient, Chi Square Ÿ Measure of Distribution (Skewness and Kurtosis), Box and Whisker Plot (Box Plot and its parts, Using Box Plots to compare distribution) and other statistical graphs.

Module 4: Introduction to Mechanical Systems & ML Applications (09 Periods)
Evolution in the context of Industry 4.0, Key issues: Adaptability, Intelligence, Autonomy, Safety, Sustainability, Interoperability, Flexibility of Mechanical Systems. Human Machine Interaction, Predictive Maintenance and Health Management, Fault Detection, Dynamic System Order Reduction, Image based part classification, Process Optimization, Material Inspection, Tuning of control algorithms.

Module 5: Development of ML Model (09 Periods)
Problem identification: classification, clustering, regression, ranking. Steps in ML modeling, Data Collection, Data pre-processing, Model Selection, Model training (Training, Testing, K-fold Cross Validation), Model evaluation (understanding and interpretation of confusion matrix, Accuracy, Precision, Recall, True positive, false positive etc.), Hyper parameter Tuning, Predictions.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Artificial intelligence for engineering design, analysis and manufacturing
2. Machine learning and artificial intelligence for robotics
3. Material modelling and smart materials
4. Intelligent control and damage detection

RESOURCES

TEXT BOOKS:

1. Rajkumar, Dionisio De Niz, and Mark Klein, Cyber-Physical Systems, Wesley Professional.
2. Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press, 2015.
3. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.

REFERENCE BOOKS:

1. Robert Levine et al., "A Comprehensive guide to AI and Expert Systems", McGraw Hill Inc, 1986.
2. E. A. Lee and S. A. Seshia, "Introduction to Embedded Systems: A Cyber-Physical Systems Approach", 2011.

VIDEO LECTURES:

1. https://youtu.be/r4sgKrRL2Ys
2. https://onlinecourses.nptel.ac.in/noc22_cs24/preview

WEB RESOURSES:

1. https://www.vssut.ac.in/lecture_notes/lecture1428643004.pdf
2. https://onlinecourses.nptel.ac.in/noc22_cs24/preview
3. Constance Heitmeyer and Dino Mandrioli, "Formal methods for real-time computing", Wiley publisher, 1996.
4. https://nptel.ac.in/courses/106/106/106106202/
5. C. Cassandras, S. Lafortune, "Introduction to Discrete Event Systems", Springer 2007.

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25ME201017	**COMPUTATIONAL FLUID DYNAMICS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: Computational fluid dynamics (CFD) has become an essential tool in analysis and design of thermal and fluid flow systems in wide range of industries. Few prominent areas of applications of CFD include meteorology, transport systems (aerospace, automobile, highspeed trains), energy systems, environment, electronics, bio-medical (design of life support and drug delivery systems), etc.

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

CO1. Demonstrate the solution method involved in basics of CFD.

CO2. Demonstrate different schemes involved in CFD.

CO3. Analyse the flow problems through Finite Difference method.

CO4. Analyse the flow problems through Finite Volume method.

CO5. Apply CFD concepts in steady state and transient problems.

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: BASICS OF CFD **(10 Periods)**

Introduction: Finite difference method, finite volume method, finite element method, governing equations and boundary conditions. Derivation of finite difference equations. **Solution methods:** Solution methods of elliptical equations – finite difference formulations, interactive solution methods, direct method with Gaussian elimination. Parabolic equations-explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tridiagonal matrix algorithm.

Module 2: SCHEMES AND STABILITY **(09 Periods)**

Hyperbolic equations: explicit schemes and Von Neumann stability analysis, implicit schemes, multi-step methods, nonlinear problems, second order one-dimensional wave equations. Burgers equations: Explicit and implicit schemes, Runge-Kutta method.

Module 3: FINITE DEIFFERENCE METHOD **(09 Periods)**

Formulations of incompressible viscous flows: Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods. **Formulations of compressible flows**: potential equation, Eluer equations, Navier-stokes system of equations, flow field-dependent variation methods, boundary conditions, example problems.

Module 4: FUNDAMENTALS OF DISCRETIZATION: **(08 Periods)**

Fundamentals of Discretization: Finite Element Method, Finite Difference and Finite Volume Method, Consistency, Stability and Convergence. 1-D Steady State Diffusion Problems- Source term linearization, Implementation of boundary conditions

Module 5: APPLICATIONS & Simple CFD Techniques: **(09 Periods)**

Standard variational methods: Linear fluid flow problems, steady state problems, Transient problems. **Simple CFD Techniques:** Viscous flows conservation form space marching, relovation techniques, viscous flows, conservation from space marching relovation techniques, computer graphic techniques used in CFD. Quasi one dimensional flow through a nozzle, turbulence models, standard and high Reynolds number models and their applications.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Collect the blood flow pattern of heart patient and carry out the CFD analysis of blood veins.
2. Carry out aerodynamic analysis of Aircraft moving at Mach

RESOURCES

TEXT BOOKS:

1. H. Versteeg W. Malalasekera"Computational fluid dynamics", PHI; 2nd edition, 2008.
2. R N Jazar, "Introduction to Computational Fluid Dynamics, An: The Finite Volume Method", Springer. 2008.

REFERENCE BOOKS:

1. Frank Chorlton. "Text book of fluid dynamics,", CBS Publishers &distributors, 1985.
2. John D. Anderson.,'Computational Fluid Dynamics: An Introduction" 6th ed. edition McGraw Hill Education India., 1995.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/112105045
2. https://onlinecourses.nptel.ac.in/noc21_me126/preview

WEB RESOURSES:

1. https://www.sciencedirect.com/topics/materials-science/computational-fluid-dynamics.
2. https://blog.spatial.com/cfd-modeling-applications

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25ME201018	**COMPUTER AIDED GEOMETRIC DESIGN**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This Course Provides Information on Geometrical Representation, 2-D And 3d Transformations, Cubic Splines, Berustein's polynomials Bezier Curves And B-Spline Curves, Explicit and Implicit equations of surfaces, Parametric and Tricubic solids, sweep solids, Topology of models.

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

CO1. Analyze geometric models based on equations and solve problems related to it.

CO2. Demonstrate knowledge on analytical fundamentals that are used to create and manipulate geometric models in a computer program.

CO3. Demonstrate knowledge on cubic splines, Bezer curves and B-spline curves

CO4. Demonstrate knowledge on of surfaces, quadratic surfaces and analyze mathematically.

CO5. Analyze boolean based models and B-rep models.

CO-PO Mapping Table:

Course 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: GEOMETRICAL MODELLING (09 Periods)

Geometrical Modelling: Introduction, History, Geometrical representation, Linear Algebra Boolean Algebra, Vectors, Matrices, Equations for curves- Intrinsic and Explicit ,parametric equations of curves, conic curves and points on curves, Problems.

