NEW HORIZON
COLLEGE OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

Academic Year 2026–27

3rd and 4th Semester
Scheme & Syllabus
BATCH: 2025–29
CREDITS: 160

NEW HORIZON COLLEGE OF ENGINEERING

VISION

To emerge as an institute of eminence in the fields of engineering, technology and management in serving the industry and the nation by empowering students with a high degree of technical, managerial and practical competence.

MISSION

- To strengthen the theoretical, practical and ethical dimensions of the learning process by fostering a culture of research and innovation among faculty members and students.
- To encourage long-term interaction between the academia and industry through their involvement in the design of curriculum and its hands-on implementation.
- To strengthen and mould students in professional, ethical, social and environmental dimensions by encouraging participation in co-curricular and extracurricular activities.

QUALITY POLICY

To provide educational services of the highest quality both curricular and co-curricular to enable students integrate skills and serve the industry and society equally well at global level

VALUES

- Academic Freedom
- Integrity
- Inclusiveness
- Innovation
- Professionalism
- Social Responsibility

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

To create competent mechanical engineers capable of working in diversified disciplines for transformative impact on societal progressive development in the field of mechanical engineering through creative research and lifelong learning

MISSION

- To impart excellent education by providing the state of art research facilities in the field of mechanical engineering.
- To develop alliances with industries and other organizations for excellence in teaching learning process, research and consultancy projects.
- To enhance the knowledge of students in intellectual, entrepreneurial and ethical challenges through active participation by critical thinking.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

- **PEO 1**: The graduates will be able to apply the overall knowledge of Mechanical Engineering along with concepts of Mathematics, Science, Communication and Computing skills to understand specific problem areas and finding the optimal solutions for the same.

- **PEO 2**: The graduates will be able to implement ideas of Mechanical Engineering for the challenging tasks in the interdisciplinary areas like Electrical, Electronics, Computer Science, Civil, Bio-Technology and allied branches.

- **PEO 3**: The graduates will be widely talented in the fields of manufacturing, service and design industries, which will not only improve their employability but also aid in establishing the above said industries.

- **PEO 4**: The graduates will develop lifelong learning attitudes, ethics and values that will help their career employability and growth in engineering, academia, defence, state and central government sectors.

PEO TO MISSION STATEMENT MAPPING

Program Educational Objectives	M1	M2	M3
PEO 1	3	2	3
PEO 2	2	3	2
PEO 3	2	3	2
PEO 4	1	2	3

KNOWLEDGE AND ATTITUDE PROFILE (WK)

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, reuse of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

PROGRAM OUTCOMES (POs)

Graduate Attributes	PO #	Program Outcomes
Engineering knowledge	1	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
Problem Analysis	2	Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
Design Development of Solutions	3	Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
Conduct Investigations of Complex Problems	4	Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
Engineering Tool Usage	5	Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
The Engineer and The World	6	Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
Ethics	7	Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
Individual and Collaborative Team work	8	Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams
Communication	9	Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
Project Management and Finance	10	Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
Life-Long Learning	11	Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

PROGRAM SPECIFIC OUTCOMES (PSOs)

After successful completion of mechanical Engineering Program, the graduates will be able to:

PSO1	Specify, fabricate, test and operate various machines along with essential documentations.
PSO2	Analyze, design, develop and implement the concepts of mechanical systems and processes towards product development

NEW HORIZON COLLEGE OF ENGINEERING
B. E. in Mechanical Engineering

III Semester																	
S. No.	**Course and Course Code**		**Course Title**	**BoS**	**Credit Distribution**				**Overall Credits**	**TLP Contact Hours / Sem**	**TW & SL / Sem**	**Total Hours /Sem**	**Exam Hrs**	**Marks**		
					L	**T**	**P**	**S**						**CIE**	**SEE**	**Total**
1	BSC	25MAE31	Numerical Methods, Vector Spaces and Transforms	BS	3	0	0	0	3	45	45	90	3	50	50	**100**
2	PCC	25MEE32	Mechanics of Materials	ME	3	0	0	0	3	45	45	90	3	50	50	**100**
3	PCCL	25MEL32	Mechanics of Materials Lab	ME	0	0	1	0	1	30	-	30	3	50	50	**100**
4	PCC	25MEE33	Manufacturing Process	ME	3	0	0	0	3	45	45	90	3	50	50	**100**
5	PCCL	25MEL33	Manufacturing Process Lab	ME	0	0	1	0	1	30	-	30	3	50	50	**100**
6	PCC	25MEE34	Engineering Thermodynamics	ME	3	0	0	0	3	45	45	90	3	50	50	**100**
7	PCC	25MEE35	Material Science and Metallurgy	ME	3	0	0	0	3	45	45	90	3	50	50	**100**
8	AEC	25MEE36X	Ability Enhancement Course – III	ME	If the course is a Theory							30	3	50	50	**100**
					1	0	0	0	1	15	15					
					If the course is a Laboratory											
					0	0	1	0	1	30	-					
9	PROJ	25CPD37	Community Project using Innovation and Design Thinking	Any Dept	0	0	1	0	1	-	30	30	3	50	50	**100**
10	NCMC	25NSS30	National Service Scheme	-	0	0	0	0	0	-	30	30	--	50	--	**50**
		25PED30	Physical Education and Sports	-												
		25YOG30	Yoga	-												
		25MUS30	Music	-												
Total									**19**	**300/ 315**	**300 / 285**	**600**	**27**	**500**	**450**	**950**

11	NCMC	25DMAT31*	Basic Applied Mathematics -I	BS	0	0	0	0	0	15	15	30	--	50	--	**50**

BSC: Basic Science Course, **PCC**: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **NCMC:** Non-Credit Mandatory Course, **AEC**: Ability Enhancement Course, **PROJ**: Mini Project work, **L:** Lecture, **T**: Tutorial, **P**: Practical **S: SDA**: Skill Development Activity, **TW & SL-** Term Work & Self Learning, **K:** This letter in the course code indicates common to all the stream of engineering. **ESC:** Engineering Science Course, **CIE**: Continuous Internal Evaluation, **SEE**:Semester End Evaluation.

25DMAT31*: This non-credit mandatory course to be offered with only CIE and no SEE to Lateral entry students.

Ability Enhancement Course – III (1-0-0-0 or 0-0-1-0)			
25MEE361	IoT for Mechanical Systems	25MEE364	Instrumentation and Control Systems
25MEE362	Bio Energy and Biofuels	25MEE365	Bio Inspired Design and Innovation (1-0-0-0)
25MEE363	Energy Management and Auditing		

Community Project using Innovation and Design Thinking: A community is a social unit or group of people sharing socially-significant characteristics, such as place, set of norms, culture, religion, values, customs, or identity. The Community Project using Innovation and Design Thinking course involves addressing complex issues within such a community through a human-centered lens. By integrating design thinking methodologies, these projects move beyond traditional service to focus on empathy, iterative problem-solving, and the creation of sustainable, innovative solutions. Whether establishing welfare initiatives like orphanages, implementing renewable energy systems, or developing environmental technologies, the process begins with deep community engagement to uncover latent needs before defining specific challenges.

This experiential learning activity encourages students to identify, analyze, and address real-life problems by synthesizing engineering knowledge with creative strategy. The design thinking framework guides students through stages of empathy, ideation, and rapid prototyping, ensuring that the final interventions are not only technically sound but also culturally appropriate and user-validated. This approach promotes social responsibility and civic engagement while fostering interdisciplinary collaboration and the practical application of theoretical concepts. By navigating the ambiguity of real-world constraints through an innovative mindset, students contribute meaningfully to community welfare and sustainable development. Students may undertake these projects individually or in collaborative groups 2 to 4 members.

CIE:

The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide. The CIE marks awarded for the project work shall be based on the rubrics.

25XXX35(HSMS)- This course must be pertaining to economics and management of the concerned degree program. The course syllabus should have both economics and management topics and the course title should bear the word Management.

For IT allied Branches: Software Product/ Project Management

For Core Branches: Engineering Economics and Management / Industrial Management and Entrepreneurship.

National Service Scheme /Physical Education/Yoga/ Music: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PED) (Sports and Athletics), Yoga (YOG), and Music (MUS) with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semester and IV semester (for 2 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, Yoga and Music activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree. Students may opt for different activities/options across semesters. For instance, a student participating in PE during 3rd semester may choose NSS in the 4th semester or Yoga or Music.

NEW HORIZON COLLEGE OF ENGINEERING
B. E. in Mechanical Engineering

IV Semester																	
S. No.	**Course and Course Code**		**Course Title**	**BoS**	**Credit Distribution**				**Overall Credits**	**TLP Contact Hours / Sem**	**TW & SL / Sem**	**Total Hours /Sem**	**Exam Hrs**	**Marks**		
					L	**T**	**P**	**S**						**CIE**	**SEE**	**Total**
1	BSC	25MAE41	Complex Analysis, Optimization and Probability Distributions	BS	3	0	0	0	3	45	45	90	3	50	50	**100**
2	PCC	25MEE42	Heat Power Cycles	ME	3	0	0	0	3	45	45	90	3	50	50	**100**
3	PCCL	25MEL42	Heat Power Cycles Lab	ME	0	0	1	0	1	30	-	30	3	50	50	**100**
4	PCC	25MEE43	Fluid Mechanics	ME	3	0	0	0	3	45	45	90	3	50	50	**100**
5	PCCL	25MEL43	Fluid Mechanics Lab	ME	0	0	1	0	1	30	-	30	3	50	50	**100**
6	PCC	25MEE44	Machine Tools and Metrology	ME	3	0	0	0	3	45	45	90	3	50	50	**100**
7	PCCL	25MEL44	Machine Tools and Metrology Lab	ME	0	0	1	0	1	30	-	30	3	50	50	**100**
8	PEC	25MEE45X	Professional Elective Course-I	ME	3	0	0	0	3	45	45	90	3	50	50	**100**
9	AEC	25MEE46X	Ability Enhancement Course – IV	ME	If the course is a Theory							30	3	50	50	**100**
					1	0	0	0	1	15	15					
					If the course is a Laboratory											
					0	0	1	0	1	30	-					
10	PROJ	25EPP47	Environmental Science Project	ME	0	0	2	0	2	-	60	60	3	50	50	**100**
11	NCMC	25NSS40	National Service Scheme	-	0	0	0	0	0	-	30	30	--	50	--	**50**
		25PED40	Physical Education and Sports	-												
		25YOG40	Yoga	-												
		25MUS40	Music	-												
Total									**21**	**330 / 345**	**330 / 315**	**660**	**30**	**550**	**500**	**1050**

12	NCMC	25DMAT41*	Basic Applied Mathematics -II	BS	0	0	0	0	0	15	15	30	--	50	--	**50**

BSC: Basic Science Course, **PCC**: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **NCMC:** Non-Credit Mandatory Course, **AEC**: Ability Enhancement Course, **PROJ**: Mini Project work, **L:** Lecture, **T**: Tutorial, **P**: Practical **S: SDA**: Skill Development Activity, **TW & SL-** Term Work & Self Learning, **K:** This letter in the course code indicates common to all the stream of engineering. **ESC:** Engineering Science Course, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation.

25DMAT41*: This non-credit mandatory course to be offered with only CIE and no SEE to Lateral entry students.

Professional Elective Course-I			
25MEE451	Cogeneration and Waste Heat Recovery	25MEE454	Aerospace Propulsion Systems
25MEE452	Intelligent Manufacturing Systems	25MEE455	Bio Mechanics
25MEE453	Electric Vehicles and Battery Management System		

Ability Enhancement Course – IV (1-0-0-0 or 0-0-1-0)			
25MEE461	Computer Aided Machine Drawing	25MEE464	Aeromodelling Design
25MEE462	MATLAB for Mechanical Applications	25MEE465	Computational Mechanics And Simulation
25MEE463	PLC Programming		

Environmental Science Project: The Environmental Science Project is an applied learning component designed to develop students' awareness, understanding, and responsibility toward the environment. It provides an opportunity to study real-world environmental issues and apply scientific and engineering principles to design feasible and sustainable solutions. Central to this course is the alignment with the United Nations Sustainable Development Goals (SDGs), providing a global framework for students to address urgent environmental challenges through localized action.

The topics under environment include, but are not limited to, climate change, biodiversity, air and water pollution, land use, excess use of natural resources, earthquakes, rise in the earth's temperature, power generation, and soil erosion. By exploring these themes, students contribute to the realization of specific global targets, including Clean Water and Sanitation, Affordable and Clean Energy, Climate Action, Life Below Water, and Life on Land.

The project involves problem identification, field surveys, case studies, data collection, environmental audits, analysis, and the proposal of remedial or preventive measures. These interventions are aimed at improving biodiversity, air quality, and thermal comfort while promoting Responsible Consumption and Production and Sustainable Cities and Communities. Students can take up the project individually or in a group not exceeding four members. Participants are also encouraged to opt for Interdisciplinary Projects, fostering the collaborative thinking essential for achieving a sustainable balance between human activity and the natural world.

CIE:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project.

The CIE marks awarded for the project work shall be based on the rubrics. The marks awarded for the project report shall be the same for all the batches mates.

National Service Scheme /Physical Education/Yoga/ Music: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PED) (Sports and Athletics), Yoga (YOG), and Music (MUS) with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semester and IV semester (for 2 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, Yoga and Music activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree. Students may opt for different activities/options across semesters. For instance, a student participating in PE during 3rd semester may choose NSS in the 4th semester or Yoga or Music.

III Semester Syllabus

NUMERICAL METHODS, VECTOR SPACES AND TRANSFORMS			
Course Code	**25MAE31**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**45**	**SEE Marks**	**50**
TW & SL / Sem	**45**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:

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

25MAE31.1	Apply numerical techniques to solve engineering problems involving nonlinear equations and estimation of unknown data values.
25MAE31.2	Analyze engineering problems and select appropriate numerical techniques to obtain accurate approximate solutions.
25MAE31.3	Apply the concepts of vector spaces, inner product spaces, orthogonality, and linear transformations to represent and solve engineering and scientific problems.
25MAE31.4	Analyze harmonic components of periodic signals using Fourier series and interpret their significance in engineering systems.
25MAE31.5	Understand the concepts of Fourier transforms and their significance in the analysis of continuous-time engineering systems.
25MAE31.6	Apply the concepts of Z-transforms, their properties in the analysis of discrete-time engineering systems.

MODULE-1	**NUMERICAL SOLUTIONS AND INTERPOLATION**	**25MAE31.1**	**9 Hours**
Numerical solution of algebraic and transcendental equations - Newton-Raphson Method. Interpolation / Extrapolation: Newton's forward and backward formulae for equal intervals, Newton divided differences, Lagrange's formulae for unequal intervals.			
Self-study	Numerical solution of algebraic and transcendental equations using bisection method, Regula – Falsi method. Inverse Lagrange interpolation		
Text Book	Text Book 1: 28.2, 28.3, 29.6, 29.10, 29.11, 29.13, Text Book 2: 19.2, 19.3.		
MODULE-2	**NUMERICAL INTEGRATION, SOLUTION OF DIFFERENTIAL EQUATIONS**	**25MAE31.2**	**9 Hours**
Numerical integration by Simpson's 1/3rd, 3/8th & Weddle's rules. Application of numerical integration to velocity, area and volume. Numerical solution to 1^{st} order & 1^{st} degree ordinary differential equations by Taylor's series method, Modified Euler's method and Runge-Kutta method of 4^{th} order.			
Self-study	Numerical differentiation, Numerical integration by Trapezoidal rule. Numerical solution to 1^{st} order & 1^{st} degree ordinary differential equations by Picard's method.		
Text Book	Text Book 1: 32.3, 32.5, 32.7, 32.9, 30.7, 30.8, 30.10, Text Book 2: 19.5, 21.1.		
MODULE-3	**VECTOR SPACES AND LINEAR TRANSFORMATIONS**	**25MAE31.3**	**9 Hours**
Vector Space examples, Subspaces, Linear dependence and Independence, Spanning Sets, Basis and dimension. Inner product space, Orthogonal and Orthonormal basis by Gram Schmidt orthogonalization process. Introduction to Linear Transformations, matrix of linear transformation, rank and nullity theorem			
Self-study	Verifying the given basis is Orthogonal and Orthonormal basis. Orthogonal compliment, projection mapping.		
Text Book	Text Book 3: 4.1, 4.2, 4.3, 4.4, 4.5.		
MODULE-4	**FOURIER SERIES**	**25MAE31.4**	**9 Hours**
Periodic function, Dirichlet's conditions, Fourier series of periodic functions of period 2π and arbitrary period $2l$, Fourier series of full wave & half wave rectifiers, triangular wave, square wave and saw-toothed wave functions. Half range series-Problems. Practical harmonic analysis, variation of periodic current.			
Self-study	Complex Fourier Series, Half range practical harmonic analysis.		