Module 2: TRANSFORMATIONS (09 Periods)

Transformations: 2-D and 3D Transformations, translation, Rotation, Homogeneous space, Scaling, stretching, Mirror reflection, Composite Transformations and problems

Module 3: CUBIC SPLINES, BEZIER CURVES AND B-SPLINE CURVES (09 Periods)

Cubic Splines: Algebraic and geometric force of cubic spline, parametric space of a curve, blending functions, Problems.

Bezier Curves: Bernstein's polynomials, equations, control points, convex hull property, truncating and subdividing composite and Rational Bezier curves, Problems

B-Spline Curves: Uniform and non-uniform B-Spline basis functions, quadratic and cubic B-spline basis functions, NURBS.

Module 4: SURFACES AND SOLIDS (09 Periods)

Surfaces: Explicit and Implicit equations of surfaces, quadratic surfaces, parametric equation of surfaces, Curve Nets and Embedded Curves, Generation, Mathematical Analysis, Applications of Bezier and B-Spline Surfaces, Surface patches.

Solids: Boolean based models, Constructive solid Geometry (CSG), B-rep models.

Module 5: GEOMETRIC MODELING FOR SIMULATION & ADDITIVE MANUFACTURING (09 Periods)

Geometry preparation for simulation (meshing & surface healing), Conversion of CAD models to STL, formats, Errors in STL file and repair techniques (holes, normals, inverted meshes), Design constraints for additive manufacturing (overhangs, supports, slicing), Role of geometric models in FEA, Introduction to generative design and topology optimization

Total Periods: 45

EXPERIENTIAL LEARNING

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

1. Implement various curve interpolation and approximation techniques that allow the interactive specification of three-dimensional curves (e.g. Bezier, B-spline, rational curves).
2. Integrate the curve and surface modules into a system that allows the user to interactively design and store simple, 3D geometries

CASE STUDIES/ ARTICELS:

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

RESOURCES

TEXT BOOKS:

1. Ibrahim Zeid, and Sivasubramanian R.R., CAD/CAM Theory and Practice, New Delhi: Tata Mc Graw Hill, 2nd edition, 2010.
2. P. N. Rao, CAD/CAM: Principles and applications, New Delhi: Tata McGraw Hill Education Pvt. Ltd., 3rd edition, 2010.

REFERENCE BOOKS:

1. P. Radhakrishnan / V. Raju / S. Subramanian, CAD / CAM / CIM, New Delh, New Age International Pvt. Ltd.,2nd edition, 2008.
2. Jerry, Banks. John, Carson., Barry, Nelson., and David. Nicol, Discrete-Event System Simulation, Pearson Education, India, 5th edition, 2010.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=0IgOapAtauM
2. https://freevideolectures.com/course/3087/computer-aided-engineering-design

WEB RESOURSES:

1. https://www.tugraz.at/institute/cgv/teaching/lectures/computer-aided-geometric-design/
2. https://cagd.me.wisc.edu/

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25ME201019	**EXPERIMENTAL MODAL ANALYSIS**	3	-	-	-	3

Pre-Requisite Advanced Mechanical Vibrations

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course introduces the theory and practical implementation of experimental modal analysis for mechanical and structural systems. It emphasizes the measurement, interpretation, and application of modal parameters such as natural frequencies, damping ratios, and mode shapes.

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

CO1. Analyse mode shapes of SDOF/MDOF systems.

CO2. Apply principles to measure excitation of structures using transducers, amplifiers, sensors etc.

CO3. Analyse the modal parameters by using extraction methods for SDOF.

CO4. Develop MDOF curve-fitting procedures using inverse methods.

CO5. Apply statistical techniques on SDOF and MDOF to extract modal parameters.

CO-PO Mapping Table:

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

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

COURSE CONTENT

Module 1: MODAL THEORY AND TESTING UNCERTAINTY (10 Periods)

Overview of modal analysis, Vibrations of single and multiple degree of freedom (SDOF, MDOF) systems, Frequency response functions (FRFs) for SDOF/MDOF systems. Types of FRFs. Orthogonality of modes and their application in modal analysis, Theory of undamped, proportionally damped systems. Modal testing errors and uncertainty quantification.

Module 2: MODERN SIGNAL PROCESSING FOR MODAL TESTING (09 Periods)

Introduction to test planning, Excitation of structures (electromagnetic and electrohydraulic shakers, hammers, etc.), Transducers and amplifiers for measurements (force transducer, accelerometers, laser vibrometers, signal conditioners, amplifiers etc.), Actuator/sensor placement considerations. Modern signal processing techniques: wavelet transform, order tracking analysis.

Module 3: PARAMETER EXTRACTION FOR SDOF AND MDOF (08 Periods)

Introduction, Preliminary checks of FRF Data, SDOF Modal Analysis-I - Peak-amplitude; SDOF Modal Analysis-II - Circle Fit Method; MDOF Modal Analysis basics.

Module 4: INVERSE TECHNIQUES AND OPERATIONAL MODAL ANALYSIS (09 Periods)

Residuals – MDOF curve-fitting procedures – MDOF curve fitting in the Time Domain – Global or Multi-Curve fitting – Operational Modal Analysis (OMA) principles and field testing considerations.

Module 5: VALIDATION, DAMAGE DETECTION AND APPLICATIONS (09 Periods)

Model correlation. Concepts of modal assurance criterion and some of its variants, Dynamic sub structuring, Modal reduction and expansion, Model updating, Experimental validation techniques and basics of structural damage detection.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Experimental modal analysis of Beams, Estimation of Natural frequency, Extraction of mode shape, Estimation of Damping
2. Modal Assurance Criteria (MAC) analysis between experimental data and numerical method
3. Conduct an operational modal test on a real structure and evaluate damage indicators.

RESOURCES

TEXT BOOKS:

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

REFERENCE BOOKS:

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

VIDEO LECTURES:

1. https://onlinecourses.nptel.ac.in/noc21_me42/preview
2. https://nptel.ac.in/courses/112105055

WEB RESOURSES

1. https://dewesoft.com/daq/what-is-modal-analysis
2. https://edurev.in/studytube/Modal-Analysis-Approximate-Methods-I/bf921fa0-4dc7-4d0c-ac9b-0d95a0c701fc_p

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25ME201020	**MECHATRONICS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course is designed for graduate students to understand the concept of mechatronics, learn design principles to integrate multidisciplinary components as a system to meet requirements of products, and gain the fundamental knowledge about sensors and actuators.

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

CO1. Design the various components related to the mechatronics.

CO2. Analyse the real time interfacing, sensors for condition monitoring.

CO3. Design Micro-controller for motion control and path planning

CO4. Analysis of Feature and pattern recognition methods

CO5. Design of Micro mechatronic Systems applied for sensors and actuators

CO-PO 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	2	2	-	-	-
Course Correlation Mapping	**3**	**3**	**3**	**-**	**-**	**-**

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

COURSE CONTENT

Module 1: ACTUATORS AND DRIVES (10 Periods)

Introduction: Definition of Mechatronics products, design considerations and tradeoffs. Overview of Mechtronic products. Intelligent machine Vs Automatic machine economic and social justification.