Text Book	Text Book 1: 10.2, 10.4, 10.5, 10.6, 10.7, 10.11, Text Book 2: 11.1, 11.2,		
MODULE-5	**FOURIER TRANSFORMS AND Z - TRANSFORMS**	**25MAE31.5 25MAE31.6**	**9 Hours**

Fourier Transforms: Infinite Fourier transforms, Fourier Sine and Cosine transforms, Inverse Fourier sine and cosine transform. Convolution theorem.
Z-transform definition, Z-transforms of some standard functions, properties, damping rule, shifting rule, initial and final value theorems. Inverse Z- transforms by partial fractions method. Convolution theorem. Solution of difference equations using Z-transform

Self-study	Finite Fourier Transforms, Problems on initial and final value theorems of Z – transforms.
Text Book	Text Book 1: 22.4, 22.5, 23.3, 23.4, 23.5, 23.6, 23.9, 23.15, 23.16 Test Book 2: 11.7, 11.8

CIE Assessment Pattern (50 Marks – Theory) –

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	5	5	-
L3	Apply	10	5	5
L4	Analyze	10	5	5
L5	Evaluate	-	-	-
L6	Create			-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	10
L3	Apply	20
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Text Books:

1) B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, Forty fourth Edition, 2022, 9788193328491.
2) Erwin Kreyszig, Advanced Engineering Mathematics, Wiley-India Publishers, Tenth Edition, Reprint ISBN: 9788126554232.
3) David C Lay, Linear Algebra and its applications, Addison-Wesley Publishers, Fourth Edition, 2012, ISBN: 9780321385178

Reference Books:

1) Glyn James, Advanced Modern Engineering Mathematics, Pearson Education, Fourth Edition, 2015, 9780273719236
2) B. V. Ramana, Higher Engineering Mathematics, McGraw Hill Education (India) Private Limited, 4th E 2017, ISBN: 9780070634190
3) H. K. Dass, Advanced Engineering Mathematics, S. Chand & Company Ltd., Twenty Second Edition, 2018 9789352533831
4) N. P. Bali and Manish Goyal, A Text Book of Engineering Mathematics, Laxmi Publications (P) Ltd., 9th Ed 2014, ISBN: 9788131808320

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=f_EqOpgRwRM&t=16s
- https://www.youtube.com/watch?v=Xb9Ypn77LBo&t=16s
- https://www.youtube.com/watch?v=csgvZol6Wfw

- https://www.youtube.com/watch?v=Atv3IsQsak8
- https://www.youtube.com/watch?v=aEF5PPbv8Oc
- https://www.youtube.com/watch?v=Pwk7p8WiCh0
- https://www.youtube.com/watch?v=LGxE_yZYigI
- https://www.youtube.com/watch?v=RFlAiEXRwoo
- https://www.youtube.com/watch?v=RFlAiEXRwoo&t=128s
- https://www.youtube.com/watch?v=sMYtHaSIXbU

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Problem solving Approach
- Organizing Group wise discussions on related topics
- Seminars

MECHANICS OF MATERIALS

Course Code	**25MEE32**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**45**	**SEE Marks**	**50**
TW & SL / Sem	**45**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:

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

25MEE32.1	Understand mechanical properties of engineering materials and compute simple axial stresses, strains, and deformations in uniform, stepped, and continuously varying cross-sections.
25MEE32.2	Analyze beam behavior by constructing Shear Force and Bending Moment Diagrams under combined loads, and calculate deflections using analytical methods.
25MEE32.3	Analyze bending and shear stress distributions across various structural cross-sections to determine moment carrying capacities
25MEE32.4	Develop analytical models and design formulations for column structural stability using Euler's buckling theory and Rankine's formula.
25MEE32.5	Design circular shafts subjected to torsional loading and compute stresses/strains in thin and thick cylindrical pressure vessels using Lame's equations
25MEE32.6	Apply principles of deformable body mechanics to solve complex structural engineering problems and foster continuous technical learning.

MODULE-1	**SIMPLE STRESS AND STRAIN**	**25MEE32.1, 25MEE32.6**	**9 Hours**

Assumptions in MOM, stress, strain, mechanical properties of materials, Hooke's Law and Poisson's ratio, Stress-Strain curve for Mild steel, cast iron and Aluminium. Extension /Shortening of a bar, bars with cross section varying in steps, bars with continuously varying cross sections (circular and rectangular), Elongation due to self-weight, Principle of super position and numericals, Thermal Stresses (No numericals), elastic constants (only definitions).

Self-study	Study the mechanical properties of various materials and their applications
Text Book	Text Book 1: 2.1,2.2,2.4,2.5,2.6,2.7 Text Book 2: Page No. 1-90

MODULE-2	**BENDING MOMENT AND SHEAR FORCE DIAGRAMS**	**25MEE32.2, 25MEE32.6**	**9 Hours**

Introduction, Types of beams, loads and reactions, shear forces and bending moments, Rate of loading, sign conventions, relationship between shear force and bending moments. Shear force and bending moment diagrams for different beams subjected to concentrated loads, uniformly distributed load, (UDL) uniformly varying load (UVL) and couple for different types of beams, numericals. Analysis of SFD , BMD using AI tools.

Case Study	Study the various types of load acting on various structural members.
Text Book	Text Book 1:5.1,5.2,5.3 Text Book 2: Page No.160-282

MODULE-3	**TORSION OF CIRCULAR SHAFTS, THICK AND THIN CYLINDERS**	**25MEE32.5 25MEE32.6**	**9 Hours**

Torsion of Circular Shafts: Introduction, Pure torsion, assumptions, derivation of torsional equations, polar modulus, Torsional rigidity / stiffness of shafts. Power transmitted by solid and hollow circular shafts, numericals.

Thick and Thin Cylinders: Stresses in thin cylinders, changes in dimensions of cylinder (diameter, length and volume). Thick cylinders - Lame's equation, Problems on Lame's equation.

Self-study	Study the importance of design parameters in the design of Boilers, Tanks and Gun

	Barrels etc. Also study the importance of design of shafts.		
Text Book	Text Book 1:3.1,3.2 , Text Book 2: Page No.759-798 and 945-981		
MODULE-4	**BENDING AND SHEAR STRESSES IN BEAMS**	**25MEE32.3, 25MEE32.6**	**9 Hours**
Introduction, Theory of simple bending, assumptions in simple bending. Bending stress equation, relationship between bending stress and radius of curvature, relationship between bending moment and radius of curvature. Moment carrying capacity of a section. Shearing stresses in beams, shear stress across rectangular, circular, symmetrical I and T sections.			
Self-study	Study the importance of moment of inertia and kinds of cross sections for beams.		
Text Book	Text Book 1: 9.1,9.2,9.3,10.1,10.2,10.3,10.4 Text Book 2:Page No.441-575 and 982-1010		
MODULE-5	**DEFLECTION OF BEAMS AND ELASTIC STABILITY OF COLUMNS**	**25MEE32.2 25MEE32.4 25MEE32.6**	**9 Hours**
Deflection of Beams: Introduction, Differential equation for deflection. Equations for deflection, slope and bending moment. Double integration method for cantilever and simply supported beams for point load, UDL, UVL and Couple, Macaulay's method, Analysis of deflection of beams using AI tools. Elastic Stability of Columns: Introduction, Columns and struts, slenderness ratio, Classification of columns, buckling load or critical load, Sign conventions, Euler's theory of buckling, Effective length for various boundary conditions, Limitations of Euler's theory, Rankine formula, numericals.			
Case Study	Study the importance of deflection of beams and slenderness ratio and applications of Euler's critical load in the design of long columns.		
Text Book	Text Book 1:4.1,4.2,4.6,4.8,6.1,6.2,6.3 Text Book 2: Page No.283-333		

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	5	5	-
L3	Apply	10	5	5
L4	Analyze	10	5	5
L5	Evaluate	-	-	-
L6	Create			-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	10
L3	Apply	20
L4	Analyze	10
L5	Evaluate	--
L6	Create	--

Suggested Learning Resources:

Text Books:

1) Ferdinand Beer & Russell Johston., 'Mechanics of Materials', McGraw Hill India, 19th Edition, 2020, ISBN-(13 digits): 9789390219421.
2) Ramamrutham S., 'Strength of Materials', Dhanpat Rai Publishing Co Pvt Ltd, 16th Edition, 2008, ISBN- 9789352162031.

Reference Books:

1) R C Hibbeler., 'Mechanics of Materials', Pearson Education, 9th Edition, 2018, ISBN-(13 digits): 978- 9332584037; ISBN-(10 digits): 9332584036.
2) James M. Gere, Barry J. Goodno., 'Mechanics of Materials', Cengage Learning, 8th Edition, 2014, ISBN- (13 digits): 9788131524749.
3) S S Rattan., 'Strength of Materials', McGraw Hill India, 2nd Edition, 2011, ISBN-(13 digits): 978- 0071072564; ISBN-(10 digits): 007107256X.

Web links and Video Lectures (e-Resources):

- **https://www.youtube.com/watch?v=La4UEa7hA7Q&list=PLJoALJA_KMOARYNi50T6b488kPU BbOIsX**
- **https://www.youtube.com/watch?v=GkFgysZC4Vc**
- **https://www.youtube.com/watch?v=aQf6Q8t1FQE&list=PLEYqyyrm- hQ3wtF34smyJSAOqUJqnf1ch**
- **https://www.youtube.com/watch?v=B9lyGZzb_6M&list=PLIhUrsYr8yHzft7ygw5THZo4aD csxEadP**
- **https://www.youtube.com/watch?v=MFsirsHnQi4 https://www.youtube.com/watch?v=ihsnQWp09zg&list=PLDN15nk5uLiCAnu7Rjta7vvNhoJZv_gAt**

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Visit to any design department of manufacturing/aero/auto industry
- Demonstration of short, medium and long columns
- Video demonstration of finding the mechanical properties of materials.
- Contents related activities (Activity-based discussions)
  - Organizing Group wise discussions on issues
  - Seminars

MECHANICS OF MATERIALS LAB			
Course Code	**25MEL32**	**Credits**	**01**
L:T:P:S	**0:0:1:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**30**	**SEE Marks**	**50**
TW & SL / Sem	**-**	**Total Marks**	**100**
Total Hours /Sem	**30**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

25MEL32.1	Examine the microstructure details of Ferrous and nonferrous materials.
25MEL32.2	Understand the function on multi-disciplinary teams in the area of materials testing stresses and strains in the members subjected to axial, bending and torsional loads.
25MEL32.3	Determine the impact strength, hardness and wear rate of various materials.
25MEL32.4	Identify the surface defects through NDT techniques for ferrous and nonferrous materials.

Exp. No.	List of Experiments	Hours	COs
	Prerequisite Experiments		
	Demo: To determine the wear rate of the given specimen using Pin on Disc apparatus.	2	NA
	PART-A		
1	Determine the hardness number of aluminum specimen using Brinell hardness test.	2	25MEL32.3
2	Evaluating the hardness number of hardened steel specimen using Vickers'shardness test.	2	25MEL32.3
3	Determine the hardness number of mild steel/cast iron specimen using Rockwell hardness test.	2	25MEL32.3
4	Metallographic examination and identification of microstructures of ferrous and non-ferrous materials materials.	2	25MEL32.3
5	Determination of cracks in given material using dye penetrant test.	2	25MEL32.1
6	Determination of defects in given material using magnetic crack detector.	2	25MEL32.4
	PART-B		
7	Determine the impact energy and strength of notched specimen using Charpy and Izod tests.	2	25MEL32.3
8	Determine the ultimate shear strength of the given specimen in single and double shear using UTM.	2	25MEL32.2
9	Determine the moment of inertia, modulus of elasticity and maximum bending stress of wood specimen by conducting bending test.	2	25MEL32.2
10	Determine the compressive strength, modulus of elasticity, % reduction in length and % increase in area of cast iron specimen by conducting compression test on universal testing machine.	2	25MEL32.2
11	Determine the modulus of rigidity, Torsional strength and modulus of toughness of mild steel specimen using torsion test.	2	25MEL32.2
12	Determine the elastic strength, ultimate tensile strength, modulus of toughness and young's modulus of mild steel specimen by conducting	2	25MEL32.2

	tensile test on universal testing machine.		

PART-C

Beyond Syllabus Virtual Lab Content (4 Hours)

(To be done during Lab but not to be included for CIE or SEE)

- **Impact Test**
  https://sm-nitk.vlabs.ac.in/exp/izod-impact-test/
- **Charpy Impact Test**
  https://sm-nitk.vlabs.ac.in/exp/charpy-impact-test/
- **Brinell Hardness Test**
  https://sm-nitk.vlabs.ac.in/exp/brinell-hardness-test/
- **Rockwell Hardness Test**
  https://sm-nitk.vlabs.ac.in/exp/rockwell-hardness-test/
- **Vickers Hardness Test**
  https://sm-nitk.vlabs.ac.in/exp/vickers-hardness-test/
- **Tensile Test on Mild Steel**
  https://sm-nitk.vlabs.ac.in/exp/tensile-test-mild-steel/
- **Compression Test**
  https://sm-nitk.vlabs.ac.in/exp/compression-test-cast-iron/
- **Torsion Test on Mild Steel**
  https://sm-nitk.vlabs.ac.in/exp/torsion-test-mild-steel/
- **Shear Test**
  https://sm-nitk.vlabs.ac.in/exp/direct-shear-test-timber/

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		30	20
L1	Remember	-	-
L2	Understand	10	-
L3	Apply	10	10
L4	Analyze	10	10
L5	Evaluate	-	-
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	05
L2	Understand	05
L3	Apply	20
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Reference Books:

1) R C Hibbeler., 'Mechanics of Materials', Pearson Education, 9th Edition, 2018, ISBN-(13 digits): 978-9332584037; ISBN-(10 digits): 9332584036.
2) James M. Gere, Barry J. Goodno., 'Mechanics of Materials', Cengage Learning, 8th Edition, 2014, ISBN-(13 digits): 9788131524749.
3) S S Rattan., 'Strength of Materials', McGraw Hill India, 2nd Edition, 2011, ISBN-(13 digits): 978-0071072564; ISBN-(10 digits): 007107256X.

MANUFACTURING PROCESS

Course Code	**25MEE33**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**45**	**SEE Marks**	**50**
TW & SL / Sem	**45**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:

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

25MEE33.1	Understand the principles of casting, mould preparation, pattern making and furnace operations for producing defect-free cast components.
25MEE33.2	Analyze welding defects and select suitable joining processes such as arc welding, gas welding, soldering and brazing for engineering applications.
25MEE33.3	Apply the principles of forging, rolling, extrusion and drawing to select suitable metal forming processes for manufacturing engineering components.
25MEE33.4	Analyze additive manufacturing processes, materials, advantages, limitations and applications for rapid prototyping and 3D-printed component development.
25MEE33.5	Apply Industry 4.0 technologies to improve productivity, quality, flexibility and decision-making in modern manufacturing systems.
25MEE33.6	Illustrate the integration of IoT, cyber-physical systems, automation and digital twins for developing intelligent and connected manufacturing environments.

MODULE-1	**INTRODUCTION TO MANUFACTURING**	**25MEE33.1 25MEE33.2**	**9 Hours**

Introduction and classification of manufacturing processes.
Casting, type of patterns and pattern materials and allowances, types of gates, types of risers, moulding sands, binders and additives, moulding machines, Moulding sands, Moulding machines.
Moulding methods: green sand, dry sand, Centrifugal, shell, investment, plaster, and cement-bonded moulding. Classification of Melting Furnaces.

Case Study	Investigate Sand mould by suitable moulding machine.
Text Book	Text Book 1: chapter1.1,1.2,2.1,2.2,2.3,2.4,2.5,2.6

MODULE-2	**WELDING AND JOINING PROCESSES**	**25MEE33.2**	**9 Hours**

Classification, Types of Welds and Welded joints, Metal arc welding (MAW), Tungsten inert gas welding (TIG), Metal inert gas welding (MIG), Laser Welding (LBW), Electron Beam Welding (EBW), Plasma Arc Welding (PAW), Friction Stir Welding (FSW), Explosive Welding, Resistance Spot Welding, , Gas Welding , Robotic Welding, Welding defects and their remedies. Soldering, Brazing

Self-study	Analyze the welding and joining processes used in the fabrication of automobile chassis or pressure vessels, focusing on the selection of welding techniques
Text Book	Text Book 1: chapter3.11, 3.13, 5.2

MODULE-3	**FORGING, FORMING, DRAWING PROCESSES**	**25MEE33.3, 25MEE33.4**	**9 Hours**

Introduction to forming processes, Classification of forging. Open die forging and closed die forging, Forging defects. Classification of rolling mills, Rolling defects, Direct extrusion, Indirect extrusion, principle of drawing, drawing dies, process variables, strain rate and temperature effects.

Case Study	Analyze an automotive manufacturing company about rolling, forging, extrusion, and to produce high-strength components while minimizing material waste and improving production efficiency.
Text Book	Text Book 2: Chapters 2.12,2.19,4.5,4.8,4.11,4.12,4.13 Text Book 3: Chapters 12.1,12.2,12.6,12.12,12.39,16.2,16.3,16.4,16.15,16.17,16.27,18.4,18.7

MODULE-4	**ADDITIVE MANUFACTURING**	**25MEE33.5**	**9 Hours**

Introduction to Additive Manufacturing: Introduction to AM, AM evolution, Need for Additive Manufacturing, process, Stereolithography (SL), Materials, SL resin curing process, Micro-stereoli thography, Process Benefits and Drawbacks of 3D printing, rapid proto typing , Selective laser Sintering (SLS), , Fused Deposition Modeling (FDM), Principles, Materials. Applications of Additive Manufacturing.

Applications	Analyze the Additive Manufacturing process used, the material selection criteria, benefits		
Text Book	Text Book 1: chapter 23.1, 23.2, 23.3, 23.4, 23.5, 23.6, 23.7		
MODULE-5	**SMART MANUFACTURING**	**25MEE33.6**	**9 Hours**

Evolution of manufacturing from Industry 1.0 to Industry 4.0, Sensors and IoT technologies in Manufacturing, Intelligent Production systems, smart factories, cyber-physical systems, IoT-enabled production, automation, Digital Twin.