Actuators and drive systems: Mechanical, Electrical, hydraulic drive systems, Electric Motors: DC Motors, Stepper Motor, Selecting Motor, Characteristics of mechanical, Electrical, Hydraulic and pneumatic actuators and their limitations.

Module 2: FUNDAMENTALS MOTION CONTROL (09 Periods)

Motion Control: Control parameters and system objectives, Mechanical Configurations, Popular control system configurations. S-curve, motor/load inertia matching, design with linear slides.

Motion Control algorithms: Significance of feed forward control loops, shortfalls, fundamentals concepts of adaptive and fuzzy – control. Fuzzy logic compensatory control of transformation and deformation non- linearity's.

Module 3: ELEMENTS OF MOTION CONTROL (10 Periods)

Sensor interfacing: Analog and digital sensors for motion measurement, digital transducers, Semiconductor Sensors and Microelectromechanical Devices, human Machine and machine- Machine interfacing devices and strategy.

Architecture of intelligent machines: Introduction to Microprocessor, Microcomputers and programmable logic controls and identification of systems. System design classification, motion control aspects in design.

Module 4: MACHINE VISION (08 Periods)

Feature and pattern recognition methods, concepts of perception and cognition in decision-making, basics of image processing, binary and grey scale images, sharpening and smoothening of images, AI-Based Image Classification and Object Detection.

Module 5: MICROMECHATRONIC SYTEMS: (08 Periods)

Micro sensors, micro actuators, smart instrumentation, microfabrication methods – lithography, etching, micro-joing, Case Study on Mechatronic Design of a Robotic Walking Machine.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Discuss the design and development of a robotic arm for a pick-and-place application in a packaging unit. Choose suitable actuators for each joint of the arm from mechanical, electrical, pneumatic, or hydraulic types. Justify your choices based on load, speed, precision, and control characteristics. What trade-offs would you consider during selection?
2. Analyze a machine vision system that sorts objects based on colour and shape using grayscale image processing. How would micro mechatronic sensors and actuators be integrated into such a system for precision and miniaturization? Propose an improvement to make the system more intelligent and autonomous.
3. Study and discuss the AI-powered object detection and classification system using platforms like Google Teachable Machine and Google Colab with Tensor Flow.

RESOURCES

TEXT BOOKS:

1. MichelB.Histand and david G. Alciatore, "Designing intelligent machines", open university, London.
2. C.W.desilva, "Control sensors and actuators, Prentice Hall.

REFERENCE BOOKS:

1. David G. Alciatore, "Introduction To Mechatronics And Measurement Systems" Tata Mcgraw - Hill Publishing Company Limited, 2007
2. W. Boton, "Mechatronics", 5th edition, Adison Wesley Longman ltd, 2010.
3. Saeed B Niku, "Introduction to Robotics: Analysis, Systems, Applications ", 2nd edition, Pearson Education India, PHI, 2003.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=qmyvoSohfP0
2. https://www.youtube.com/watch?v=ompQg0pciWE

WEB RESOURSES:

1. https://www.mscsoftware.com/node/108
2. https://www.3ds.com/products-services/simulia/products/multibody-system-simulation/
3. https://www.comsol.com/multibody-dynamics-module
4. https://www.youtube.com/watch?v=GUvoVvXwoOQ

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25ME201021	**MULTIBODY DYNAMICS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course reviews and reinforces the student's understanding Kinematics and Dynamics of multibody systems with immediate application to the dynamics of systems of rigid bodies. The course will place equal emphasis on gaining both an analytical understanding and insight/intuition on the subject.

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

CO1. Formulate a model and free body diagram of multibody systems.

CO2. Develop the holonomic and nonholonomic constraints into a multibody system.

CO3. Derive the nonlinear and linear equations of motion of a multibody system.

CO4. Interpret and analyze the results of simulation.

CO5. Apply various dynamic analyses for Flexible Multibody Systems.

CO-PO 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	2	2	-	-	-
Course Correlation Mapping	**3**	**3**	**3**	**-**	**-**	**-**

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

COURSE CONTENT

Module 1: BASIC CONCEPTS IN 3-D RIGID-BODY MECHANICS (10 Periods)

Degrees-of-freedom; Rigid body vs. flexible body; Spatial kinematics (3-D rotation transformations); Euler theorem, rotation parameterization, Rodriguez formula; Moments and products of inertia; Quaternion representation for rotations and its advantages over Euler angles. Newton-Euler equations of motion; Lagrange Equation; Generalized forces, Applications in robotics and aerospace systems.

Module 2: INTER-CONNECTED RIGID BODIES (09 Periods)

Kinematic pairs (joints) with classification of constraints; holonomic and non-holonomic constraints; Virtual constraints and their role in modern robotics. Springs, dampers, actuators, and controllers. Introduction to under actuated and over constrained systems. Brief introduction to controls theory.

Module 3: FORMULATION OF EQUATIONS OF MOTION FOR INTER-CONNECTED BODIES (10 Periods)

Relative coordinates, generalized coordinates, Cartesian co-ordinates; Lagrange's equations and other approaches; Kane's method for efficient equation formulation. Differential equations (ODE) and differential algebraic equations (DAE); Co-ordinate partitioning and Lagrange multipliers; Real-time simulation challenges and constraint stabilization techniques. Types of analyses (kinematic, static, quasi-static, kineto-static, dynamic and linear dynamic).

Module 4: APPLICATION OF NUMERICAL METHODS (08 Periods)

Newton-Raphson method, Jacobian, ODE integrators (Euler methods and Implicit methods); Symplectic integrators for energy conservation in long-term simulations. Stability, accuracy and Dahl Quist's trade-off criteria; Stiffness and damping - physical vs numerical; Machine learning approaches for solving stiff multibody systems. Lock-up, bifurcation and singularities.

Module 5: FLEXIBLE MULTIBODY SYSTEMS (08 Periods)

Flexible multibody systems, the large deformations problem in Flexible multi-body systems, I so geometric analysis (IGA) for flexible body dynamics. Dynamic analyses using classical approximation. Model order reduction techniques for real-time flexible multibody simulations. Dynamic Finite Element Analysis for dynamic deformations and loads.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Simulate a four-bar model at different coupler link lengths and plot the resulting coupler curves using Matlabsimulink.
2. Use the Transform Sensor block to sense frame motion in a simple multibody model.
3. Use the sensing capability of a joint block to sense the internal forces acting on a mechanical link.