Case Study	Analyze how a smart manufacturing system integrates IoT-enabled machines, real-time data analytics, and automation to improve productivity, quality, and operational efficiency in a manufacturing plant.
Text Book	Text Book 4: Chapters 3.3,3.7,3.9,3.14,3.16,3.17

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	5	5	-
L3	Apply	10	5	5
L4	Analyze	10	5	5
L5	Evaluate	-	-	-
L6	Create			-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	10
L3	Apply	20
L4	Analyze	10
L5	Evaluate	--
L6	Create	--

Suggested Learning Resources:

Text Books:

1) R.K.Jain, 'Production Technology', Khanna Publishers-Delhi , 2022, ISBN:9788174090997
2) Hazara Choudhry, 'Work shop Technology', Vol – II, Media promoters and publishers Pvt. Ltd. 2021, ISBN:9788185099156
3) Manufacturing Process-I, Dr.K.Radhakrishna, Sapna Book House, 7th Revised Edition 2021, ISBN:978-8128002076R
4) Additive Manufacturing, Ian Gibson, David W. Rosen, Brent Stucker, and Mahyar Khorasani, 3rd Edition, Springer, 2021, ISBN: 978-3-030-56129-1

Reference Books:

1) HMT, 'Production Technology', HMT, Tata McGraw Hill, 2022, ISBN:978-0070964433
2) Internet of Things for Industry 4.0,G. R. Kanagachidambaresan et al. (Eds.), Design, Challenges and Solutions, 1st Edition, Springer, 2020, ISBN: 978-3-030-32532-9

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc24_me84/preview
- https://archive.nptel.ac.in/noc/courses/noc18/SEM2/noc18-me51/
- https://onlinecourses-archive.nptel.ac.in/noc18_me05/
- https://onlinecourses-archive.nptel.ac.in/noc19_mm12/
- https://onlinecourses.nptel.ac.in/noc23_me92/preview
- https://elearn.nptel.ac.in/shop/completed-courses/execedu-closed/additive-manufacturing-technologies-for-practising-engineers-cohort-3/
- https://nptel.ac.in/courses/127101872
- https://onlinecourses.nptel.ac.in/noc25_mm01/preview

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Visit to any manufacturing of aero or auto industry.
- Demonstration of lathe/milling/drilling/CNC operations
- Demonstration of metal joining process
- Video demonstration of latest trends.
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare Flowcharts and Handouts
  - Organizing Group wise discussions on issues
- Seminars

MANUFACTURING PROCESS LAB

Course Code	**25MEL33**	**Credits**	**01**
L:T:P:S	**0:0:1:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**30**	**SEE Marks**	**50**
TW & SL / Sem	**-**	**Total Marks**	**100**
Total Hours /Sem	**30**	**Exam Hours**	**03**

Course outcomes:

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

25MEL33.1	Understand mould preparation and pattern making operations used in foundry.
25MEL33.2	Apply soldering and brazing processes for metal joining applications.
25MEL33.3	Analyze and Perform electric arc welding and gas welding operations for fabrication of joints.
25MEL33.4	Apply and perform 3D Printing and Laser cutting for the manufacture of components.

Exp. No.	List of Experiments	Hours	COs
	Prerequisite Experiments		
	• Familiarization with safety practices and personal protective equipment. • Introduction to foundry equipment, welding equipment and forging tools.	2	NA
	PART-A		
1	Preparation of mould using two moulding boxes method	2	25MEL33.1
2	Preparation of model on joining process by Soldering.	2	25MEL33.3
3	Preparation of model on joining process by Brazing.	2	25MEL33.3
4	Preparation of Lap Joint using Electric Arc Welding.	2	25MEL33.4
5	Preparation of Butt Joint using Electric Arc Welding.	2	25MEL33.4
6	Preparation of T Joint using Electric Arc Welding.	2	25MEL33.4
	PART-B		
7	Preparation of Welded Joints using Gas Welding	2	25MEL33.4
8	Modeling and 3D printing of helical gear	2	25MEL33.2
9	Preparation of spur gear using Laser cutting method	2	25MEL33.2
10	Modeling and 3D printing of Nut and Bolt	2	25MEL33.2
11	Modeling and 3D printing of Connecting rod	2	25MEL33.2
12	Modeling and 3D printing of Piston and cylinder	2	25MEL33.2

PART-C

Beyond Syllabus Virtual Lab Content (4 Hours)

(To be done during Lab but not to be included for CIE or SEE)

- **Foundry**
  https://msvs-dei.vlabs.ac.in/Foundry.php
- **Welding**
  https://msvs-dei.vlabs.ac.in/Welding.php
- **3D Printing**
  https://3dp-dei.vlabs.ac.in/?utm_source

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		30	20
L1	Remember	-	-
L2	Understand	10	-
L3	Apply	10	10
L4	Analyze	10	10
L5	Evaluate	-	-
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	5
L2	Understand	5
L3	Apply	20
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Reference Books:

1.Manufacturing Process-I, Dr.K.Radhakrishna, Sapna Book House, 7th Revised Edition 2021,ISBN:978-8128002076

2.Hazara Choudhry, 'Work shop Technology', Vol – II, Media promoters and publishers Pvt. Ltd. 2021, ISBN:9788185099156

3.R.K.Jain, 'Production Technology', Khanna Publishers-Delhi , 2022, ISBN:9788174090997

4.Manufacturing Process-III, Dr.K.Radhakrishna, Sapna Book House, 7th Revised Edition 2021,ISBN:978-8128010439

ENGINEERING THERMODYNAMICS			
Course Code	**25MEE34**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**45**	**SEE Marks**	**50**
TW & SL / Sem	**45**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:

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

25MEE34.1	Understand the fundamental concepts, thermodynamic systems, properties, temperature concepts and units used in thermodynamic analysis
25MEE34.2	Apply the principles of work and heat transfer to determine energy interactions in closed and open systems
25MEE34.3	Analyze energy transfer processes and energy balance equations in thermodynamic systems using the First Law of Thermodynamics
25MEE34.4	Illustrate the feasibility, direction, and performance of thermodynamic processes and cycles using the Second Law of Thermodynamics
25MEE34.5	Determine thermodynamic properties and entropy changes of pure substances using property relations and thermodynamic tables
25MEE34.6	Apply the principles of ideal gas mixtures and real gas equations of state to understand the behavior of gas mixtures under various conditions

MODULE-1	**FUNDAMENTAL CONCEPTS & DEFINITIONS**	**25MEE34.1**	**9 Hours**

Fundamental Concepts & Definitions: Microscopic and Macroscopic approaches. System and its types, Surroundings, boundary, Thermodynamic properties: definition and units, Intensive and extensive properties, quasi-static process. Thermodynamic equilibrium: definition and conditions, Zeroth law of thermodynamics.
Temperature: concept, two-point scales and one-point scale, International fixed points. Temperature measurements, Numerical on temperature scales

Applications	Analyze the Practical Applications of zeroth law of thermodynamics and temperature concepts.
Text Book	Text Book 1: 1.1, 1.2, 1.3, 1.4,1.5, 2.1,2.2, 2.3 Text Book 2: 1.1, 1.2, 1.3, 1.4, 1.5, 1.6,

MODULE-2	**WORK AND HEAT AND FIRST LAW OF THERMODYNAMICS:**	**25MEE34.2 25MEE34.3**	**9 Hours**

Work and Heat: Mechanics definition of work and its limitations. Thermodynamic definition of work; examples, sign convention. Displacement work explanation, expressions for displacement work in various processes through p-V diagrams, Problems on work transfer and heat transfer.
First Law of Thermodynamics: Joules experiment, equivalence of heat and work. Statement of the First law of thermodynamics, Internal energy, prove energy is a property of the system, steady state-steady flow energy equation, Assumptions for SFEE and some important applications. Numerical on open and closed systems

Self Study	Investigate the applications of steady flow energy equation
Text Book	Text Book 1: 3.1, 3.2, 3.5, 3.6 , 4.1, 4.2, 4.3 , 5.1, 5.2 Text Book 2: 2.1, 2.2, 2.3, 3.1, 3.2, 3.3

MODULE-3	**SECOND LAW OF THERMODYNAMICS**	**25MEE34.4**	**9 Hours**

Second Law of Thermodynamics: Thermal reservoirs. Direct heat engine; schematic representation and efficiency. Reversed heat engine, schematic representation, coefficients of performance. Kelvin - Planck and Clausius statement; PMM I and PMM II, Equivalence of the two statements; Reversible and irreversible processes; factors that make a process irreversible, reversible heat engines, Carnot cycle, Numerical

Applications	Analyze the Application of second law of thermodynamics

Text Book	Text Book 1: 6.3, 6.4, 6.5, 6.6, 6.7, 6.8 Text Book 2: 4.1, 4.2, 4.3, 4.4, 4.5, 4.6		
MODULE-4	**ENTROPY AND PURE SUBSTANCES**	**25MEE34.5**	**9 Hours**

Entropy: Clausius theorem, Clausius inequality; Statement, proof, application to a reversible cycle. Entropy; definition, a property, change of entropy for irreversible process, principle of increase in entropy of the universe, entropy as a quantitative test for irreversibility, Numerical

Pure Substances: P-T and P-V diagrams, triple point and critical points. Sub cooled liquid, saturated liquid, mixture of saturated liquid and vapour, saturated vapour and superheated vapour states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and H-S diagrams, Numerical.

Case Study	Case study on Entropy and pure substance concepts
Text Book	Text Book 1: 7.4, 7.6, 7.7, 7.8, 9.1, 9.2, 9.7 Text Book 2: 5.1, 5.6, 5.7, 5.8, 7.1, 7.2, 7.3

MODULE-5	**IDEAL GAS MIXTURES AND REAL GASES**	**25MEE34.6**	**9 Hours**

Ideal gas mixtures: Ideal gas mixture; Dalton's laws of partial pressures, Amagat's law of additive volumes, evaluation of mass fractions, mole fractions, Expressions for C_P,C_V and Gas constant of the mixture. Numerical on mixtures.

Real Gases: Introduction. Van-der Waal's Equation of state, Van-der Waal's constants in terms of critical properties, Law of corresponding states, compressibility factor; compressibility chart. Numerical on real gases. Machine Learning models for predicting compressibility factor, specific heat, and gas mixture properties.

Applications	Investigate the applications of Ideal and Real gas mixtures
Text Book	Text Book 1: 10.1,10.2,10.3, 10.4, 10.5 Text Book 2: 8.1, 8.2, 8.3, 8.5.

CIE Assessment Pattern (50 Marks – Theory) –

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	5	5	-
L3	Apply	10	5	5
L4	Analyze	10	5	5
L5	Evaluate	-	-	-
L6	Create			-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	10
L3	Apply	20
L4	Analyze	10
L5	Evaluate	--
L6	Create	--

Suggested Learning Resources:

Text Books:

1. Basic and Applied Thermodynamics, P.K.Nag, Tata McGraw Hill Publication, 7th edition, 2025, ISBN: 9364444329.
2. Basic Thermodynamics, B.K Venkanna, Swati B. Wadavadagi, PHI Learning Private Limited, 2020, ISBN 13 – 9788120341128.

Reference Books:

1. Fundamentals of Engineering Thermodynamics, Moran J Shapiro., John wiley Pub.2015, ISBN – 9780470032091.
2.Thermodynamics, An Engineering Approach, YunusA.Cenegal and Michael A.Boles, Tata McGraw Hill

publications, 2016, ISBN – 9780073305370

3. Fundamentals of Thermodynamics, Claus Borgnakke, Richard Edwin Sonntag, 8th Edition,2024,WILEY, ISBN – 9781306947732

Web links and Video Lectures (e-Resources):

- **https://www.learnthermo.com/T1-tutorial/ch01/lesson-A/pg01.php**
- **http://www.freeonlinecoursesforall.com/2017/01/01/10-free-online-courses-on-thermodynamics/**
- **https://archive.nptel.ac.in/courses/112/105/112105123/**
- **http://www.digimat.in/nptel/courses/video/112105123/L13.html**

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Visit to any Thermal power plant
- Demonstration of working of IC engine/refrigerator
- Video demonstration on Laws of thermodynamics
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare thermodynamics related Flowcharts and Handouts
  - Organizing Group wise discussions on issues
- Seminars

MATERIAL SCIENCE AND METALLURGY

Course Code	**25MEE35**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**45**	**SEE Marks**	**50**
TW & SL / Sem	**45**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:

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

25MEE35.1	Analyze crystal structures, crystal imperfections, and diffusion mechanisms to evaluate the properties and behavior of engineering materials
25MEE35.2	Construct phase diagrams for various materials and analyze the phase transformations
25MEE35.3	Analyze iron-carbon equilibrium diagrams, TTT/CCT diagrams to correlate microstructure with material properties.
25MEE35.4	Identify suitable type of Heat treatment processes and Significance of properties vs microstructure.
25MEE35.5	Select suitable ferrous and non-ferrous engineering materials for engineering applications and AI-assisted material selection approaches.
25MEE35.6	Evaluate the processing, properties, and applications of ceramics, glasses, powder metallurgy products, and composite materials for engineering applications.

MODULE-1	**CRYSTAL STRUCTURE**	**25MEE35.1**	**9 Hours**

Introduction to crystal structure, BCC, FCC and HCP Structures, coordination number and atomic packing factors, Derivation of APF for BCC, FCC & HCP structures, crystal imperfections - point line and surface imperfections. Simple problems. Atomic Diffusion: Phenomenon, Ficks laws of diffusion, factors affecting diffusion. Simple problems. Failure of materials: Fracture: Type I, Type II and Type III, Creep: Description of the phenomenon with examples, three stages of creep, Fatigue: Types of fatigue loading with examples, Mechanism of fatigue, fatigue properties

Self-study	Study crystal structure and Diffusion
Text Book	Text Book 1: 1.2, 1.3, 1.4, 1.13, 1.15, 1.16

MODULE-2	**PHASE DIAGRAM**	**25MEE35.2**	**9 Hours**

Phase Diagram I: Solid solutions, Hume Rothary rule, substitutional and interstitial solid solutions, intermediate phases, Gibbs phase rule.

Phase Diagram II: Construction of equilibrium diagrams involving complete and partial solubility, lever rule. Different types invariant reactions – Eutectic, Eutectoid, Peritectic, Peritectectoid reactions

Case Study	Metallurgical study of different materials using metallurgical microscope
Text Book	Text Book 1: 2.2, 2.3, 2.4 to 2.15

MODULE-3	**IRON CARBON EQUILIBRIUM DIAGRAM**	**25MEE35.3 25MEE35.4**	**9 Hours**

Description of phases, solidification of steels and cast irons, invariant reactions. Heat treating of metals. Time Temperature Transformation (TTT) curves, continuous cooling curves, description of the following heat treatment processes with industrial applications: annealing and its types, normalizing, hardening, tempering, martempering, austempering, hardenability, surface hardening methods like carburizing, cyaniding, nitriding, flame hardening, induction hardening.

Applications	Influence of different phases of steel and cast iron on its properties and applications.
Text Book	Text Book 2: 3.1, 3.3, 3.5, 3.7, 3.10

MODULE-4	**ENGINEERING MATERIALS**	**25MEE35.5**	**9 Hours**

Engineering materials: Properties, Composition and Applications of Grey cast iron, White cast Iron, malleable iron, SG iron and steels, Copper & Aluminium alloys. Titanium and Magnesium alloys.

AI and ML in Materials engineering: AI-Driven Materials Discovery, Machine Learning for Alloy Design-

Supervised vs. Unsupervised Learning:, AI/ML for materials characterization, AI for Experimental Data Analysis			
Case Study	Aerospace material selection case studies		
Text Book	Text Book 1: 6.1, 6.3, 6.5, 6.7, Text Book 2: 10.1, 10.3, 10.5, 10.7		
MODULE-5	**CERAMICS AND COMPOSITE MATERIALS**	**25MEE35.6**	**9 Hours**
Ceramics: Introduction to ceramics, nature of ceramics, types of ceramics, properties of ceramics materials, ceramic forming techniques, applications of ceramics. Glass: Definition of glass, Basic concept of glass manufacturing process, Different types of glasses - Properties and Applications. Powder Metallurgy: Definition and concept, applications, powder metallurgy process, Production of metal powders, characteristics of metal powders, compacting, pre-sintering and sintering Composite materials - Definition, classification, types of matrix materials & reinforcements - Properties and applications.			
Applications	Powder Metallurgy applications in mechanical components.		
Text Book	Text Book 2: 12.1 to 12.10, Ref. book 2: 20.1 to 20.5		

CIE Assessment Pattern (50 Marks – Theory) –

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	5	5	-
L3	Apply	10	5	5
L4	Analyze	10	5	5
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	10
L3	Apply	20
L4	Analyze	10
L5	Evaluate	--
L6	Create	--

Suggested Learning Resources:

Text Books:

1. Materials Science and Engineering: An Introduction, William D. Callister Jr. and David G. Rethwisch, Wiley, 11th Edition, 2023, ISBN: 9781119721772
2. Materials Science and Engineering, V. Raghavan, PHI Learning, 8th Edition, 2022, ISBN: 9789390544066

Reference Books:

1. Powder Metallurgy: Science, Technology and Applications, P.C. Angelo and R. Subramanian, PHI learning publication, 2023, ISBN:9789391818487
2. Balasubramaniam, R., Materials Science and Technology, Wiley India, 2023, ISBN: 9788126541607
3. Engineering Materials, Kenneth G. Budinski, Michael K. Budinski, Prentice Hall, 9 edition, 2010, ISBN: 978013712842
4. Peng, S., & Li, P, Nanomaterials and Nanotechnology: Basic, Preparation and Applications, Springer Singapore, First Edition, 2024, ISBN: 9780137128427.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=zGUGBegBgdk
- https://www.youtube.com/watch?v=CRPMDb0Xr1s&t=713s
- https://www.youtube.com/watch?v=ejg27ozbPA8
- https://www.youtube.com/watch?v=-YIGjX-jcMo
- https://www.youtube.com/watch?v=PaGJwOPg2kU
- https://www.youtube.com/watch?v=H50zsHuIgrU
- https://www.youtube.com/watch?v=OLa8DQkKlyU&t=21s
- https://www.youtube.com/watch?v=N4-kfSD6XJI
- http://www.digimat.in/nptel/courses/video/113104517/L05.html

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Video demonstration of phase transformation
- Presentation based on collection of different mechanical components and materials.
- Contents related activities (Activity-based discussions)
- Preparation of flow charts on properties of materials
- Seminars

IoT FOR MECHANICAL SYSTEMS

Course Code	**25MEE361**	**Credits**	**01**
L:T:P:S	**0:0:1:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**30**	**SEE Marks**	**50**
TW & SL / Sem	**-**	**Total Marks**	**100**
Total Hours /Sem	**30**	**Exam Hours**	**03**

Course outcomes:

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

25MEE361.1	Understand the basic architecture of IoT systems, sensors, actuators, and microcontroller platforms (Arduino/ESP32/Raspberry Pi).
25MEE361.2	Analyze the interfacing of various sensors with microcontrollers and interpret the performance of sensor-based monitoring systems for mechanical applications.
25MEE361.3	Illustrate the architecture and working principles of IoT-based monitoring and control systems for mechanical equipment such as motors, pumps, and conveyor systems.
25MEE361.4	Apply cloud platforms and IoT dashboards for real-time data acquisition, visualization, and predictive maintenance of mechanical systems.