RESOURCES

TEXT BOOKS:

1. Shabana A. A., John Wiley & Sons, Computational dynamics, Third Edition
2. Roberson R. E., and Richard S., Springer-Verlag, Dynamics of Multibody Systems,

REFERENCE BOOKS:

1. Dynamics of Multibody Systems, Shabana A. A., Cambridge University press.
2. Flexible Multibody Dynamics, Bauchau O. A., Vol. 176. Springer.
3. Dynamics and Balancing of Multibody Systems, Chaudhary H., and S K Saha. Springer.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=qmyvoSohfP0
2. https://www.youtube.com/watch?v=ompQg0pciWE

WEB RESOURSES:

1. https://www.mscsoftware.com/node/108
2. https://www.3ds.com/products-services/simulia/products/multibody-system-simulation/
3. https://www.comsol.com/multibody-dynamics-module
4. https://www.youtube.com/watch?v=GUvoVvXwoOQ

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25ME201022	**QUALITY CONCEPTS IN DESIGN**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: To impart knowledge on various concepts in engineering design and principles of implementing quality in a product or service through tools such as quality houses, control charts, statistical process control method, failure mode effect analysis and various strategies of designing experiments, methods to uphold the status of six sigma and improve the reliability of a product.

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

CO1. Demonstrate knowledge on Morphology, Concurrent Engineering, Problem solving and Manufacture.

CO2. Demonstrate knowledge on design quality function deployment, House of Quality and Objectives.

CO3. Apply six sigma problem solving techniques for failure modes.

CO4. Design of experiments by two and three factor full Factorial experiments and Taguchi's approach.

CO5. Analyse statistical data using Pareto diagrams, Box plots, Scatter diagrams – Multivariable chart and Weibull distribution.

CO-PO Mapping Table:

Course 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: DESIGN FUNDAMENTALS, METHODS AND MATERIAL SELECTION (09 Periods)

Morphology of Design – The Design Process – Computer Aided Engineering – Concurrent Engineering – Competition Bench Marking – Creativity – Theory of Problem solving (TRIZ) – Value Analysis - Design for Manufacture, Design for Assembly – Design for casting, Forging, Metal Forming, Machining and Welding. Additive manufacturing and smart material considerations – green material selection principles.

Module 2: DESIGN FOR QUALITY (09 Periods)

Quality Function Deployment -House of Quality-Objectives and functions-Targets-Stakeholders-Measures and Matrices-Design of Experiments –design process-Identification of control factors, noise factors, and performance metrics - developing the experimental plan- experimental design –testing noise factors- Running the experiments –Conducting the analysis-Selecting and conforming factor-Set points-reflecting and repeating. Agile quality methods – integration with iterative product cycles.

Module 3: FAILURE MODE EFFECT ANALYSIS AND DESIGN FOR SIX SIGMA (09 Periods)

Basic methods: Refining geometry and layout, general process of product embodiment - Embodiment checklist- Advanced methods: systems modeling, mechanical embodiment principles-FMEA method- linking fault states to systems modeling - Basis of SIX SIGMA – Project selection for SIX SIGMA- SIX SIGMA problem solving- SIX SIGMA in service and small organizations - SIX SIGMA and lean production –Lean SIX SIGMA and services.AI and machine learning in predictive maintenance and fault detection.

Module 4: DESIGN OF EXPERIMENTS (09 Periods)

Importance of Experiments, Experimental Strategies, Basic principles of Design, Terminology, ANOVA, Steps in Experimentation, Sample size, Single Factor experiments - Completely Randomized design, Randomized Block design, Statistical Analysis, Multifactor experiments - Two and three factor full Factorial experiments, 2K factorial Experiments, Confounding and Blocking designs, Fractional factorial design, Taguchi's approach - Steps in experimentation, Design using Orthogonal Arrays, Data Analysis, Robust Design- Control and Noise factors, S/N ratios. Integration of DoE with simulation tools and digital twins.

Module 5: STATISTICAL CONSIDERATION AND RELIABILITY (09 Periods)

Frequency distributions and Histograms- Run charts –stem and leaf plots- Pareto diagrams-Cause and Effect diagrams-Box plots- Probability distribution-Statistical Process control–Scatter diagrams –Multivariable charts –Matrix plots and 3-D plots.-Reliability-Survival and Failure-Series and parallel systems-Mean time between failure-Weibull distributions. Resilience modeling – use of Bayesian statistics in reliability engineering.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Conduct Design of Experiments (DoE) using full-factorial and Taguchi methods with simulation tools.
2. Perform Six Sigma analysis and process capability evaluation for a sample design or production case.

RESOURCES

TEXT BOOKS:

1. Dieter, George E., "Engineering Design - A Materials and Processing Approach", McGraw Hill, International Editions, Singapore, 2000.
2. Kevin Otto & Kristin Wood, "Product Design Techniques in Reverse Engineering and New Product Development", Pearson Education (LPE), 2001.
3. Mitra, A. (2016).Fundamentals of Quality Control and Improvement, 4th Edition, Wiley.

REFERENCE BOOKS:

1. Karl T. Ulrich, Steven D. Eppinger, "Product Design And Development", Tata McGraw-Hill- 3rd Edition, 2003.
2. Montgomery, D.C. (2020). Design and Analysis of Experiments, Wiley.
3. Bester field, D.H. (2009). Quality Control, Pearson.

VIDEO LECTURES:

1. https://nptel.ac.in/courses/112106249
2. https://www.youtube.com/watch?v=Sk95SHQ9e8c

WEB RESOURSES:

1. https://simplicable.com/new/design quality.
2. https://learnmech.com/design-quality-concept-benefits-design-quality-dfq/

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25ME201023	**VEHICLE DYNAMICS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: The purpose of this course is to enable the students to provide insights to principles of vehicle motion and associated parameters. Offers basic understanding of vertical motion, roll and pitch under various conditions. This course comprises theoretical and analytical concepts and require thorough understanding of laws of physics and basics of dynamic motions.

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

CO1. Apply principles of vehicle dynamics and calculate performance of various automobiles.

CO2. Develop mathematical model the vehicle suspension system.

CO3. Analyse steering mechanism and stability under aerodynamic disturbances and solve problems related it.

CO4. Analyse the stability and ride comfort of the vehicle using numerical methods.

CO5. Demonstrate the knowledge on Noise and harshness inducers of the vehicles.

CO-PO Mapping Table:

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

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

COURSE CONTENT

Module 1: VEHICLE MOTION FUNDAMENTALS (10 Periods)

Basics of Vehicle dynamics: SAE Vehicle axis system, Forces & moments affecting vehicle, Dynamic axle loads, Equations of motion, Transmission characteristics, vehicle performance, braking performance, Brake proportioning, braking efficiency.

Tyre Mechanics: Tyre forces and moments, slip angle, cornering stiffness, contact patch analysis.

Module 2: SUSPENSION KINEMATICS & DYNAMICS (09 Periods)

Suspension system: Suspension types, Roll Centre Analysis, Suspension Dynamics, Multi-body vibration, Body and Wheel hop modes. Suspension Kinematics & Compliance (K&C) testing methods; practical measurement and tuning of suspension behaviour. **Controllable Suspension Elements**: Active, Semi-Active. Choice of suspension spring rate, Calculation of effective spring rate.