Pgm. No.	List of Programs	Hours	COs
	Prerequisite Programs		
	• Familiarity with sensors and arduino IDE drom ipl projects • Knowledge of C programming and algorithms	2	NA
	PART-A		
1	Configure and operate an LED and push button using an Arduino/ESP32 microcontroller board.	2	25MEE361.1
2	Acquire and display temperature and humidity data from a DHT11 sensor on the Serial Monitor/LCD.	2	25MEE361.1
3	Develop an object detection system for a conveyor application using an IR/Ultrasonic proximity sensor.	2	25MEE361.1
4	Implement a light-based automation system using an LDR sensor.	2	25MEE361.1
5	Measure and analyze machine vibration using an ADXL335/MPU6050 accelerometer for condition monitoring.	2	25MEE361.2
6	Develop a sensor-based relay control system to operate a DC motor/fan.	2	25MEE361.2
	PART-B		
7	Transmit sensor data to a cloud platform (ThingSpeak/Blynk) using ESP32 Wi-Fi communication.	2	25MEE361.2
8	Develop a real-time machine temperature monitoring system with a cloud dashboard and alert notification.	2	25MEE361.2
9	Implement an IoT-based smart irrigation/pump control system using a soil moisture sensor.	2	25MEE361.3
10	Develop and monitor an IoT-based condition monitoring system for a rotating machine with cloud data logging.	2	25MEE361.3
11	Develop an IoT-based smart energy meter/motor load monitoring system.	2	25MEE361.4
12	Design and develop an IoT-based predictive maintenance system for a mechanical component by integrating multiple sensors with cloud-	2	25MEE361.4

	based alerts.		

PART-C
Beyond Syllabus Virtual Lab Content (4 Hours)
(To be done during Lab but not to be included for CIE or SEE)

- **Temperature-sensor**
  https://iot-vlab.vlabs.ac.in/exp/temperature-sensor-interfacing/
- **Light-sensor**
  https://iot-vlab.vlabs.ac.in/exp/light-sensor-interfacing/
- **Motion-sensor**
  https://iot-vlab.vlabs.ac.in/exp/motion-sensor-interfacing/
- **Smart-irrigation**
  https://iot-vlab.vlabs.ac.in/exp/smart-irrigation-system/
- **Home-automation**
  https://iot-vlab.vlabs.ac.in/exp/home-automation-system/
- **Industrial-monitoring**
  https://iot-vlab.vlabs.ac.in/exp/industrial-monitoring-system/

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		30	20
L1	Remember	-	-
L2	Understand	10	-
L3	Apply	10	10
L4	Analyze	10	10
L5	Evaluate	-	-
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	05
L2	Understand	05
L3	Apply	20
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:
Reference Books:

1.Jeeva Jose, "Internet of Things", Khanna Book Publishing, 2021, ISBN- 9789390398085
2.Raj Kamal, "Internet of Things: Architecture and Design Principles", 2nd Edition, Publisher: McGraw-Hill Education, 2021, ISBN- 9789354601395

BIO ENERGY AND BIOFUELS

Course Code	**25MEE362**	**Credits**	**01**
L:T:P:S	**0:0:1:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**30**	**SEE Marks**	**50**
TW & SL / Sem	**-**	**Total Marks**	**100**
Total Hours /Sem	**30**	**Exam Hours**	**03**

Course outcomes:

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

25MEE362.1	Explain the fundamental concepts of bioenergy resources and biofuel production pathways
25MEE362.2	Determination the properties of different biofuels
25MEE362.3	Analyze the performance of fuel used in energy conversion system
25MEE362.4	Apply knowledge of the environmental impacts of bioenergy systems to practical applications.

Exp. No.	List of Experiments	Hours	COs
	Prerequisite Experiments		
	• Study of basic energy sources and classification of biomass • Demonstration of biomass sample identification and physical properties • Introduction to biofuel production pathways	2	NA
	PART-A		
1	Production of biodiesel using transesterification process	2	25MEE362.1
2	Pyrolysis process for conversion of biomass into bio-oil	2	25MEE362.1
3	Biogas production using anaerobic digestion process	2	25MEE362.1
4	Biogas production using fermentation process	2	25MEE362.1
5	Determination of calorific value of solid biofuels using bomb calorimeter	2	25MEE362.2
6	Determination of calorific value of gaseous fuels using gas calorimeter	2	25MEE362.3
	PART-B		
7	Measurement of various fuel properties of given Biodiesel sample 1 (B100, B10 and B20 - Biodiesel fuel blend)	2	25MEE362.2
8	Measurement of various fuel properties of given Biodiesel sample 2 (B100, B10 and B20 - Biodiesel fuel blend)	2	25MEE362.2
9	Performance evaluation of engine using Biodiesel sample 1 (B100, B10 and B20 - Biodiesel fuel blend)	2	25MEE362.3
10	Performance evaluation of engine using Biodiesel sample 2 (B100, B10 and B20 - Biodiesel fuel blend)	2	25MEE362.3
11	Heat balance test on diesel engine using biodiesel blends	2	25MEE362.4
12	Morse test on diesel engine using biodiesel blends in multi cylinder engine	2	25MEE362.4

PART-C
Beyond Syllabus Virtual Lab Content (4 Hours)
(To be done during Lab but not to be included for CIE or SEE)

- **Biomass-gasification**
  https://vlab.co.in/biomass-gasification
- **Biogas-production**

https://vlab.co.in/biogas-production

- **Biodiesel Process**
  https://vlab.co.in/biodiesel-process
- **Biomass- Pyrolysis**
  https://vlab.co.in/biomass-pyrolysis
- **Biofuel Properties**
  https://vlab.co.in/biofuel-properties

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		30	20
L1	Remember	-	-
L2	Understand	10	-
L3	Apply	10	10
L4	Analyze	10	10
L5	Evaluate	-	-
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	5
L2	Understand	5
L3	Apply	20
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Reference Books:

1. S. C. Bhatia, "Advanced Renewable Energy Systems", Woodhead Publishing ,2014,ISBN-13:9781782422693
2. R. C. Saxena, "Biofuels: Production and Future Perspectives", CRC Press, 1st Edition, 2017, ISBN-13: 9781498723596
3.Ashok Pandey, "Biofuels: Alternative Feedstocks and Conversion Processes ", Elsevier, 2019, ISBN-13: 9780128168561

ENERGY MANAGEMENT AND AUDITING			
Course Code	**25MEE363**	**Credits**	**01**
L:T:P:S	**0:0:1:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**30**	**SEE Marks**	**50**
TW & SL / Sem	**-**	**Total Marks**	**100**
Total Hours /Sem	**30**	**Exam Hours**	**03**

Course outcomes:
At the end of the course, the student will be able to:

25MEE363.1	Analyze the demand-supply gap of energy in specific applications within educational buildings
25MEE363.2	Apply appropriate methods to conduct an energy audit for applications in industries or organizations
25MEE363.3	Understand and interpret the energy flow in an application by creating diagrams and analyzing energy losses
25MEE363.4	Enumerate the energy usage of an application through auditing and recommend appropriate conservation measures

Exp. No.	List of Experiments	Hours	COs
	Prerequisite Experiments /Demo		
	• Understand the concept of energy management and auditing in engineering field.	2	NA
	PART-A		
1	Determination of demand supply gap of energy .	2	25MEE363.1
2	Determination of demand supply gap of energy in Cooling Towers.	2	25MEE363.1
3	Determination of energy management values on Solar Collector.	2	25MEE363.1
4	Determination the efficiency of waste heat recovery system in engine setup.	2	25MEE363.3
5	Calibration on solar heating system.	2	25MEE363.2
6	Determination the Co efficient of Performance on refrigeration systems.	2	25MEE363.2
	PART-B		
7	Determination of the energy consumption and audit on forced convection apparatus.	2	25MEE363.4
8	Conduct the energy audit waste heat recovery in engine setup	2	25MEE363.3
9	Conduct the energy audit on Solar panel power generation.	2	25MEE363.4
10	Calibration of performance of cooling tower.	2	25MEE363.2
11	Conduct the energy audit on wind power generation.	2	25MEE363.4
12	Conduct the energy audit on VCR and VAR system	2	25MEE363.4

PART-C
Beyond Syllabus Virtual Lab Content (4 Hours)
(To be done during Lab but not to be included for CIE or SEE)

- **Determination of energy management values on Solar Collector**
  https://www.youtube.com/watch?v=nXUiDBaEC0k

- **Determination the efficiency of waste heat recovery system in engine setup**
  https://www.youtube.com/watch?v=IM1QLY2NP3I&list=PLSGws_74K019s_QRXAm-icFCKCalbggHO
- **Calibration on solar heating system**
  https://www.youtube.com/watch?v=DZ30tWPOO1I
- **Conduct the energy audit on VCR and VAR system**
  https://www.youtube.com/watch?v=TTq6W6HmKFE
- **Conduct the energy audit on wind power generation**
  https://www.youtube.com/watch?v=qx_M0nvDIGU&list=PLk4P1oALloq11CR89wfB3MUmlxMJ7jJbW

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		30	20
L1	Remember	-	-
L2	Understand	10	-
L3	Apply	10	10
L4	Analyze	10	10
L5	Evaluate	-	-
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	5
L2	Understand	5
L3	Apply	20
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Text Books:

1. Y P Abbi and Shashank Jain , "Hand book on Energy Audit and Environment Management", TERI, New Delhi,2021, ISBN-13: 978-8179931013.
2. Trivedi, PR, Jolka KR, "Energy Management", Commonwealth Publication, New Delhi, 2019. ISBN-13: 978-8171694235

Reference Books:

1. Ursala Eicker, "Solar Technologies for buildings", Wiley publications, 2022. ISBN-13: 978-0-471-48637-4

INSTRUMENTATION AND CONTROL SYSTEMS

Course Code	**25MEE364**	**Credits**	**01**
L:T:P:S	**0:0:1:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**30**	**SEE Marks**	**50**
TW & SL / Sem	**-**	**Total Marks**	**100**
Total Hours /Sem	**30**	**Exam Hours**	**03**

Course outcomes:

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

25MEE364.1	Understand the calibration procedures and static characteristics of sensing elements and measurement systems used for measuring pressure, temperature, and displacement
25MEE364.2	Analyze the performance characteristics of load, torque, and speed measurement systems under varying operating conditions.
25MEE364.3	Determine the mathematical models and transient response specifications of first and second-order systems using simulation tools.
25MEE364.4	Analyze the performance of Proportional-Integral-Derivative (PID) controllers in standard industrial process control applications.

Exp. No.	List of Experiments	Hours	COs
	Prerequisite Experiments		
	Demo : Introduction to generalized measurement systems, errors in instrumentation, safety protocols, and a demonstration of data acquisition software (e.g: MATLAB-Simulink).	2	NA
	PART-A		
1	Measurement of temperature using a Thermocouple and RTD , comparing their time constants and sensitivity.	2	25MEE364.1
2	Temperature Measurement and Characteristics of Thermistor.	2	25MEE364.1
3	Calibration and Study of Strain gauge for temperature measurement.	2	25MEE364.1
4	Calibration of a Bourdon tube pressure gauge using a Dead Weight Tester to assess hysteretic behavior and accuracy.	2	25MEE364.1
5	Calibration of LVDT (Linear Variable Differential Transformer) for displacement measurement and determination of its linearity and sensitivity.	2	25MEE364.2
6	Measurement of force/load using a Strain Gauge load cell configuration	2	25MEE364.2
	PART-B		
7	Calibration and Study of Rotameter for flow measurement.	2	25MEE364.2
8	Calibration and Study of McLeod gauge for low pressure.	2	25MEE364.2
9	Calibration and Study of Pressure Gauges	2	25MEE364.3
10	Measurement of angular velocity (speed) using Photo-reflective and Magnetic pick-up tachometers, and comparing their characteristics	2	25MEE364.3
11	Design and simulation of a P, PI, and PID controller for a temperature/level control loop.	2	25MEE364.4
12	Calibration of a capacitive/inductive transducer for proximity and displacement sensing.	2	25MEE364.4
	PART-C **Beyond Syllabus Virtual Lab Content (4 Hours)**		

(To be done during Lab but not to be included for CIE or SEE)

- **Two-Tank Water Level Control**
  https://vlabs.iitkgp.ac.in/ctrl/Exp10/simulation/index.html
- **Vacuum Measurement - Thermal Conductivity Gauges**
  https://ic-coep.vlabs.ac.in/exp/thermal-conductivity-gauges/simulation.html
- **Identify suitable accelerometer for an application**
  https://ic-coep.vlabs.ac.in/exp/accelerometer/simulation.html
- .**Measurement of flow using a Rotameter**
  https://ic-coep.vlabs.ac.in/exp/flow-using-rotameter/simulation.html
- **Characterize a density sensor for a particular application**
  https://ic-coep.vlabs.ac.in/exp/density-sensor/simulation.html

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		30	20
L1	Remember	-	-
L2	Understand	10	-
L3	Apply	10	10
L4	Analyze	10	10
L5	Evaluate	-	-
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	05
L2	Understand	05
L3	Apply	20
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Reference Books:

1. Nakra, B. C., & Chaudhry, K. K., Instrumentation, Measurement and Analysis, 4th Edition, McGraw Hill Education, 2017, ISBN- 978-9352602368
2. Ogata, Katsuhiko, Modern Control Engineering, 5th Edition, Pearson Education / Prentice Hall, 2010, ISBN-978-0136156734
3. Doebelin, Ernest O., Measurement Systems: Application and Design, 6th Edition, McGraw Hill Education, 2015, ISBN- 978-0078024306
4. Gopal, Madan, Control Systems: Principles and Design, 4th Edition, Tata McGraw Hill, 2012, ISBN-978-1259000155

BIO INSPIRED DESIGN AND INNOVATION

Course Code	**25MEE365**	**Credits**	**03**
L:T:P:S	**1:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**15**	**SEE Marks**	**50**
TW & SL / Sem	**15**	**Total Marks**	**100**
Total Hours /Sem	**30**	**Exam Hours**	**03**

Course outcomes:

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

25MEE365.1	Understand the fundamentals and significance of bio-inspired design and engineering
25MEE365.2	Apply biomaterials and bio-inspired healthcare systems for engineering applications..
25MEE365.3	Analyze bio-inspired optimization techniques to solve sustainable engineering and environmental management problems..
25MEE365.4	Apply bio-inspired AI innovations in manufacturing, automation, materials, and sustainable product development.

MODULE-1	**BIO-INSPIRED DESIGN AND ENGINEERING**	**25MEE365.1**	**3 Hours**
Bio-Inspired Engineering and design, History, Need for Bio-Inspired Designs. Bio inspired Additive manufacturing techniques, (self-healing, self-assembly).			
Self-study	Investigate the Challenges of Bio inspired design, Compare with traditional areas of science and engineering		
Text Book	Text Book 1: 1.2, 1.3, 1.4, 1.13, 1.15, 1.16		
MODULE-2	**BIO MATERIALS AND BIO HEALTHCARE DESIGN**	**25MEE365.2**	**3 Hours**
Biomaterials, Design of Forms- (Hexagonal unit cells, Intrinsic disorder, anisotropy), Bio- Mechanics, Applications of Biomaterials and Bio systems in Health care design (Human Prosthetics, Parasitic, WaspInspired Needle)			
Case Study	Investigate Bio-Compatible and health care applications.		
Text Book	Text Book 1: 2.2, 2.3, 2.4 to 2.15		
MODULE-3	**BIO SUSTAINABLE DEVELOPMENT**	**25MEE365.3**	**3Hours**
Innovations in Energy (Termite mound inspired shopping malls), Innovations in Resource-Air purification, filtration), Dew water collection systems, water purification, desalination.			
Case Study	Explore the Bio inspired environmental constructions and development.		
Text Book	Text Book 2: 3.1, 3.3, 3.5, 3.7, 3.10		
MODULE-4	**BIO-OPTIMISATION TECHNIQUES**	**25MEE365.4**	**3 Hours**
No Free Lunch Theorem, Bat Algorithm, Flower Pollination Algorithm, Genetic Algorithm, Ant Colony Optimisation (ACO), Swam Intelligence- Particle Swam Optimisation (PSO).			
Self-study	Scrutinize the Different types of Optimization techniques, genetic research.		
Text Book	Text Book 1: 6.1, 6.3, 6.5, 6.7, Text Book 2: 10.1, 10.3, 10.5, 10.7		
MODULE-5	**Applications of Bio-Inspired AI Innovations**	**25MEE365.5, 25MEE365.6**	**3 Hours**
Bio-inspired innovations in AI Integrated automotive systems, automation and robotics, AI-driven Bio materials discovery and manufacturing, AI Driven predictive modeling, digital twins, and sustainable product design for addressing environmental and industrial challenges.			
Case Study	Survey on Bio inspired Innovations, design, applications and case studies of the same.		
Text Book	Text Book 2: 12.1 to 12.10		

CIE Assessment Pattern (50 Marks – Theory) –

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	5	-
L3	Apply	10	5	5
L4	Analyze	5	5	5
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	10
L3	Apply	20
L4	Analyze	10
L5	Evaluate	--
L6	Create	--

Suggested Learning Resources:

Text Books:

1) Helena Hashemi Farzaneh, Udo Lindemann, "A Practical Guide to Bio-inspired Design", Springer Vieweg, 1st edition 2019, ISBN-10: 366257683X, ISBN-13: 978-3662576830.
2) Torben A. Lenau, Akhlesh Lakhtakia," Biologically Inspired Design: A Primer (Synthesis Lectures on Engineering, Science, and Technology)", Publisher: Morgan & Claypool Publishers, 2021, ISBN-10:1636390471, ISBN-13: 978-1636390475

Reference Books:

1) French M, "Invention and evolution: Design in nature and engineering", Publisher: Cambridge University Press, 2020, ISBN-13: 978-1108492263.
2) Pan L., Pang S., Song T. and Gong F. eds, "Bio-Inspired Computing: Theories and Applications", 15th International Conference, BIC-TA 2020, Qingdao, China, October 23-25, 2021, Revised Selected Papers (Vol. 1363). Springer Nature, 2021, ISBN: 978-981-16-1820-1.

Web links and Video Lectures (e-Resources)

- https://onlinecourses.nptel.ac.in/noc22_ge24/preview
- https://biodesign.berkeley.edu/bioinspired-design-course/
- https://nsf-gov-resources.nsf.gov/2023-03/Bio-inspired%20Design20Workshop%20Report_2232327_October%202022_Final.508.pdf

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Bio Materials printing using 3D Printing
- Flipped class room
- Organizing Group wise discussions on sub topics
- Student presentations

COMMUNITY PROJECT USING INNOVATION AND DESIGN THINKING			
Course Code	**25CPD37**	**Credits**	**01**
L:T:P:S	**0:0:1:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**--**	**SEE Marks**	**50**
TW & SL / Sem	**30**	**Total Marks**	**100**
Total Hours /Sem	**30**	**Exam Hours**	**03**

Course outcomes:

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

25CPD37.1	Identify and analyze community-based problems through stakeholder interaction, need assessment, and problem-definition techniques.
25CPD37.2	Apply Design Thinking principles to generate innovative, user-centered, and sustainable solutions for community challenges.
25CPD37.3	Design, develop, and test prototypes or models by integrating engineering knowledge and practical problem-solving skills.
25CPD37.4	Evaluate the effectiveness, feasibility, and societal impact of the proposed solution and communicate the project outcomes professionally.

COMMUNITY PROJECT USING INNOVATION AND DESIGN THINKING: Guiding Principles for COMMUNITY PROJECT USING INNOVATION AND DESIGN THINKING

Project Overview:

- A user-centered project that applies innovation and design thinking principles to identify community needs, develop creative solutions, and create sustainable social impact through practical implementation.

Project Milestones:

- Identification of a community problem, stakeholder need analysis, ideation of innovative solutions, prototype development, testing, validation, and implementation of a sustainable solution using the Design Thinking approach.

Project Requirements:

- The project requires the identification of a real community problem through stakeholder interaction and needs assessment using the Design Thinking approach.
- Students must develop, prototype, test, and validate an innovative, feasible, and sustainable solution that addresses the identified community need.

Testing and Quality Assurance:

- The developed solution is tested with community stakeholders to evaluate its functionality, usability, reliability, and effectiveness in addressing the identified problem. Feedback obtained during testing is used to refine the design and ensure the solution meets quality, sustainability, and user requirements.

Collaboration and Communication:

- If the project involves teamwork, outline expectations for collaboration, including communication channels and responsibilities within the team.

Documentation:

- Emphasize the importance of thorough documentation throughout the project.
- Require students to maintain documentation for code, design, and usage instructions.

Presentation:

- Require students to present their projects to the class, explaining their design choices, challenges faced, and how they overcame them.

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	5	-	-
L3	Apply	5	5	5
L4	Analyze	5	5	5
L5	Evaluate	5	5	-
L6	Create	5	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	10
L3	Apply	10
L4	Analyze	10
L5	Evaluate	10
L6	Create	10

Suggested Learning Resources:

Text Books:

1) Idris Mootee " Design Thinking for Strategic Innovation", 1st Edition 2013, 9781118620120

2) Andrew Pressman, " Design Thinking: A Guide to Creative Problem Solving for Everyone", 1st Edition,2019,9781138218130

Web links and Video Lectures (e-Resources):

- **https://www.coursera.org/learn/uva-darden-designbiz**
- **https://www.ideou.com/pages/design-thinking-resources?srsltid=AfmBOor28UpIEJ_RrrkN7P_-H1Oxf3t-a5rB57e5xJqKGqyq8ogz1tY3**
- **https://vtu.ac.in/pdf/bvoc2024/4amtsyll.pdf**

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Empathy and Problem Identification
- Ideation and Concept Development
- Prototype Design and Validation

BASIC APPLIED MATHEMATICS - I			
Course Code	**25DMAT31**	**Credits**	**0**
L:T:P:S	**0:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**15**	**SEE Marks**	**--**
TW & SL / Sem	**15**	**Total Marks**	**50**
Total Hours /Sem	**30**	**Exam Hours**	**--**

Course outcomes:

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

25DMAT31.1	Understand the concepts of elementary transformations to the rank of a matrix, and apply the consistency and solutions of systems of linear equations
25DMAT31.2	Apply eigenvalues and eigenvectors of square matrices for matrix diagonalization, and compute the powers of matrices for engineering and computational applications
25DMAT31.3	Analyze curves represented in Cartesian, polar coordinate systems, determine tangents, angles between polar curves, and derive pedal equations for scientific modeling.
25DMAT31.4	Apply techniques of partial differentiation, chain rule, Euler's theorem for homogeneous functions, Jacobians of functions to solve multivariable engineering problems
25DMAT31.5	Analyze the motion of particles using velocity and acceleration vectors, and evaluate gradient and directional derivatives to interpret rates of change in scalar fields.
25DMAT31.6	Apply vector differential operators—gradient, divergence, and curl—to investigate scalar and vector fields

MODULE-1	**LINEAR ALGEBRA - 1**	**25DMAT31.1**	**3 Hours**
Elementary transformations, Reduction of the given matrix to echelon form, Rank of a Matrix, Consistency of a system of linear equations, Solution of a system of non-homogeneous linear equations.			
Self-study	Rank of a matrix by normal form, Solution of a system of homogeneous linear equations		
Text Book	Text Book 1: 2.7, 28.6, Text Book 2: 7.3, 7.4		
MODULE-2	**LINEAR ALGEBRA - 2**	**25DMAT31.2**	**3 Hours**
Linear transform, Eigen values and Eigen vectors of a square matrix, Diagonalization of a square matrix and Power of matrices using Diagonalization.			
Self-study	Reduction of quadratic expression to canonical form.		
Text Book	Text Book 1: 2.11, 2.13, Text Book 2: 7.9, 8.1.		
MODULE-3	**DIFFERENTIAL CALCULUS**	**25DMAT31.3**	**3 Hours**
Importance of cartesian and polar coordinate systems, Angle between the radius vector and tangent to a polar curve, angle between two polar curves, Pedal equation of a polar curve.			
Self-study	Radius of curvature in cartesian, parametric, polar forms		
Text Book	Text Book 1: 4.4, 4.7, 4.8		
MODULE-4	**MULTIVARIABLE CALCULUS**	**25DMAT31.4**	**3 Hours**
Introduction to partial differentiation, total differentiation, chain rule, Euler's theorem for Homogeneous functions, Jacobians, Extreme values of the functions with two variables.			
Self-study	Basic problems on partial differentiation		
Text Book	Text Book 1: 5.4, 5.7		
MODULE-5	**VECTOR CALCULUS**	**25DMAT31.5 25DMAT31.6**	**3 Hours**
Velocity and Acceleration of a particle, Gradient of scalar function, directional derivative, Divergence and Curl of vector functions, Solenoidal and Irrotational vector fields.			
Self-study	Vector identities		
Text Book	Text Book 1: 8.3, 8.5, 8.7, 8.18 Text Book 2: 9.7, 9.8, 9.9		

CIE Assessment Pattern (50 Marks – Theory) –

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	5	-	-
L3	Apply	10	5	5
L4	Analyze	10	5	5
L5	Evaluate	-	5	-
L6	Create			-

Suggested Learning Resources:

Text Books:

1) B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, Forty fourth Edition, 2022, 9788193328491.
2) Erwin Kreyszig, Advanced Engineering Mathematics, Wiley-India Publishers, Tenth Edition, Reprint ISBN: 9788126554232.

Reference Books:

1) Glyn James, Advanced Modern Engineering Mathematics, Pearson Education, Fourth Edition, 2015, 9780273719236
2) B. V. Ramana, Higher Engineering Mathematics, McGraw Hill Education (India) Private Limited, 4th E 2017, ISBN: 9780070634190
3) H. K. Dass, Advanced Engineering Mathematics, S. Chand & Company Ltd., Twenty Second Edition, 2018 9789352533831
4) N. P. Bali and Manish Goyal, A Text Book of Engineering Mathematics, Laxmi Publications (P) Ltd., 9th Ed 2014, ISBN: 9788131808320

Web links and Video Lectures (e-Resources):

- https://youtu.be/IUV0_Nj4d1s?si=eO3s7keCbCO1_jcz
- https://youtu.be/VzUcs7aiqgg?si=YLtTUGr4Xp88KGY3
- https://youtu.be/LDBnS4c7YbA?si=udUOdJ-u0ZxFmBAW
- https://youtu.be/palSdK9P-ns?si=7A8_VSxEI4lGvksB
- https://youtu.be/Bw5yEqwMjQU?si=jzbklZmVev1w8K2S
- https://youtu.be/LBqdGn1r_fQ?si=DWcAIiFnosT7zikY
- https://youtu.be/N5YCGOyTSuU?si=Wsf75V5fkUpfVVxr
- https://youtu.be/gd1FYn86P0c?si=7drzBEqVFSv6sQeZ
- https://youtu.be/cSj82GG6MX4?si=4QN1DFXEqaJoUBn7
- https://youtu.be/0c3yq9btr3A?si=jIoz8eu5TgV7mh8G
- https://youtu.be/PhfbEr2btGQ?si=HVK1uk65oHph0t8G

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Problem solving Approach
- Organizing Group wise discussions on related topics
- Seminars

IV Semester Syllabus

COMPLEX ANALYSIS, OPTIMIZATION AND PROBABILITY DISTRIBUTIONS

Course Code	**25MAE41**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**45**	**SEE Marks**	**50**
TW & SL / Sem	**45**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:

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

25MAE41.1	Analyze two-dimensional potential flow problems using velocity potential, stream functions, and complex potential functions in engineering applications.
25MAE41.2	Apply Operations Research techniques to analyze and optimize engineering systems involving production planning, scheduling, logistics, network optimization, and resource management.
25MAE41.3	Analyze engineering problems involving uncertainty and random processes and select appropriate probability distributions.
25MAE41.4	Analyze sample data by selecting appropriate statistical tests, interpreting hypothesis test results, evaluating confidence limits, and applying the Central Limit Theorem for engineering applications.
25MAE41.5	Apply Markov chain models to solve engineering problems involving state transitions and compute higher transition probabilities using matrix methods
25MAE41.6	Apply the queueing models to determine key performance measures such as system utilization, average queue length, average waiting time, and probability of system states

MODULE-1	**COMPLEX ANALYSIS**	**25MAE41.1**	**9 Hours**

Functions of complex variables, Analytical functions, Cauchy-Riemann Equations in Cartesian and Polar forms, Harmonic functions and Construction of analytic functions using Milne-Thompson's method. Applications of Flow Problems-Velocity potential, Stream functions and complex potential functions. Conformal Transformations of $W = z^2$ and $W = e^z$. Cauchy's Theorem, Generalized Cauchy's integral formula

Self-study	Bilinear transformation, conformal transformation of $w = z + \frac{1}{z}$, complex line integration.
Text Book	Text Book 1: 20.3, 20.4, 20.5, 20.6, 20.9, 20.13, 20.14. Text Book 2: 13.3, 13.4, 14.2, 14.3

MODULE-2	**OPTIMIZATION TECHNIQUES**	**25MAE41.2**	**9 Hours**

Introduction to optimization techniques, Objectives and Characteristics of Operation Research. Introduction to Linear programming, solution by simplex and Big M methods. Formulation of transportation problem, Initial Basic feasible solution by North-West Corner method, least cost method, Vogel's approximation method. Optimal solutions-Problems. Formulation of assignment problems, Hungarian method.

Self-study	Linear programming, solution by graphical method, two phase simplex method
Text Book	Text Book 1: 34.1, 34.2, 34.7, 34.8, 34.9, 34.14, 34.15, 34.17, 34.18 Text Book 2: 22.3, 22.4

MODULE-3	**PROBABILITY DISTRIBUTIONS**	**25MAE41.3**	**9 Hours**

Random variables, discrete and continuous random variables, probability density functions, Expectation and Standard deviation. Discrete Probability distribution, Binomial and Poisson Distributions. Continuous Probability distribution, Normal distribution. Joint probability distribution - dependent and independent Random variables, Covariance, Correlation coefficient.

Self-study	Basic probability theory, Baye's theorem, Bernoulli distribution, uniform distribution, exponential distribution
Text Book	Text Book 1: 25.12, 25.13, 26.8, 26.9, 26.10, 26.11, 26.12, 26.14, 26.15, 26.16.

MODULE-4	**SAMPLING THEORY**	**25MAE41.4**	**9 Hours**

Sampling, Sampling distributions, Level of significance, Type-I & Type-II errors, one tail and two tail tests, test of hypothesis of large samples for means and proportions, Inferences for variance and proportion.

Central limit theorem, confidence limits for means, Student's t-distribution, F-distribution and Chi-square distribution for test of goodness of fit for small samples.

Self-study	Confidence limits problems.
Text Book	Text Book 1: 27.2, 27.4, 27.6, 27.8, 27.10, 27.12, 27.14, 27.16, 27.18, 27.20,

MODULE-5	**MARKOV CHAIN AND QUEUEING THEORY**	**25MAE41.5 25MAE41.6**	**9 Hours**

Stochastic Process: Stochastic processes, probability vector, stochastic matrices, fixed probability vector, regular stochastic matrices, Markov chains, higher transition probability problems.
Queueing Theory: Problems on Queueing model with M/M/1 and M/M/C

Self-study	Queueing model with M/G/1 and M/D/1
Text Book	Text Book 3: 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 11.1, 11.2, 11.3, 11.4, 11.5, 11.6, 11.7

CIE Assessment Pattern (50 Marks – Theory) –

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	5	-	-
L3	Apply	10	5	5
L4	Analyze	10	5	5
L5	Evaluate	-	5	-
L6	Create			-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	--
L2	Understand	10
L3	Apply	20
L4	Analyze	20
L5	Evaluate	--
L6	Create	--

Suggested Learning Resources:
Text Books:

1) B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, Forty fourth Edition, 2022, 9788193328491.
2) Erwin Kreyszig, Advanced Engineering Mathematics, Wiley-India Publishers, Tenth Edition, Reprint ISBN: 9788126554232.
3) William J. Stewart, Probability, Markov Chains, Queues, and Simulation: The Mathematical Basis of Performance Modeling, Princeton University Press, ISBN 9780691140629

Reference Books:

1) Glyn James, Advanced Modern Engineering Mathematics, Pearson Education, Fourth Edition, 2015, 9780273719236
2) B. V. Ramana, Higher Engineering Mathematics, McGraw Hill Education (India) Private Limited, 4th E 2017, ISBN: 9780070634190
3) H. K. Dass, Advanced Engineering Mathematics, S. Chand & Company Ltd., Twenty Second Edition, 2018 9789352533831
4) N. P. Bali and Manish Goyal, A Text Book of Engineering Mathematics, Laxmi Publications (P) Ltd., 9th Ed 2014, ISBN: 9788131808320

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=f_EqOpgRwRM&t=16s
- https://www.youtube.com/watch?v=Xb9Ypn77LBo&t=16s

- https://www.youtube.com/watch?v=csgvZol6Wfw
- https://www.youtube.com/watch?v=Atv3IsQsak8
- https://www.youtube.com/watch?v=aEF5PPbv8Oc
- https://www.youtube.com/watch?v=Pwk7p8WiCh0
- https://www.youtube.com/watch?v=LGxE_yZYigI
- https://www.youtube.com/watch?v=RFlAiEXRwoo
- https://www.youtube.com/watch?v=RFlAiEXRwoo&t=128s
- https://www.youtube.com/watch?v=sMYtHaSIXbU

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Problem solving Approach
- Organizing Group wise discussions on related topics
- Seminars

HEAT POWER CYCLES

Course Code	**25MEE42**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**45**	**SEE Marks**	**50**
TW & SL / Sem	**45**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:

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

25MEE42.1	Understand the working, performance, testing, emissions, and recent developments of internal combustion engines.
25MEE42.2	Apply the principles of air-standard cycles in the assessment of performance characteristics of thermal systems and power-producing devices
25MEE42.3	Determine the performance characteristics of vapor power cycles used in power generation systems
25MEE42.4	Analyze the performance of gas turbine cycles, nozzles, and jet propulsion systems under different operating conditions
25MEE42.5	Apply performance evaluation methods to assess refrigeration systems and select suitable refrigerants for different applications
25MEE42.6	Analyze psychrometric processes and air-conditioning systems using psychrometric properties and charts

MODULE-1	**INTERNAL COMBUSTION ENGINES**	**25MEE42.1**	**9 Hours**

Concepts of Four-stroke & Two -stroke Engine and valve timing diagram, Measurement of air and fuel flow rates, Engine output and efficiency, Engine performance characteristics and factors influencing the same, concepts, problems on Morse test and Heat Balance Sheet, Concepts of Turbo charger and super charger, Modern developments in IC engines (restricted up to 4 stroke BIOFUELS), Engine emission and legal requirements. Numerical on performance of IC engine

Case Study	Performance and emission characteristics of IC engine
Text Book	Text Book 1: 3.1, 3.2, 3.3

MODULE-2	**HEAT & VAPOUR POWER CYCLES**	**25MEE42.2 25MEE42.3**	**9 Hours**

Air standard cycle (Otto, Diesel, Dual) cycles, Derivation on efficiencies of the cycles, Comparison on air standard cycle , Problems on Otto, Diesel, Dual cycles and MEP , concept of Stirling cycle, Rankine cycle, Rankine cycle with superheat , The Enthalpy Entropy chart , Regenerative cycle ,binary vapor cycle, combined cycle ,different steam turbine arrangement

Applications	Investigate the applications of air standard cycles and Rankine cycle
Text Book	Text Book 1: 4.1, 4.2, 4.3, 4.4

MODULE-3	**GAS TURBINE AND JET PROPULSION**	**25MEE42.4**	**9 Hours**

The practical gas turbine cycle, modification to the basic cycle (with Regenerators and Intercoolers), Derivation on efficiency of Brayton Cycle, Work ratio, Optimum Pressure ratio, Problems on gas turbines. Nozzle shape critical pressure ratio, Nozzle efficiency, fundamental Problems on nozzle Jet propulsion, Turbo prop, Turbo jet, solid propellant and liquid propellant rocket engine, Ramjet, Scramjet

Applications	Analyze the Applications of gas turbine cycles
Text Book	Text Book 2: 3.1, 3.2, 3.3

MODULE-4	**REFRIGERATION**	**25MEE42.5**	**9 Hours**

Performance of Reversed Carnot cycle, Vapor compression cycles- Effect of sub cooling and super heating, Refrigerating load, Pressure Enthalpy diagram, Vapor absorption cycles, Gas cycles, Liquefaction of gases, Steam jet refrigeration, Refrigerants- International Union of Pure and Applied Chemistry (IUPAC) nomenclature, types and applications, Control of refrigerating capacity and problems.