Module 3: STEERING DYNAMICS & STABILITY CONTROL (10 Periods)

Steering systems and stability: The Steering Linkages, Steering System Forces and Moments, Steering System Models, Effect of Vehicle Roll on Transient Handling, Quasi-Static Rollover of a Rigid Vehicle, Quasi-Static Rollover of a Suspended Vehicle.

Aerodynamics of the vehicle: Vehicle Dynamic Control (VDC) systems, Electronic Stability Control (ESC) and Anti-lock Braking System (ABS).

Module 4: RIDE QUALITY & HUMAN FACTORS (08 Periods)

Riding comfort; perception of vibration; vibration sources; vibration transmission to the passengers; vibration models; vibration isolation techniques. Human Vibration Standards: ISO guidelines for ride comfort and practical measurement methods.

Module 5: NVH MATERIALS & TREATMENTS (08 Periods)

Fundamentals of sound: Direct sound generation mechanism, Acoustic variables, Measures of sound,

Vehicle Interior and Exterior noise: Internal noise sources in vehicles and sound package solution to reduce the interior and exterior noise. Practical damping and noise control materials; advanced vibration damping treatments.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Modelling of vehicle system using Equation motion (Simulink modelling).
2. Develop the Simulink model and analyses the performance at various road input conditions. (Use MATLAB).
3. Conduct tyre force measurement and K&C analysis using simulation tools; design a simple ESC logic and validate it in simulation.

RESOURCES

TEXT BOOKS:

1. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", SAE, 1992.
2. R N Jazar, "Vehicle Dynamics: Theory and Application", Springer. 2008.

REFERENCE BOOKS:

1. Rajesh Rajamani, Vehicle Dynamics & control, Springer.
2. R.V. Dukkipati, Vehicle dynamics, Narsova Publications.
3. Wong J Y, "Theory of Ground Vehicles", John Wiley & Sons, New York, 1978.

VIDEO LECTURES:

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

WEB RESOURSES

1. https://ritzel.siu.edu/courses/302s/vehicle/vehicledynamics.htm.
2. https://www.vehicledynamicsinternational.com/

PROGRAM ELECTIVE

Course Code	Course Title	L	T	P	S	C
25ME201024	**3D Printing**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course provides a detailed on basic principles, development of 3D printing technology, 3D printing process chain, powder bed fusion Processes, Extrusion-Based Systems, Applications for 3D Printing. The course further explores recent innovations, sustainability aspects, and integration of 3D printing with Industry 4.0 technologies.

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

CO1. Demonstrate knowledge on 3D printing principles in Manufacturing.

CO2. Demonstrate knowledge on different 3D Printing Techniques in manufacturing.

CO3. Demonstrate knowledge on powder bed fusion processes & extrusion-based systems

CO4. Develop CAD models for 3D printing

CO5. Evaluate sustainability, cost, and material optimization in additive manufacturing workflows.

CO-PO Mapping Table:

Course 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 AND BASIC PRINCIPLES (09 Periods)

3D Printing: Generic 3D Printing Process, Benefits of 3D Printing, Distinction Between 3D Printing and CNC Machining, Other Related Technologies.

Development of 3D Printing Technology: Introduction, The Use of Layers, Classification of 3D Printing Processes, Metal Systems, Hybrid Systems, Milestones in 3D Printing Development. **Recent advances in additive manufacturing technologies and integration with cyber-physical systems.**

Module 2: 3D PRINTING PROCESS CHAIN (09 Periods)

3D Printing process chain: Introduction to Photo polymerization Processes: Photo polymerization Materials, Reaction Rates, Vector Scan SL, SL Resin Curing Process, SL Scan Patterns, Vector Scan Micro stereolithography, Mask Projection Photo polymerization Technologies and Processes. **Comparison of different process chains based on time, resolution, and material compatibility.**

Module 3: POWDER BED FUSION PROCESSES & EXTRUSION-BASED SYSTEMS (09 Periods)

Powder Bed Fusion Processes: Introduction, SLS Process Description, Powder Handling, Approaches to Metal and Ceric Part Creation, Variants of Powder Bed Fusion Processes, Typical Materials and Applications, Materials - Capabilities and Limitations.

Extrusion-Based Systems: Introduction, Basic Principles, Plotting and Path Control, Materials, Limitations of FDM, Bio extrusion, Other Systems. **Fused filament fabrication for composite materials and recycling-friendly feedstocks.**

Module 4: DESIGN, GUIDELINES FOR PROCESS SELECTION & SOFTWARE ISSUES (09 Periods)

Design for 3D Printing : Design for Manufacturing and Assembly, Core DFM for 3D Printing Concepts and Objectives, 3D Printing Unique Capabilities, Exploring Design Freedoms, Design Tools for 3D Printing.

Software Issues for 3D Printing: Preparation of CAD Models – the STL File, Problems with STL Files, STL File Manipulation, Beyond the STL File, Additional Software to Assist 3D Printing. **Introduction to generative design tools and AI-assisted modeling in 3D printing.**

Module 5: MEDICAL APPLICATIONS (09 Periods)

Medical Applications for 3D Printing :Use of 3D Printing to Support Medical Applications, Software Support for Medical Applications, Limitations of 3D Printing for Medical Applications, Further Development of Medical 3D Printing Applications. **Tissue engineering scaffolds, dental printing applications, and regulatory considerations for biomedical printing.**

Total Periods: 45

EXPERIENTIAL LEARNING

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

1. Three Dimensional Printing Process (3 D Printing - Powder Based Rapid Prototyping System),https://www.youtube.com/watch?v=aqnf-OSQ1gY
2. Develop functional prototypes using open-source slicing software and analyze material usage efficiency.

CASE STUDIES/ ARTICELS:

1. https://www.stratasys.com/en/stratasysdirect/resources/case-studies/urethane-casting-aircraft-models/
2. https://www.ge.com/research/project/additive-manufacturing-industrial-applications
3. https://formlabs.com/blog/3d-printing-sustainable-manufacturing/

RESOURCES

TEXT BOOKS:

1. Ian Gibson, David W Rosen, Brent Stucker., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010

2. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 2001.

3. Andreas Gebhardt, Understanding Additive Manufacturing, Hanser Publishers, 2012

REFERENCE BOOKS:

1. Ali K. Kamrani, Emand Abouel Nasr, Rapid Prototyping: Theory & Practice, Springer, 2006.

2. Chua Chee Kai, Leong Kah Fai, Rapid Prototyping: Principles & Applications, World Scientific, 2003

3. Kalpak Jian & Schmid, Manufacturing Processes for Engineering Materials, Pearson, 2014

VIDEO LECTURES:

1. https://nptel.ac.in/courses/112103306
2. https://nptel.ac.in/courses/112104265

WEB RESOURSES:

1. The 3D printer manufacturer Form labs have a very good overview of 3D printing and applications in education, medicine, manufacturing and more. The tutorials are also a goldmine of information about things like scanning, reverse engineering, and prototyping.
   https://formlabs.com/3d-printers/
2. https://formlabs.com/3d-printers/
   https://www.3dnatives.com/en/ – A comprehensive resource for industry news, tutorials, and product reviews.

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
25AI201701	**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.

CO-PO Mapping Table:

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

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

COURSE CONTENT

Module 1: FOUNDATIONS OF BUSINESS ANALYTICS (09 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 (09 Periods)

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 RESOURSES:

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

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
25AI201702	**ETHICS FOR AI**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION:

Recognize the fundamental ideas and standards of AI ethics. Recognizing fairness and prejudice in artificial intelligence. Obstacles to obtaining explain ability and openness. Frameworks based on ethics and the law that designate accountability. Privacy and security concerns related to AI ethics. Ethics in AI in the future.

COURSE OUTCOMES: At the end of the course, student will be able to:

CO1. Understand the basic concepts of AI Ethics and ethical principles.

CO2. Understanding the concept of bias and fairness in AI.

CO3. Challenges in achieving the transparency and explain ability.

CO4. Legal and ethical frameworks for assigning responsibility.

CO5. Security and privacy issues of AI Ethics. Future of AI ethics.

CO - PO Mapping Table

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

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

COURSE CONTENT

Module 1: INTRODUCTION TO AI ETHICS (09 Periods)

Overview of ethical issues in AI. Historical context and key concepts. Importance of ethical considerations in AI development and deployment.

Ethical Principles and Frameworks:

Utilitarianism, deontology, virtue ethics, and other ethical theories. Ethical principles for AI, such as fairness, transparency, accountability, and privacy.

Module 2: BIAS AND FAIRNESS IN AI (09 Periods)

Understanding bias in AI systems. Types of bias (e.g., algorithmic bias, dataset bias). Approaches to detecting and mitigating bias. Fairness metrics and fairness-aware machine learning algorithms.

Module 3: TRANSPARENCYANDEXPLAINABILITY (09 Periods)

Importance of transparency and explain ability in AI. Techniques for explaining AI decisions. Challenges and trade-offs in achieving transparency and explain ability. Regulatory requirements and guidelines for transparent AI systems.

Module 4: ACCOUNTABILITY AND RESPONISIBILITY (09 Periods)

Holding AI developers, users, and organizations accountable for AI systems' actions. Legal and ethical frameworks for assigning responsibility. Challenges in attributing responsibility in complex AI systems

Module 5: PRIVACY AND DATA PROTECTION (09 Periods)

Privacy issues in AI, including data collection, storage, and sharing. Privacy-preserving AI techniques. Regulatory frameworks (e.g., GDPR) and ethical guidelines for data protection in AI. Ethical considerations in emerging AI technologies.

Total Periods: 45

EXPERENTIAL LEARNING

Case -1: Emergence of Bias and Fairness Interventions

For the problem of Loan Approval and Hiring by AI, specify the steps and practices to the entry of bias and fairness improvement interventions.

Case-2: AI governance with critical thinking, negotiation skills, and a multi-stakeholder perspective
Undertake the study from ethical perspective for the problem of Public response system, Policy making and Contract negotiation.

(**Note:** It's an indicative one. Course Instructor may change activities and shall be reflected in course Handout)

RESOURCES

TEXT BOOKS:

1. Müller, Vincent C., Ethics of Artificial Intelligence and Robotics. The Stanford Encyclopedia of Philosophy, 2021.
2. Meredith Broussard, Artificial Unintelligence: How Computers Misunderstand the World, Cambridge, MA: MIT Press, 2018.

REFERENCE BOOKS:

1. Brett Frischmann and Evan Selinger, Re-Engineering Humanity, Cambridge University Press, Cambridge, 2018.
2. Cathy O'Neil, Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy, Crown Publishers, 2016.
3. Shoshana Zuboff, The Age of Surveillance Capitalism, Financial Times, 2020.

VIDEO LECTURES:

1. https://rainermuehlhoff.de/en/EoAI2025/
2. https://www.youtube.com/watch?v=qpp1G0iEL_c
3. https://rainermuehlhoff.de/en/EoAI2025/

WEB RESOURSES:

1. https://www.ibm.com/topics/ai-ethics
2. https://www.coursera.org/articles/ai-ethics
3. https://ai.google/responsibility/principles/

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
25CM201701	**COST MANAGEMENT OF ENGINEERING PROJECTS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course will provide an understanding of the cost tools and techniques that can be used throughout a project's design and development. The students will be exposed to the methods, processes, and tools needed to conduct economic analysis, estimation of Project.

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

CO1. Understand the costing concepts and their role in decision-making.

CO2. Understand the project management concepts and their various aspects in selection.

CO3. Interpret costing concepts with project execution.

CO4. Knowledge of costing techniques in the service sector and various budgetary control techniques.

CO5. Become familiar with quantitative techniques in cost management.

CO-PO Mapping Table:

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

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

COURSE CONTENT

Module 1: INTRODUCTION TO COSTING CONCEPTS (05 Periods)

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost, and Opportunity cost; Creation of a Database for operational control.

Module 2: INTRODUCTION TO PROJECT MANAGEMENT (10 Periods)

Project: meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre-project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts

Module 3: PROJECT EXECUTION AND COSTING CONCEPTS (10 Periods)

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing

Module 4: COSTING OF SERVICE SECTOR AND BUDGETARY CONTROL (10 Periods)

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets

Module 5: QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT (10 Periods)

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Prepare a mini-project report regarding cost control techniques in manufacturing units.
2. Prepare a report on real-life engineering project case studies, especially those that faced cost overruns or successfully managed costs
3. Conduct hands-on budgeting exercises where participants are given a project scope, and they have to create detailed budgets.

RESOURCES

TEXT BOOKS:

1. John M. Nicholas, Herman Steyn Project Management for Engineering, Business and Technology, Taylor & Francis, 2 August 2020, ISBN: 9781000092561
2. Albert Lester, Project Management, Planning and Control, Elsevier/Butterworth-Heinemann, 2007, ISBN: 9780750669566, 075066956X.

REFERENCE BOOKS:

1. Charles T. Horngren et al Cost Accounting a Managerial Emphasis, Prentice Hall of India, New Delhi, 2011.
2. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991.
3. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=rck3MnC7OXA
2. https://www.youtube.com/watch?v=QWD1LMzStI4

WEB RESOURSES:

1. https://www.superfastcpa.com/what-are-cost-concepts-in-decision-making
2. https://www.indeed.com/career-advice/career-development/project-cost-controls
3. https://www.geeksforgeeks.org/difference-between-pert-and-cpm/

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
25CE201701	**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
CO1	-	-	-	-	-	2
CO2	-	-	-	-	-	2
CO3	-	-	-	-	-	2
CO4	-	-	-	-	-	2
CO5	-	-	-	-	-	2
Course Correlation Mapping	**-**	**-**	**-**	**-**	**-**	**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, and Disaster Management in India: Perspectives, issues and strategies, New Royal book Company.
6. Sahni, Pradeep Et.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 RESOURSES:

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

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
25SS201701	**VALUE EDUCATION**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course deals with understanding the value of education and self-development, Imbibe good values in students, and making them know about the importance of character.