Case Study	Practical applications of reversed Carnot cycle, vapor absorption cycles
Text Book	Text Book 2: 8.1, 8.2, 8.4, 8.5, 8.6

MODULE-5	**HEATING VENTILATION AND AIR CONDITIONING SYSTEM**	**25MEE42.6**	**9 Hours**

Psychometric mixtures, specific humidity, Relative humidity, and percentage saturation, Specific Enthalpy, Specific Heat Capacity and Specific volume of moist air, Dry bulb temperatures. Wet bulb temperatures, Dew point temperatures, Construction and use of Psychometric chart, Different Psychometric process, Air conditioning systems. Machine Learning for Performance Prediction of Engines, Turbines, and Refrigeration Systems, **AI-Based Predictive Maintenance** and Fault Diagnosis of Thermal Systems

Applications	Investigate the applications of Psychometric Chart
Text Book	Textbook 1: 10.1, 10.2, 10.3 , Text Book 2: 9.1, 9.2, 9.3

CIE Assessment Pattern (50 Marks – Theory) –

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	5	-
L3	Apply	10	5	5
L4	Analyze	5	5	5
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	10
L3	Apply	20
L4	Analyze	10
L5	Evaluate	--
L6	Create	--

Suggested Learning Resources:

Text Books:

1) Applied Thermodynamics By R.K.Rajput , Lakshmi Publications Ltd., 2nd Ed, 2016, ISBN:9789351343479
2) Basic and Applied Thermodynamics By P.K.Nag , Tata McGraw-Hill Education, 2nd Ed, 2017, ISBN:9780070151314

Reference Books:

1) Applied Thermodynamics for Engineering Technologies ,Fifth Edition By T.D.EASTOP and A. McCONKEY, Pearson Education, 2000, ISBN13: 9780582091931
2) Fundamentals of Engineering Thermodynamics by Moran M. J. and H. N. Shapiro, 9th Edition, 2018,ISBN : 978-1-118-82044-5
3) Thermodynamics: An Engineering Approach by Cengel Y. A. and Boles M. A, 8th Ed, 2015,

ISBN:9789339221652

4) Principles of Refrigeration by Dossat R. J. and Horan T. J. Refrigeration and Air-conditioning by Arora C. P, 6th Ed,2001, ISBN:9789351340164

Web links and Video Lectures (e-Resources):

- **https://www.learnthermo.com/T1-tutorial/ch01/lesson-A/pg01.php**
- **http://www.freeonlinecoursesforall.com/2017/01/01/10-free-online-courses-on-thermodynamics/**
- **https://archive.nptel.ac.in/courses/112/105/112105123/**
- **http://www.digimat.in/nptel/courses/video/112105123/L13.html**

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Visit to any Thermal power plant
- Demonstration of working of IC engine/refrigerator
- Video demonstration on Laws of thermodynamics
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare thermodynamics related Flowcharts and Handouts
  - Organizing Group wise discussions on issues
- Seminars

HEAT POWER CYCLES LAB

Course Code	**25MEL42**	**Credits**	**01**
L:T:P:S	**0:0:1:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**30**	**SEE Marks**	**50**
TW & SL / Sem	**-**	**Total Marks**	**100**
Total Hours /Sem	**30**	**Exam Hours**	**03**

Course outcomes:

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

25MEL42.1	Understand the procedures for determining the properties of fuels, such as cloud point, pour point, and calorific value
25MEL42.2	Apply standard testing methods to measure the viscosity of lubricating oils using Saybolt and Redwood viscometers
25MEL42.3	Analyze the performance characteristics of single-cylinder and multi-cylinder diesel engines using experimental test data
25MEL42.4	Analyze the engine performance, heat balance, lubricant properties, and refrigerant characteristics through laboratory investigations

Exp. No.	List of Experiments	Hours	COs
	Prerequisite Experiments / Demo		
	• Understand the properties of Refrigerants • Demonstration on working of 2-stroke engine and 4-stroke engine.	2	NA
	PART-A		
1	Determination of cloud point of the given sample	2	25MEL42.1
2	Determination of Pour point of the given sample	2	25MEL42.1
3	Determination of Calorific value of solid and liquid fuels	2	25MEL42.1
4	Determination of Calorific value of gaseous fuels	2	25MEL42.1
5	Determination of viscosity of given lubricating oil using Saybolt Viscometer.	2	25MEL42.2
6	Determination of viscosity of given lubricating oil using Torsion Viscometer.	2	25MEL42.2
	PART-B		
7	Determination of Heat balance sheet for Single cylinder Four Stroke Diesel Engine	2	25MEL42.2
8	Determination of Heat balance sheet for Multi cylinder Four Stroke Diesel Engine	2	25MEL42.3
9	Performance Tests on multi cylinder diesel Engine	2	25MEL42.4
10	Determination of Morse test for Four Stroke Diesel Engine	2	25MEL42.4
11	Performance Tests on single cylinder diesel Engine	2	25MEL42.3
12	Determination of property values for common refrigerants using tables	2	25MEL42.4
	PART-C **Beyond Syllabus Virtual Lab Content** **(To be done during Lab but not to be included for CIE or SEE)**		

- **Thermo_Couple_**
  http://htv-au.vlabs.ac.in/heat thermodynamics/Thermo_Couple_Seebeck_Effect/
- **Thermistor**
  http://htv-au.vlabs.ac.in/heat-thermodynamics/Characteristics_of_Thermistor/
- **PV Diagram of a Spark Ignition (SI) Engine**
  http://vlabs.iitkgp.ernet.in/rtvlas/exp1/index.html
- **Mean Effective Pressure**
  http://vlabs.iitkgp.ernet.in/rtvlas/exp5/index.html

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		30	20
L1	Remember	-	-
L2	Understand	10	-
L3	Apply	10	10
L4	Analyze	10	10
L5	Evaluate	-	-
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	05
L2	Understand	05
L3	Apply	20
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Reference Books:

1) Engineering Thermodynamics, P.K.Nag, Tata McGraw Hill Publication, 6th edition, 2017, ISBN: 9789352606429

2) Engineering Thermodynamics, R.K Rajput, Lakshmi Publications , 2019, ISBN 9788131800584.

FLUID MECHANICS			
Course Code	**25MEE43**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**45**	**SEE Marks**	**50**
TW & SL / Sem	**45**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:

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

25MEE43.1	Understand the fundamental properties of fluids such as surface tension, viscosity, and capillarity to explain fluid behavior in practical scenarios
25MEE43.2	Analyze the principles of aerodynamics to compute lift, drag, and moment forces acting on simple aerodynamic profiles in inviscid and steady fluid flows
25MEE43.3	Apply the concepts of fluid statics, kinematics, and dynamics to solve engineering problems in Aerodynamics, Hydraulics, Marine Engineering, and Gas Dynamics.
25MEE43.4	Analyze the causes of major and minor losses in pipe flows and assess their impact on fluid transport systems
25MEE43.5	Apply the Continuity and Bernoulli equations to model and solve real-time fluid flow problems in engineering systems
25MEE43.6	Illustrate the various types of fluid flow and flow descriptions, and design an appropriate flow measuring device to assess discharge and performance.

MODULE-1	**INTRODUCTION TO FLUID MECHANICS**	**25MEE43.1 25MEE43.3**	**9 Hours**

Fluid Properties: Types of fluids, Mass Density, Specific Weight, Specific Gravity, Newton's Law of Viscosity, Dynamic Viscosity, Surface Tension, Capillarity, Compressibility, Vapour pressure , numericals
Fluid Statics: Pascal's law, Hydrostatic law, pressure variation in a static fluid in 2D.

Case Study	Vapour pressure and cavitation
Text Book	Text Book 1: 1.1, 1.2, 1.3, 1.6, 2.1, 2.2, 2.3, 4.1, 4.2, 4.3, 4.4, 4.5 Text Book 2: 1.1, 1.2,1.3, 1.4, 1.5, 1.6, 2.3, 4.1, 4.2, 4.3, 4.4

MODULE-2	**FLUID KINEMATICS**	**25MEE43.3 25MEE43.5**	**9 Hours**

Fluid Kinematics: Types of Flow- steady, unsteady, uniform, non-uniform, laminar, turbulent, one, two and three dimensional, compressible, incompressible, rotational, irrotational, stream lines, path lines, streak lines, Continuity equation in 2D and 3D (Cartesian Co-ordinates only), velocity and acceleration, velocity potential function and stream function (Numerical).

Self-study	Determination of metacentric height
Text Book	Text Book 1: 5.1, 5.2, 5.3,5.4,5.5, 5.7,5.8, 6.1,6.2,6.3,6.4, 7.1, 7.3 Text Book 2: 5.1, 5.3, 5.6, 6.1,

MODULE-3	**FLUID DYNAMICS**	**25MEE43.3 25MEE43.4 25MEE43.6**	**9 Hours**

Fluid Dynamics: Introduction to Navier-Stroke's Equation, derivation of Euler equation of motion along a stream line, and Bernoulli's equation from Euler's equation and first principles (Numerical). Application of Bernoulli's equation to pitot tube, venturimeter, orifice meter (No Derivation of discharge equation).

Self-study	flow measuring devices
Text Book	Text Book 1: 9.1, 9.2, 9.310.1, 10.2, 10.3 Text Book 2: 11.2, 11.2, 10.4, 10.5

MODULE-4	**FLOW THROUGH PIPES**	**25MEE43.4**	**9 Hours**

Flow Through Pipes: Energy losses through pipe, Major losses, Darcy- Weisbach equation, Chezy's Equation, Minor losses in pipes-sudden enlargement, sudden contraction, TEL, HGL, pipes in series and parallel, Siphons, Transmission of power. (Numerical).
Laminar And Turbulent Flow: Definition, Relation between pressure and shear stresses, Laminar flow through circular pipe, Fixed parallel plates, turbulent flow and velocity distribution. (Numerical)

Case Study	HGL and TEL
Text Book	Text Book 1: 19.1, 19.2, 19.3, 19.7, 19.9 , Text Book 2: 3.1, 3.2, 3.3, 3.4, 3.5

MODULE-5	**FLOW AROUND IMMERSED BODIES**	**25MEE43.3 25MEE43.2**	**9 Hours**

Buoyancy: Buoyancy, centre of buoyancy, Archimedes' principle, principle of floatation, metacentre and metacentric height, stability of floating and submerged bodies, determination of Metacentric height by experimental method.(Numerical)
Flow around Immersed Bodies: -Force exerted by flowing fluid on stationary body, expression for Lift and Drag, Classification of Drag, Flow around circular cylinder and Aerofoil, Development of lift on Aerofoil(Numerical). AI-Assisted Aerodynamic Shape Optimization of Aerofoils and Flow Systems, AI-Based Stability Monitoring and Prediction of Floating Bodies Using Metacentric Height Data

Applications	Applications of AI in Fluid Mechanics
Text Book	Text Book : 18.1, 18.2, 18.5, 18.6 18.8, 18.10 , Text Book 2: 2.1, 2.2, 2.3, 2.4

CIE Assessment Pattern (50 Marks – Theory) –

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	5	-
L3	Apply	10	5	5
L4	Analyze	5	5	5
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	10
L3	Apply	20
L4	Analyze	10
L5	Evaluate	--
L6	Create	--

Suggested Learning Resources:

Text Books:

1) Bansal R.K., "Fluid Mechanics and Hydraulic Machines", 9th edition, Laxmi Publications (P)Ltd., New Delhi, 2018, ISBN 9788131808153
2) R.K. Rajput, "A Text Book of Fluid Mechanics and Hydraulic Machines", 6th edition, S. Chand, 2015, ISBN 9789385401374

Reference Books:

1) Yunus A. Cengel and John M. Cimbala., 'Fluid Mechanics', McGraw Hill, 4th Edition, 2017, ISBN-(13 digits): 978-9385401374

2) P.N.Modi and Seth, "Fluid Mechanics and Hydraulic Machines",22nd edition, Standard Book House,

2018, ISBN-13: 978-8189401269

Web links and Video Lectures (e-Resources)

- **https://archive.nptel.ac.in/courses/112/105/112105171/**
- **https://unacademy.com/content/gate/videos/mechanical-engineering/fluid-mechanics/#**
- **https://www.youtube.com/watch?v=clVwKynHpB0**
- **https://nptel.ac.in/courses/103102211**
  https://nitsri.ac.in/Department/DisplayDeptPage.aspx?page=magee&ItemID=ocgkk&nDeptID=e

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Visit to any Hydraulic power plant
- Demonstration on working of Pumps /Turbines
- Demonstration on Flow measuring Devices
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare Fluid Mechanics and Machinery related Flowcharts.
  - Organizing Group wise discussions on issues
  - Seminars

FLUID MECHANICS LAB

Course Code	**25MEL43**	**Credits**	**01**
L:T:P:S	**0:0:1:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**30**	**SEE Marks**	**50**
TW & SL / Sem	**-**	**Total Marks**	**100**
Total Hours /Sem	**30**	**Exam Hours**	**03**

Course outcomes:

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

25MEL43.1	Apply the flow measuring devices such as Venturi meter and Notches to predict the coefficient of discharge for flow through pipes
25MEL43.2	Investigate the friction and measure the frictional losses in fluid flow
25MEL43.3	Understand the working of impact of jet on various types of vanes
25MEL43.4	Analyze the performance of hydraulic turbine, pumps, Air blower under different working conditions

Exp. No.	List of Experiments	Hours	COs
	Prerequisite Experiments		
	• Understand the properties of fluids • Demonstration on pascal's law, hydrostatic law • Demonstration on Buoyancy, determination of metacentric height.	2	NA
	PART-A		
1	Calibration of given Venturi meter and plotting the suitable calibration curve	2	25MEL43.1
2	Determination of the impact of jet on Flat Vanes	2	25MEL43.1
3	Determination of the impact of jet on hemispherical vanes	2	25MEL43.1
4	Determination of the impact of jet on Inclined Vanes	2	25MEL43.2
5	Determination of coefficient of friction and Chezy's constant for turbulent flow in pipes.	2	25MEL43.2
6	Determination of minor losses coefficient in flow through pipes due to sudden contraction and sudden expansion	2	25MEL43.1
	PART-B		
7	Conduct Performance analysis of Air compressor	2	25MEL43.3
8	Determine the efficiency of air blower	2	25MEL43.4
9	Calibration of given V-notch, rectangular notch and plotting the suitable calibration curve	2	25MEL43.4
10	Investigate the Performance test on Pelton Wheel Turbine	2	25MEL43.4
11	Determination of performance characteristics of centrifugal pump	2	25MEL43.4
12	Conduct Performance test on Kaplan Turbine	2	25MEL43.4

PART-C

Beyond Syllabus Virtual Lab Content (4 Hours)

(To be done during Lab but not to be included for CIE or SEE)

- **Reciprocating-pump**
  https://fmc-nitk.vlabs.ac.in/exp/reciprocating-pump/
- **Francis-turbine**
  https://fmc-nitk.vlabs.ac.in/exp/francis-turbine/

- **Reynolds Experiment**
  https://me.iitp.ac.in/Virtual-Fluid-Laboratory/reynolds/introduction.html
- **Pitot Tube**
  https://me.iitp.ac.in/Virtual-Fluid-Laboratory/pitot/introduction.html
- **Metacenter**
  https://me.iitp.ac.in/Virtual-FluidLaboratory/metacenter/introduction.html

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		30	20
L1	Remember	-	-
L2	Understand	10	-
L3	Apply	10	10
L4	Analyze	10	10
L5	Evaluate	-	-
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	05
L2	Understand	05
L3	Apply	20
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Reference Books:

1) Bansal R.K., "Fluid Mechanics and Hydraulic Machines", 9th edition, Laxmi Publications (P)Ltd., New Delhi, 2018, ISBN 9788131808153

2) R.K. Rajput, "A Text Book of Fluid Mechanics and Hydraulic Machines", 6th edition, S. Chand, 2015, ISBN 9789385401374

MACHINE TOOLS AND METROLOGY

Course Code	**25MEE44**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**45**	**SEE Marks**	**50**
TW & SL / Sem	**45**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:

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

25MEE44.1	Understand metal cutting principles, tool geometry, tool materials, cutting fluids, tool wear and lathe operations for machining engineering components.
25MEE44.2	Apply milling, indexing, drilling and grinding principles to select suitable machining processes for manufacturing engineering components.
25MEE44.3	Analyze the working principles and applications of shaping, planing, slotting and broaching machines for appropriate machining operations.
25MEE44.4	Apply CNC machining principles, coordinate systems and machine-tool capabilities for planning modern manufacturing operations.
25MEE44.5	Analyze measurement standards, calibration procedures and measurement systems to ensure dimensional accuracy in engineering applications.
25MEE44.6	Design gauges using limits, fits, tolerances and GD&T principles for inspection and quality control of engineering components.

MODULE-1	**METAL CUTTING FUNDAMENTALS, LATHE**	**25MEE44.1**	**9 Hours**

Single point cutting tool nomenclature, types of metal cutting, Mechanism of chip formation, types of chips. Tool Materials, Cutting Fluids and its Functions, Tool wear and tool failure, tool life. Effects of cutting parameters on tool life. Constructional features of Turret and Capstan Lathe. Tool Layout.