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

CO1. Demonstrate the knowledge of values and self-development

CO2. Analyze the importance of the cultivation of values.

CO3. Learn suitable aspects of personality and behavioral development

CO4. Function as a member and leader in multi-disciplinary teams by avoiding faulty thinking.

CO5. Develop character and competence for effective studies.

CO-PO Mapping Table:

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

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

COURSE CONTENT

Module 1: VALUES AND SELF-DEVELOPMENT (09 Periods)

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements- Case studies

Module 2: IMPORTANCE OF CULTIVATION OF VALUES. (09 Periods)

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline- Case studies

Module 3: PERSONALITY AND BEHAVIOR DEVELOPMENT (09 Periods)

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline, Punctuality, Love and Kindness - Case studies

Module 4: AVOID FAULTY THINKING. (09 Periods)

Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature - Case studies

Module 5: CHARACTER AND COMPETENCE (09 Periods)

Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation, Equality, Nonviolence, Humility, Role of Women. All religions and the same message. Mind your Mind, Self-control. Honesty, Studying effectively- Case studies

Total Periods: 45

EXPERIENTIAL LEARNING

1. Demonstrate orally using your experiences of what values are naturally acceptable in a relationship to nurture or exploit others.
2. Prepare a report by identifying and analyzing the importance of cultivation of values.
3. Present a poster on different attitudes and behaviours.
4. Students give a PowerPoint presentation on doing best for nature.
5. Students are encouraged to bring a daily newspaper to class or to access any news related to the need for human values and note down the points.
6. Prepare a case study on how to maintain harmony with different religious people through character and competence.

(It’s an indicative one. The Course Instructor may change the activities and the same shall be reflected in the Course Handout)

RESOURCES

TEXTBOOKS:

1. R. Subramanaian, Professional Ethics, Oxford Higher Education, 2013.
2. Mike W. Martin and Roland Schinzinger, Ethics in Engineering, Tata McGraw-Hill, 3rd Edition, 2007.
3. Chakravarthy, S.K.: Values and ethics for Organizations: Theory and Practice, Oxford University Press, New Delhi, 1999.

REFERENCE BOOKS:

1. M.G. Chitakra: Education and Human Values, A.P.H. Publishing Corporation, New Delhi, 2003
2. Awakening Indians to India, Chinmayananda Mission, 2003
3. Satchidananda, M.K.: Ethics, Education, Indian Unity and Culture, Ajantha Publications, Delhi, 1991

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=90VQPZURN5c
2. https://www.youtube.com/watch?v=6ofPcK0uDaA
3. https://www.youtube.com/watch?v=5_f-7zCi79A
4. https://www.youtube.com/watch?v=2ve49BWAJRE
5. https://www.youtube.com/watch?v=kCOIfnxxQ5U

WEB RESOURSES:

1. https://www.livingvalues.net/
2. https://livingvalues.net/materials-for-schools/
3. https://www.edb.gov.hk/en/curriculum-development/4-key-tasks/moral-civic/index.html

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
25SS201702	**PEDAGOGY STUDIES**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course deals with understanding pedagogical practices that are being used by teachers in formal and informal classrooms, the effectiveness of pedagogical practices, teacher education (curriculum and practicum), and the school curriculum and guidance materials that can best support effective pedagogy.

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

CO1. Demonstrate knowledge of pedagogical methodology

CO2. Analyze the functional knowledge in Pedagogical practices, Curriculum, and Teacher Education

CO3. Learn effective pedagogical practices and apply strategies.

CO4. Function effectively as an individual and as a member of the Professional development.

CO5. Understand research Gaps and provide future Directions.

CO-PO Mapping Table:

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

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

COURSE CONTENT

Module 1: INTRODUCTION AND METHODOLOGY (09 Periods)

Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of Methodology and Searching- Case studies

Module 2: THEMATIC OVERVIEW (09 Periods)

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher Education- Case studies

Module 3: EFFECTIVENESS OF PEDAGOGICAL PRACTICES (09 Periods)

Evidence on the effectiveness of pedagogical practices, Methodology for the in-depth stage: quality

Assessment of included studies, teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy, Theory of change, Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' Attitudes and beliefs and Pedagogic strategies- Case studies

Module 4: PROFESSIONAL DEVELOPMENT (09 Periods)

Alignment with classroom practices and follow-up support, Peer support, and Support from the head teacher and the community. Curriculum and assessment, Barriers to learning: limited resources and large class sizes- Case studies

Module 5: RESEARCH GAPS AND FUTURE DIRECTIONS (09 Periods)

Research design, Contexts, Pedagogy, Teacher Education, Curriculum and Assessment, Dissemination and research impact- Case studies

Total Periods: 45

EXPERIENTIAL LEARNING

1. List out the self-improvement in you after going through pedagogical methodologies.
2. Discuss different practices that you would like to adopt in the curriculum.
3. Describe in your own words how can you bring effectiveness to the curriculum.
4. Imagine you are a head teacher and illustrate different barriers to learning.
5. Assume you are a teacher and Interpret different directions that you would bring for the assessment of the students.

(It's an indicative one. The Course Instructor may change the activities and the same shall be reflected in the Course Handout)

RESOURCES

TEXTBOOK:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education.

REFERENCES:

1. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.Oxford and Boston: Blackwell. Educational Development, 33 (3): 272–282.
3. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal
4. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=WL40UeySag4
2. https://www.youtube.com/watch?v=MMXaXDIHFJ8
3. https://www.youtube.com/watch?v=7uJL1R6M4Iw

WEB RESOURSES:

1. https://acrl.ala.org/IS/instruction-tools-resources-2/pedagogy/a-selected-list-of-journals-on-teaching-learning/
2. https://guides.douglascollege.ca/TLonline/resourcesforonlinepedagogy
3. https://www.refseek.com/directory/teacher_resources.html

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
25LG201701	**PERSONALITY DEVELOPMENT THROUGH ESSENTIAL LIFE SKILLS**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course gives awareness to students about the various dynamics of personality development.

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

CO1. Demonstrate knowledge in Self-Management and Planning Career

CO2. Analyze the functional knowledge in attitudes and thinking strategies

CO3. Learn and apply soft skills for professional success.

CO4. Function effectively as an individual and as a member in diverse teams

CO5. Communicate effectively in public speaking in formal and informal situations.