Case Study	Investigate tool wear mechanisms in single-point cutting tools.
Text Book	Text Book 1: chapter1.1,1.2,2.1,2.2,2.3,2.4,2.5,2.6

MODULE-2	**MILLING, DRILLING AND GRINDING MACHINES**	**25MEE44.1, 25MEE44.2 25MEE44.3**	**9 Hours**

Milling machines: Classification, constructional features, milling cutters nomenclature, up milling and down milling . Simple, compound, differential and angular indexing. Drilling machines: Classification, constructional features, drilling operations. Types of drill & drill bit nomenclature, drill materials.
Grinding machines: Types of abrasives, Grain size, bonding process, grinding wheel types. Classification, constructional features of grinding machines, Principle of broaching. Details of a broach. Types of broaching machines-constructional details.

Case Study	Investigate indexing operations and production of gear blanks using milling machines.
Text Book	Text Book 2: Chapters 2.12,2.19,4.5,4.8,4.11,4.12,4.13

MODULE-3	**SHAPING , PLANING, SLOTING AND CNC MACHINES**	**25MEE44.3, 25MEE44.4**	**9 Hours**

Shaping Machines: classification, constructional features, quick return mechanisms, types of tools, machining.
Planing Machines: classification, constructional features, planing machine mechanisms, comparison between shaping and planing machines.
Slotting Machines: classification, constructional features, slotting machine mechanisms, and tooling.
CNC Machines: Introduction to CNC machines- Principles of operation. Axes of NC machine-Coordinate systems.

Case Study	CNC machining applications in modern manufacturing.
Text Book	Text Book 2: Chapters 12.1,12.2,12.6,12.12,12.39,16.2,16.3,16.4,16.15,16.17,16.27,18.4,18.7

MODULE-4	**METROLOGY AND STANDARDS OF MEASUREMENT**	**25MEE44.5**	**9 Hours**

Introduction: Definition and Objectives of metrology, Material standards-International Prototype meter, Imperial standard yard, Airy points, Wave length standard, subdivision of standards, line and end standard, calibration of end bars, Indian Standards of Slip gauges, Wringing phenomena, Numerical problems on building of slip gauges. Measurements and measurement systems: Generalized measurement system, basic definitions, Errors in measurement, classification of errors.

Case Study	Case Study on primary standards
Text Book	Text Book 3: 1.1, 1.2, 1.4, 1.5, 1.6 ,1.7, 1.8, 1.10, 1.11, 1.12,5.5, 5.7, 5.8, 5.9

MODULE-5	**LIMITS, FITS, TOLERANCE AND GAUGES**	**25MEE44.6**	**9 Hours**

Definition of tolerance, Specification in assembly, Principle of interchangeability and selective assembly limits of size, Indian standards, concept of limits of size and tolerances, compound tolerances, accumulation of tolerances, definition of fits, types of fits and their designation, geometrical dimensioning and tolerance, hole basis system, shaft basis system, classification of gauges, design of gauges, Wear allowance on gauges, plain plug gauge, ring gauge, and gauge materials, numerical problems.

Applications	Applications of gauges in industry
Text Book	Text Book 4: 2.1 to 2.11, 2.14 to 2.29

CIE Assessment Pattern (50 Marks – Theory) –

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	5	-
L3	Apply	10	5	5
L4	Analyze	5	5	5
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	10
L3	Apply	20
L4	Analyze	10
L5	Evaluate	--
L6	Create	--

Suggested Learning Resources:

Text Books:

1. Manufacturing Process-I, Dr.K.Radhakrishna, Sapna Book House, 7th Revised Edition 2021, ISBN:978- 8128002076

2. Dr. T Chandrashekar, 'Metrology and Measurement', Subhas publication, 2021, ISBN: 9789383214198.

3. N V Raghavendra and Krishnamurthy, 'Engineering Metrology and Measurement', Oxford University Press, 2023, ISBN: 9780198085492.

Reference Books:

1.Fundamentals of Metal machining and machine tools, G. Boothroyd , McGraw Hill, 2022, ISBN:978-1574446593.

2.Anand K. Bewoor & Vinay A. Kulkarni, 'Metrology & Measurement', Tata McGraw Hill Pvt. Ltd., New Delhi, 2021, ISBN: 9781259081323.

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc25_me129/preview
- https://onlinecourses.nptel.ac.in/noc24_me99/preview
- https://onlinecourses-archive.nptel.ac.in/noc18_me06/
- https://onlinecourses-archive.nptel.ac.in/noc18_me05/
- https://onlinecourses.nptel.ac.in/noc22_me08/preview
- https://onlinecourses.nptel.ac.in/noc25_me65/preview

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Visit to any manufacturing of aero or auto industry.
- Demonstration of lathe/milling/drilling
- Demonstration of metal joining process
- Video demonstration of latest trends.
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare Flowcharts and Handouts
  - Organizing Group wise discussions on issues
- Seminars

MACHINE TOOLS AND METROLOGY LAB

Course Code	**25MEL44**	**Credits**	**01**
L:T:P:S	**0:0:1:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**30**	**SEE Marks**	**50**
TW & SL / Sem	**-**	**Total Marks**	**100**
Total Hours /Sem	**30**	**Exam Hours**	**03**

Course outcomes:

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

25MEL44.1	Apply machining operations using lathe, drilling, shaping, milling, and grinding machines.
25MEL44.2	Develop and execute part programs for CNC turning and CNC milling operations.
25MEL44.3	Investigate and calibration and measurement using various metrology instruments.
25MEL44.4	Analyze screw thread and gear tooth parameters using standard metrological techniques.

Exp. No.	List of Experiments	Hours	COs
	Prerequisite Experiments		
	• Familiarization with safety practices and personal protective equipment. • Introduction to machine tools and metrology.	2	NA
	PART-A		
1	Preparation of model on lathe involving facing, plain turning, step turning, taper turning, knurling and thread cutting.	2	25MEL44.1
2	Preparation of model on Cutting of V-groove, dovetail groove and rectangular groove using shaping machine.	2	25MEL44.1
3	Preparation of models on using drilling operations involving reaming and internal thread cutting.	2	25MEL44.1
4	Preparation of models on Grinding machine and Milling of surfaces using a vertical milling machine.	2	25MEL44.1
5	Preparation of models on Part programming and machining using CNC Turning Centre.	2	25MEL44.2
6	Preparation of models on Part programming and machining using CNC Milling Centre.	2	25MEL44.2
	PART-B		
7	Calibration of micrometer using slip gauge	2	25MEL44.3
8	Measurement of alignment of surface plate using roller set	2	25MEL44.3
9	Calibration of LVDT using micrometer	2	25MEL44.3
10	Angular measurement using sine bar and bevel protractor	2	25MEL44.3
11	Measurement of a screw thread parameters using floating carriage micrometer by 2-wire method	2	25MEL44.4
12	Measurement of gear parameters using gear tooth vernier	2	25MEL44.4
	PART-C **Beyond Syllabus Virtual Lab Content (4 Hours)** **(To be done during Lab but not to be included for CIE or SEE)**		

- **Cutting Tool-life**
  https://virtual-labs.github.io/exp-tool-life-iitk/
- **Cutting tool-wear**
- https://virtual-labs.github.io/exp-tool-wear-iitk/
- **Vernier-caliper**
  https://virtual-labs.github.io/exp-vernier-caliper-iitkgp/
- **Micrometer**
  https://virtual-labs.github.io/exp-micrometer-iitkgp/

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		30	20
L1	Remember	-	-
L2	Understand	10	-
L3	Apply	10	10
L4	Analyze	10	10
L5	Evaluate	-	-
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	05
L2	Understand	05
L3	Apply	20
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Reference Books:

1.Hazara Choudhry, 'Work shop Technology', Vol – II, Media promoters and publishers Pvt. Ltd. 2021, ISBN:9788185099156

2. R.K.Jain, 'Production Technology', Khanna Publishers-Delhi , 2022, ISBN:9788174090997

3. R.K. Jain, 'Mechanical and Industrial Measurements', Khanna Publishers, 2022, ISBN: 9788174091918.

4. N V Raghavendra and Krishnamurthy, 'Engineering Metrology and Measurement', Oxford University Press, 2023, ISBN: 9780198085492.

COGENERATION AND WASTE HEAT RECOVERY			
Course Code	**25MEE451**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**45**	**SEE Marks**	**50**
TW & SL / Sem	**45**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:

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

25MEE451.1	Illustrate the fundamentals of cogeneration and waste heat recovery systems.
25MEE451.2	Compare thermodynamic principles and performance of cogeneration systems.
25MEE451.3	Perform waste heat recovery techniques in industrial applications.
25MEE451.4	Analyze the performance of waste heat recovery equipment and energy conservation systems
25MEE451.5	Apply principles of combined heat and power (CHP) systems for industrial and commercial applications.
25MEE451.6	Differentiate cogeneration and waste heat recovery projects based on their techno-economic performance and environmental impacts

MODULE-1	**INTRODUCTION TO COGENERATION AND WASTE HEAT RECOVERY**	**25MEE451.1**	**9 Hours**

Energy Scenario: Industrial energy consumption, energy efficiency, energy conservation opportunities, conventional energy utilization. Cogeneration Fundamentals: Definition, principle of cogeneration, advantages, limitations, applications, types of cogeneration systems. Waste Heat Recovery Overview: Sources of waste heat, classification of waste heat, benefits, potential in industries. Energy Policies: Energy Conservation Act, Bureau of Energy Efficiency (BEE), industrial energy efficiency standards.

Case Study	Case study on cogeneration implementation in a sugar industry
Text Book	Text Book 1: 1.1 to 1.34

MODULE-2	**THERMODYNAMICS OF COGENERATION SYSTEMS**	**25MEE451.2**	**9 Hours**

Thermodynamic Principles: First and Second Laws applied to CHP systems, energy and exergy analysis. Cogeneration Cycles: Steam turbine systems, gas turbine systems, combined cycle plants, diesel engine-based cogeneration. Performance Parameters: Heat-to-power ratio, fuel utilization factor, overall efficiency, power-to-heat ratio.

Case Study	Performance evaluation of a gas turbine-based cogeneration plant
Text Book	Text Book 1: 2.1 to 2.78

MODULE-3	**WASTE HEAT RECOVERY SYSTEMS**	**25MEE451.3 25MEE451.5**	**9 Hours**

Waste Heat Recovery Equipment: Economizers, recuperators, regenerators, air preheaters, waste heat boilers. Heat Recovery Systems: Heat exchangers, heat pipes, thermal wheels, heat pumps. Industrial Applications: Cement, steel, glass, paper, chemical and textile industries.

Case Study	Waste heat recovery from cement kiln exhaust gases.
Text Book	Text Book 2: 3: 36 to 3.75 and 4.76 to 4.110

MODULE-4	**PERFORMANCE ANALYSIS OF CHP AND WHR SYSTEMS**	**25MEE451.4**	**9 Hours**

Performance Evaluation: Energy audit, efficiency calculation, exergy efficiency, energy savings estimation. Economic Analysis: Payback period, life cycle costing, net present value, internal rate of return. Environmental Benefits: Carbon emission reduction, fuel savings, sustainability assessment.

Case Study	Performance assessment of waste heat recovery in a steel plant
Text Book	Text Book 2: 5.111 to 5.150

MODULE-5	**ADVANCED COGENERATION SYSTEMS**	**25MEE451.5 25MEE451.6**	**9 Hours**

Advanced Technologies: Trigeneration systems, micro-CHP, fuel cell cogeneration, Organic Rankine Cycle (ORC).

Integration with Renewable Energy: Solar-assisted CHP, biomass cogeneration, hybrid systems. Future Trends: Smart energy systems, digital energy management, industrial decarbonization.	
Self-study	Recent developments in Industrial Energy Management Systems (IEMS)
Text Book	Text Book 2: 6.151to6.200

CIE Assessment Pattern (50 Marks – Theory) –

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	5	-
L3	Apply	10	5	5
L4	Analyze	5	5	5
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	10
L3	Apply	20
L4	Analyze	10
L5	Evaluate	--
L6	Create	--

Suggested Learning Resources:

Text Books:

1) D.A. Reay, Industrial Energy Conservation, 2nd Edition, Pergamon Press. 2017, ISBN-13: 9780080232737
2) P.A. Pilavachi, Energy Management and Cogeneration, CRC Press.2013, ISBN-13: 978-1858610191

Reference Books:

1) A. Thumann and W.J. Younger, Handbook of Energy Audits, CRC Press.2013, ISBN-13: 978-1466561625
2) S.C. Tripathy, Utilization of Electrical Energy and Energy Conservation, McGraw Hill.1999, ISBN-13: 9780074604298

Web links and Video Lectures (e-Resources):

- https://beeindia.gov.in
- NPTEL: Energy Conservation and Management
- NPTEL: Cogeneration and Combined Cycle Power Plants
- https://powermin.gov.in
- https://eeslindia.org

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Visit to a cogeneration plant in a sugar or paper industry.
- Industrial visit to a waste heat recovery installation.
- Demonstration of economizer and recuperator models.
- Contents related activities (Activity-based discussions)
  - Prepare flowcharts of steam turbine cogeneration systems.
  - Group discussions on industrial energy conservation practices.
  - Seminars on advanced waste heat recovery technologies.

INTELLIGENT MANUFACTURING SYSTEMS

Course Code	**25MEE452**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**45**	**SEE Marks**	**50**
TW & SL / Sem	**45**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:

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

25MEE452.1	Understand the concepts of Intelligent manufacturing system.
25MEE452.2	Analyze application of machine learning and deep learning techniques for intelligent manufacturing.
25MEE452.3	Apply design principles for additive manufacturing to select appropriate processes and materials.
25MEE452.4	Implement the suitable additive manufacturing technologies for rapid prototyping process.
25MEE452.5	Illustrate the working principle of Digital Twin technology and its role in smart manufacturing
25MEE452.6	Identify the emerging Industry 4.0 technologies and their potential to transform manufacturing processes in smart factories.

MODULE-1	**FOUNDATIONS OF INTELLIGENT MANUFACTURING AND IoT**	**25MEE452.1**	**9 Hours**

Introduction to Intelligent Manufacturing: Overview of intelligent manufacturing concepts and principles, Historical context and evolution of manufacturing techniques, Importance of smart manufacturing in modern industry.

Internet of Things(IoT) in Manufacturing: Fundamentals of IoT and its application in manufacturing, Sensors, actuators and communication protocols, Data acquisition, processing and transmission, IoT platforms and architectures for manufacturing environment.

Case Study	Smart Manufacturing and IoT Implementation in an Automotive Manufacturing Plant
Text Book	Text Book 1: 1.2, 1.3, 1.4, 1.13, 1.15, 1.16

MODULE-2	**ADVANCED ANALYTICS AND ARTIFICIAL INTELLIGENCE IN MANUFACTURING**	**25MEE452.2**	**9 Hours**

Big Data analytics for Manufacturing: Introduction to big data analytics and its significance in manufacturing, Data preprocessing and cleaning techniques, Descriptive, diagnostic, predictive and prescriptive analytics, Case studies on using big data analytics to improve manufacturing processes.

Artificial Intelligence in Manufacturing: Overview of AI technologies and their role in manufacturing, Machine learning algorithms for predictive maintenance, quality control and process optimization, Deep learning for image recognition and defect detection.

Self-study	AI and Big Data Analytics for Predictive Maintenance and Quality Control in a Smart Manufacturing Plant.
Text Book	Text Book 1: 2.2, 2.3, 2.4 to 2.15

MODULE-3	**ADDITIVE MANUFACTURING IN INDUSTRY 4.0**	**25MEE452.3 25MEE452.4**	**9 Hours**

Additive Manufacturing: Fundamentals of additive manufacturing process and materials, Design considerations for additive manufacturing, Applications for 3D printing in prototyping, customization and production. Advanced topics such as multi-material printing, topology optimization and in-situ monitoring.

Case Study	Additive Manufacturing for Lightweight Aerospace Component Production
Text Book	Text Book 2: 3.1, 3.3, 3.5, 3.7, 3.10

MODULE-4	**INTELLIGENT MANUFACTURING WITH DIGITAL**	**25MEE452.5**	**9 Hours**

	TWIN TECHNOLOGY		
Digital Twin Technology: Concept of digital twins and their role in smart manufacturing, Creation and development of digital twin models, Integration of digital twins with IoT data and simulation tools, Case studies on using digital twins for predictive maintenance, process optimization and product life cycle management.			
Self-study	Digital Twin Applications in Industry 4.0: Emerging Trends and Future Opportunities		
Text Book	Text Book 1: 6.1, 6.3, 6.5, 6.7, Text Book 2: 10.1, 10.3, 10.5, 10.7		
MODULE-5	**EMERGING TECHNOLOGIES IN SMART MANUFACTURING**	**25MEE452.6**	**9 Hours**
Emerging Technologies and Trends: Overview of emerging technologies shaping the future of smart manufacturing, Augmented Reality (AR) and virtual reality applications (VR) applications in manufacturing, Blockchain for supply chain transparency and product traceability, Quantum computing and its potential impact on manufacturing optimization			
Case Study	Transforming an Automotive Manufacturing Plant Using AR, VR, Blockchain, and Quantum Computing		
Text Book	Text Book 2: 12.1 to 12.10		

CIE Assessment Pattern (50 Marks – Theory) –

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	5	-
L3	Apply	10	5	5
L4	Analyze	5	5	5
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	10
L3	Apply	20
L4	Analyze	10
L5	Evaluate	--
L6	Create	--

Suggested Learning Resources:

Suggested Learning Resources:

Text Books:

1) Shyam Varan Nath, Jelena Markovic, and Pramod Sharma, Data Analytics for Smart Manufacturing, 1st Edition, Packt Publishing, 2020, ISBN: 978-1788392358

2) Andrew Kusiak, Smart Manufacturing, 1st Edition, John Wiley & Sons, 2020, ISBN: 978-1119519898

Reference Books:

1) Thomas H. Davenport and Jill Dyché, Big Data in Practice, 1st Edition, John Wiley & Sons, 2021, ISBN: 978-1118743843

2) Michael Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, 3rd Edition, Pearson Education, 2022, ISBN: 978-03290341913

3) Wann D," Bio Logic: Designing with nature to protect the environment", Wiley Publisher, 2023, ISBN: 978-1636390475

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/@autodesk?utm_source=chatgpt.com
- https://www.youtube.com/@ROKAutomation?utm_source=chatgpt.com
- https://www.youtube.com/@IBMTechnology?utm_source=chatgpt.com
- https://www.youtube.com/@mitocw?utm_source=chatgpt.com

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Design a smart factory layout for a selected manufacturing process.
- Interpret the results and suggest improvements to the manufacturing process.
- Design a simple mechanical component using CAD software (Fusion 360, SolidWorks, or FreeCAD).
- Prepare a presentation or poster summarizing the findings and discuss how the technology supports Industry 4.0.