CO-PO Mapping Table:

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

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

COURSE CONTENT

Module 1: SELF-ESTEEM & SELF-IMPROVEMENT (09 Periods)

Concept of personality, significance of personality**-**Know Yourself – Accept Yourself; Self-Improvement: Plan to Improve - Actively Working to Improve Yourself- SWOT Analysis-Exercises- case studies

Module 2: DEVELOPING POSITIVE ATTITUDES (09 Periods)

How Attitudes Develop – Attitudes are Catching – Improve Your Attitudes – Exercises-case studies-Positive attitude and its advantages, negative attitude and its disadvantages-case studies

Module 3: SELF-MOTIVATION & SELF-MANAGEMENT (09 Periods)

Concept of motivation, significance, factors leading to de-motivation- Show Initiative – Be Responsible - Self-Management; Efficient Work Habits – Stress Management – Employers Want People Who can Think – Thinking Strategies- Exercises- case studies

Module 4: GETTING ALONG WITH THE SUPERVISOR (09 Periods)

Know your Supervisor – Communicating with your Supervisor – Special Communication with your Supervisor – What Should you Expect of Your Supervisor? – What your Supervisor expects
of you - Moving Ahead Getting Along with your Supervisor- Exercises- case studies

Module 5: WORKPLACE SUCCESS (09 Periods)

First Day on the Job – Keeping Your Job – Planning Your Career – Moving Ahead-Essential employability skills, professional attributes, and career development strategies -Exercises-Case studies.

Total Periods: 45

EXPERIENTIAL LEARNING

1. List out the self-improvements in you on the charts and explain in detail.
2. Discuss different famous personalities and their attitudes.
3. Describe different personalities concerning self-motivation and self-management.
4. Imagine you are a supervisor and illustrate different special communications.
5. Assume and Interpret different experiences on the first day of your job.

RESOURCES

TEXTBOOK:

1. Harold R. Wallace and L. Ann Masters, Personal Development for Life and Work, Cengage Learning, Delhi, 10th edition Indian Reprint, 2011. (6th Indian Reprint 2015)
2. Barun K. Mitra, Personality Development and Soft Skills, Oxford University Press, 2011.

REFERENCE BOOKS:

1. K. Alex, Soft Skills, S. Chand & Company Ltd, New Delhi, 2nd Revised Edition,
2. Stephen P. Robbins and Timothy A. Judge, Organizational Behaviour, Prentice Hall, Delhi, 16th edition, 2014

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=6Y5VWBLi1es
2. https://www.youtube.com/watch?v=H9qA3inVMrA

WEB RESOURSES:

1. https://www.universalclass.com/.../the-process-of-perso
2. https://www.ncbi.nlm.nih.gov/pubmed/25545842
3 https://www.youtube.com/watch?v=Tuw8hxrFBH8

UNIVERSITY ELECTIVE

Course Code	Course Title	L	T	P	S	C
25ME201701	**ENTREPRENEURSHIP AND INNOVATION MANAGEMENT**	3	-	-	-	3

Pre-Requisite -

Anti-Requisite -

Co-Requisite -

COURSE DESCRIPTION: This course aims to provide students with a deep understanding of entrepreneurship and innovation. It explores entrepreneurial processes, opportunity identification, business planning, innovation management, intellectual property rights, and venture growth strategies. Students will develop entrepreneurial thinking, creativity, and problem-solving abilities to create and manage innovative ventures that contribute to economic and societal development.

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

CO1. Explain the fundamentals of entrepreneurship and its role in economic development.

CO2. Analyze opportunities and prepare business plans for entrepreneurial ventures.

CO3. Apply creativity and innovation techniques to business problems.

CO4. Demonstrate knowledge of technology management, IPR, and startup ecosystem.

CO5. Evaluate financing options, marketing strategies, and growth models for ventures.

CO-PO Mapping Table:

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

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

COURSE CONTENT

Module 1: INTRODUCTION TO ENTREPRENEURSHIP (09 Periods)

Concept, meaning and importance of entrepreneurship – Characteristics and skills of entrepreneurs – Types of entrepreneurs: social, women, corporate, rural, technology-based – Intrapreneurship vs. entrepreneurship – Entrepreneurial ecosystem and its components.

Module 2: ENTREPRENEURIAL PROCESS AND BUSINESS PLANNING (09 Periods)

Stages of entrepreneurial process: Idea, Feasibility, Startup, Growth – Opportunity identification and evaluation – Market research and environmental scanning – Structure and components of a business plan – Case studies of successful entrepreneurs.

Module 3: INNOVATION MANAGEMENT (09 Periods)

Meaning, scope and significance of innovation – Types of innovation: product, process, And business model, disruptive, frugal – Creativity techniques: brainstorming, lateral thinking, design thinking, TRIZ – Managing innovation in organizations – Innovation as a competitive advantage.

Module 4: TECHNOLOGY, IPR AND STARTUP ECOSYSTEM (09 Periods)

Technology management and commercialization – Intellectual Property Rights (IPR): patents, copyrights, trademarks, designs, trade secrets – Technology transfer and licensing – Startup India, Atal Innovation Mission, MSME policies – Role of incubators, accelerators and innovation hubs.

Module 5: FINANCING AND GROWTH OF VENTURES (09 Periods)

Sources of finance: bootstrapping, angel investors, venture capital, crowdfunding, government support – Entrepreneurial marketing strategies – Financial planning for startups – Scaling up ventures: challenges and strategies – Exit strategies: mergers, acquisitions, IPO.

Total Periods: 45

EXPERIENTIAL LEARNING

1. Prepare a mini-business plan for a startup idea.
2. Visit a nearby incubation/innovation center and prepare a report.
3. Conduct a creativity workshop (brainstorming/design thinking session).
4. Prepare a case study presentation on a successful entrepreneur/startup.

RESOURCES

TEXT BOOKS:

1. Hisrich, R.D., Peters, M.P., & Shepherd, D.A. (2017), Entrepreneurship, McGraw-Hill Education.
2. Drucker, P. (2007), Innovation and Entrepreneurship, Harper Business.
3. Kuratko, D.F. (2020), Entrepreneurship: Theory, Process and Practice, Cengage Learning.

REFERENCE BOOKS:

1. Timmons, J.A., & Spinelli, S. (2019), New Venture Creation: Entrepreneurship for the 21st Century, McGraw-Hill Education.
2. Schilling, M.A. (2020), Strategic Management of Technological Innovation, McGraw-Hill Education.
3. Scarborough, N.M. (2018), Essentials of Entrepreneurship and Small Business Management, Pearson.

VIDEO LECTURES:

1. https://www.youtube.com/watch?v=rA4uKIy5gO0&list=PLsh2FvSr3n7fQlIDbfKutmSL26TsWitGQ
2. https://www.youtube.com/watch?v=itRVzjk9mkg

WEB RESOURSES:

1. https://nacosadsu.org.ng/main/docs/300L/ENT%20301.pdf?utm_source=chatgpt.com
2. https://www.measiim.edu.in/myweb/uploads/2022/05/PMFEA-IE-1.pdf?utm_source=chatgpt.com
3. https://ocw.mit.edu/courses/15-351-managing-innovation-and-entrepreneurship-spring-2008/pages/lecture-notes/?utm_source=chatgpt.com