ELECTRIC VEHICLES AND BATTERY MANAGEMENT SYSTEM			
Course Code	**25MEE453**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**45**	**SEE Marks**	**50**
TW & SL / Sem	**45**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:

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

25MEE453.1	Analyze the architecture, principles, and performance characteristics of electric and hybrid electric vehicles.
25MEE453.2	Evaluate the characteristics, performance, and suitability of batteries, ultra-capacitors, and fuel cells for electric vehicle applications.
25MEE453.3	Analyze the performance, energy consumption, and control systems of electric vehicles.
25MEE453.4	Analyze the design, control systems, energy consumption, and performance of electric and hybrid electric vehicles.
25MEE453.5	Evaluate battery pack design, battery management systems and AI-enabled monitoring for safe and efficient EV operation.
25MEE453.6	Select appropriate thermal management in batteries and controllers in electric vehicles

MODULE-1	**INTRODUCTION TO ELECTRIC AND HYBRID VEHICLES**	**25MEE453.1**	**9 Hours**

Introduction to need for Alternative System: History of electric and hybrid vehicles. Need of electric and hybrid vehicles – comparative study of diesel, petrol, electric and hybrid vehicles.

Basic architecture of hybrid drive train, vehicle motion and the dynamic equations for the vehicle, Classification of HV and EV, Advantages and Limitations of electric vehicles. Specification of different electric and hybrid vehicles

Case Study	Indian EV market analysis.
Text Book	Text Books 1: Chapter 1- 1.1,1.2,1.3

MODULE-2	**ELECTRIC VEHICLES**	**25MEE453.3**	**9 Hours**

Electric vehicle layout, performance of electric vehicles – Design parameters of batteries, ultra-capacitors and fuel cells, aerodynamic considerations, calculation of the rolling resistance and the grade resistance, traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, advantage and limitations, specifications, system components, electronic control system, safety and challenges in electric vehicles.

Self-study	Fuel Cell Range Simulation
Text Book	Text Books 1: Chapter 4- 4.1,4.2

MODULE-3	**HYBRID VEHICLES**	**25MEE453.4**	**9 Hours**

Concepts of hybrid electric drive train, types, architecture of series and parallel hybrid electric drive train, merits and demerits, hybrid electric drive train design, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles.

Case Study	Case study on Bosch parallel full hybrid
Text Book	Text Books 1: Chapter 4- 4.2, Text Books 2- Chaper 8-8.4, Chaper 14-14.4

MODULE-4	**BATTERY MANAGEMENT SYSTEM**	**25MEE453.5 25MEE453.6**	**9 Hours**

Battery Pack: selection of battery for EVs and HEVs, traction battery pack design, requirement of battery monitoring, state of charge, energy and power estimation methods, battery cell equalization,

thermal control, protection interface, battery thermal management system, Simulation of Battery pack design.
Battery Management System: definition, parts, power module, battery, DC/DC converter, load, communication channel, battery pack safety, battery standards and tests, AI-Powered Battery Management Systems (BMS)
Propulsion Motors and Controllers: Types of electric motors – working principle of AC and DC motors. AI-Driven Drives

Case Study	Case study on thermal management of batteries.
Text Book	Text Books 1: Chapter 5-5.1,5.2, Chapter6-6.1,6.2,6.3, Chapter 7-7.1,

MODULE-5	**ENERGY STORAGE DEVICES AND FUEL CELLS**	**25MEE453.2**	**9 Hours**

Energy Storage Devices and Fuel Cells: Electromechanical batteries- types of batteries –lead acid batteries, nickel based batteries, lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency and ultra-capacitors. Fuel Cell- Fuel cell characteristics- Fuel cell types, Hydrogen fuel cell, Connecting cell in series, water management in the PEM fuel cell, Thermal Management of the PEM fuel cell
Battery charging Stations: Introduction to battery charging stations and its installation and commissioning, Smart charging, Grid to vehicle and vehicle to grid, smart metering and ancillary services, preliminary discussion on vehicle to vehicle and vehicle to personal communication systems.

Self-study	Fuel Cell Range Simulation and performance analysis using MATLAB
Text Book	Fuel Cell Range Simulation and performance analysis using MATLAB

CIE Assessment Pattern (50 Marks – Theory) –

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	5	-
L3	Apply	10	5	5
L4	Analyze	5	5	5
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	10
L3	Apply	20
L4	Analyze	10
L5	Evaluate	--
L6	Create	--

Suggested Learning Resources:

Text Books:

1. Electric and Hybrid Vehicles, Tom Denton, Routledge, 2nd Edition, 2023, ISBN: 978-1032556796
2. Electric Vehicle Technology Explained, James Larminie and John Lowry, Wiley, 3rd Edition, 2022, ISBN-13: 978-1119942733.

Reference Books:

1. Emadi, A., Advanced Electric Drive Vehicles, CRC Press, First Edition, 2015, ISBN: 978-1466597693
2. Electric Vehicle Machines and Drives, K.T. Chau, Wiley, 2015, ISBN: 978-1118752524
3. Fundamentals and Applications of Lithium-ion Batteries in Electric Drive Vehicles, Jiuchun Jiang

and Caiping Zhang, Wiley, 2022, ISBN: 978-1118414781

4. Handbook of Battery Materials, Claus Daniel and J.O. Besenhard, Wiley-VCH, ISBN: 978-3527326952

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/108106170
- https://www.youtube.com/watch?v=KytCYJq8ATA
- https://www.youtube.com/watch?v=7WNIDLFX7Xk
- https://www.youtube.com/watch?v=iihYXx79QiE
- https://www.youtube.com/watch?v=cS5tkvbC4ts
- https://www.youtube.com/watch?v=D-62yeSD0LY
- https://www.youtube.com/watch?v=9aAdqxvQGeQ

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Visit to any electric vehicle industry
- Demonstration of EV, motors, and batteries
- Video demonstration of latest trends in electric vehicles and hybrid electric vehicles
- Video demonstration of latest trends in battery management systems
- Seminars
- Group discussion on latest developments in EV.

AEROSPACE PROPULSION SYSTEMS

Course Code	**25MEE454**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**45**	**SEE Marks**	**50**
TW & SL / Sem	**45**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:

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

25MEE454.1	Understand the aerospace propulsion principles and engine performance characteristics.
25MEE454.2	Analyze combustion chamber and nozzle performance in air-breathing engines.
25MEE454.3	Apply the principles of axial flow compressors to determine their design parameters and performance under different operating conditions.
25MEE454.4	Analyze the operating characteristics of axial flow turbines.
25MEE454.5	Apply rocket propulsion principles to evaluate rocket engine performance.
25MEE454.6	Illustrate the advanced aerospace propulsion technologies and their applications.

MODULE-1	**FUNDAMENTALS OF AEROSPACE PROPULSION**	**25MEE454.1**	**9 Hours**

Introduction: Review of thermodynamic principles, Principles of aircraft propulsion, Types of power plants, Illustration of working of gas turbine engine–The thrust equation–Factors affecting thrust–Effect of pressure, velocity and temperature changes of air entering compressor– Methods of thrust augmentation– Characteristics of turboprop, turbofan and turbojet– Performance characteristics. – Numerical

Case Study	Identify and demonstrate the various components of Guiberson T-1020 (9-cylinder radial engine) and Tumansky R-25-300 R-26(Jet engine) Applications: Gas turbine industries and Power plants
Text Book	Text Book 1: 1.2, 1.3, 1.4, 1.13, 1.15, 1.16

MODULE-2	**COMBUSTION CHAMBER & NOZZLES**	**25MEE454.2**	**9 Hours**

Combustion chamber: Classification of combustion chambers, important factors affecting combustion chamber design, Combustion process, Combustion chamber performance Effect of operating variables on performance, Flame tube cooling, Flame stabilization Use of flame holders Nozzles: Theory of flow in isentropic nozzles, Convergent nozzles and nozzle choking, Nozzle throat conditions. Nozzle efficiency, Losses in nozzles. Over-expanded and under-expanded nozzles, Ejector and variable area nozzles, Thrust reversal

Self-study	Study of an aircraft jet engine (Includes study of assembly of sub systems, various components, their functions and operating principles) Performance studies on a scaled jet engine Applications: Gas turbine and aircraft engine design industries
Text Book	Text Book 1: 2.2, 2.3, 2.4 to 2.15

MODULE-3	**COMPRESSOR AND TURBINE:**	**25MEE454.3, 25MEE454.4**	**9 Hours**

Compressor: Axial flow compressor- geometry- twin spools- three spools- stage analysis- velocity polygons degree of reaction – radial equilibrium theory- performance maps

Turbine: Axial flow turbines- geometry- velocity polygons- stage analysis- performance maps- thermal limit of blades and vanes.

Applications	Gas turbine industries
Text Book	Text Book 2: 3.1, 3.3, 3.5, 3.7, 3.10

MODULE-4	**ROCKET PROPULSION FUNDAMENTALS**	**25MEE454.5**	**9 Hours**

Rocket Propulsion Fundamentals: Classification of rockets-principle of rocket propulsion-analysis of ideal chemical rocket, The chemical rocket, solid propellant rockets- Basic relations and propellant burning rate, performance issues, propellant grain and grain configuration, propellant grain stress and strain, Classification,

propellant characteristics, hazards, propellant ingredients, propellant processing and manufacturing.
liquid propellant rockets- Types of propellants, propellant tanks, propellant feed systems, propellant properties, liquid oxidizers, liquid fuels, liquid monopropellants, gaseous propellant, safety and environment concern and hybrid rockets

Applications	Rockets & missile and Testing manufacturing industries
Text Book	Text Book 1: 6.1, 6.3, 6.5, 6.7, Text Book 2: 10.1, 10.3, 10.5, 10.7

MODULE-5	**ADVANCED PROPULSION SYSTEMS**	**25MEE454.6**	**9 Hours**

Ramjets, scramjets, combined-cycle propulsion, electric propulsion, environmental issues and future propulsion technologies.

Case Study	Determination of heat of combustion of aviation fuel. Make Sugar rocket by using potassium nitrate (small size)
Text Book	Text Book 2: 12.1 to 12.10

CIE Assessment Pattern (50 Marks – Theory) –

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	5	-
L3	Apply	10	5	5
L4	Analyze	5	5	5
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	10
L3	Apply	20
L4	Analyze	10
L5	Evaluate	--
L6	Create	--

Suggested Learning Resources:

Text Books:

1. Bhaskar Roy, Aircraft propulsion, Elsevier 2011,ISBN-13: 9788131214213
2. V. Ganesan, Gas Turbines, Tata McGraw-Hill,2010, New Delhi, India, ISBN: 0070681929

Reference Books:

1. G. P. Sutton, Rocket Propulsion Elements, Wiley India Pvt Ltd,7the,2010, ISBN 9781118753651
2. Hill, Philip G., and Carl R. Peterson. "Mechanics and Thermodynamics of Propulsion, 2010, ISBN: 0201146592.
3. Cohen, H.Rogers,G.F.C. and Saravanamuttoo,H.I.H., GasTurbineTheory, Longman,1989, ISBN 13: 9780582236325

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/101104018?utm_source=chatgpt.com
- https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_ae11
- https://onlinecourses.nptel.ac.in/e-learning/preview/noc22_me125
- https://archive.nptel.ac.in/content/syllabus_pdf/101101002.pdf?utm_source=chatgpt.com

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Identify and explain the functions of components in a turbojet/turbofan engine model.
- Calculate thrust and propulsion efficiency for different flight conditions using engine performance data.
- Study and demonstrate the working of a combustion chamber and flame stabilization techniques.
- Analyze nozzle performance under convergent, convergent-divergent, over-expanded, and under-expanded flow conditions.

BIO MECHANICS

Course Code	**25MEE455**	**Credits**	**03**
L:T:P:S	**3:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**45**	**SEE Marks**	**50**
TW & SL / Sem	**45**	**Total Marks**	**100**
Total Hours /Sem	**90**	**Exam Hours**	**03**

Course outcomes:

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

25MEE455.1	Understand the fundamental principles of biomechanics and the structure-function relationship of the human musculoskeletal system.
25MEE455.2	Apply kinematic and kinetic principles to analyze human movement and gait characteristics.
25MEE455.3	Analyze the classification, properties, biocompatibility, and tissue interactions of natural and synthetic biomaterials used in biomedical applications.
25MEE455.4	Apply the principles of biomaterials to select suitable materials for biomedical applications, including emerging technologies and AI-assisted biomaterial design
25MEE455.5	Enumerate computational and experimental tools for solving biomechanical engineering problems.
25MEE455.6	Analyze the principles, operation, safety, and applications of modern surgical instruments and equipment used in healthcare.

MODULE-1	**Introduction to Biomechanics and Human Anatomy**	**25MEE455.1**	**9 Hours**

Introduction to biomechanics: Definition, scope, and applications, Historical development of biomechanics, Engineering mechanics in biological systems, Overview of human anatomy and physiology, Musculoskeletal system: Bones, joints, ligaments, tendons, and muscles, Anatomical terminology and planes of motion, Degrees of freedom and joint movements, Anthropometry and body segment parameters

Case Study	Fracture Analysis of the Femur during a Road Traffic Accident
Text Book	Text Book 1: 1, 2, 3, 4 Text Book 2: 1, 2, 7, 8, 10

MODULE-2	**Biomechanics of Human Movement**	**25MEE455.2**	**9 Hours**

Kinematics of human motion, Linear and angular motion, Position, velocity, acceleration in biological systems, Gait analysis fundamentals, Walking and running biomechanics, Motion capture systems, Kinetic analysis of movement, Ground reaction forces and center of mass.

Case Study	Gait Analysis of a Patient with Knee Osteoarthritis
Text Book	Text Book 1: 2, 11, 12, 13, 14 Text Book 2: 2, 3, 4, 5, 7, 8

MODULE-3	**Biological Materials**	**25MEE455.3, 25MEE455.4**	**9 Hours**

Introduction to biomaterials, their classification, properties, and biocompatibility. Natural biomaterials such as collagen, chitosan, alginate, and silk; synthetic biomaterials including metals, ceramics, polymers, and composites used in biomedical applications. Biomaterial–tissue interactions, degradation mechanisms, and applications in implants, drug delivery, tissue engineering, wound healing, and regenerative medicine. Emerging trends in smart biomaterials, biodegradable materials, 3D bioprinting, and AI-assisted biomaterial design.

Self-study	Failure of the Achilles Tendon in Elite Athletes
Text Book	Text Book 1: 3, 4, 7, 8, 9, 10 Text Book 2: 4 and 5

MODULE-4	**Biomedical Equipment**	**25MEE455.5**	**9 Hours**

Introduction to surgical instruments and equipment used in modern healthcare, including basic surgical tools, electrosurgical units, endoscopic and laparoscopic instruments, laser-based surgical systems, robotic-assisted surgery, sterilization and infection-control equipment, operating room technologies, safety protocols, maintenance practices, and emerging trends in minimally invasive and AI-assisted surgical systems.

Case Study	Design Evaluation of a Total Hip Replacement Implant		
Text Book	Text Book 1: 6.1, 6.3, 6.5, 6.7, Text Book 2: 10.1, 10.3, 10.5, 10.7		
MODULE-5	**Applications of AI in Biomechanics**	**25MEE455.6**	**9 Hours**

Fundamentals of biomechanics and human motion analysis, biomechanical modeling of muscles, joints, and skeletal systems, AI-based gait and posture analysis, wearable sensors for motion tracking, biomechanics in robotics and prosthetic design, human–machine interaction, sports performance analysis, rehabilitation engineering, digital human modeling, and the application of machine learning and artificial intelligence for predictive analysis, assistive technologies, and intelligent healthcare systems.

Case Study	Development of a Lower-Limb Exoskeleton for Rehabilitation
Text Book	Text Book : 13, 14, 15 Text Book 2: 12, 13, 14.

CIE Assessment Pattern (50 Marks – Theory) –

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	5	-
L3	Apply	10	5	5
L4	Analyze	5	5	5
L5	Evaluate	-	-	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	10
L3	Apply	20
L4	Analyze	10
L5	Evaluate	--
L6	Create	--

Suggested Learning Resources:

Text Books:

1) Susan J. Hall., "Basic Biomechanics", 9th Edition, McGraw-Hill 2025, ISBN -13: 9781266679100
2) Y.C. Fung, "Biomechanics: Mechanical Properties of Living Tissues", 2nd edition, Springer,2015, ISBN-13: 9780387979472

Reference Books:

1) David A. Winter, 'Biomechanics and Motor Control of Human Movement', 4th Edition 2009, Wiley, ISBN-13: 9780470398180.
2) Duane Knudson, "Fundamentals of Biomechanics", 3rd Edition, Springer, 2013, ISBN-13: 97803874931144.

Web links and Video Lectures (e-Resources)

- https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_bt08
- https://ocw.mit.edu/courses/20-310j-molecular-cellular-and-tissue-biomechanics-spring-2015/resources/lecture-notes/?utm
- https://www.coursera.org/learn/clinical-biomechanics-of-the-upper-and-lower-body?utm
- https://www.coursera.org/learn/anthropometry-biomechanics-and-motorskills-in-user-design?utm
- https://www.coursera.org/learn/anatomy-physiology-and-kinesiology-for-fitness?utm

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Anthropometric Measurement Study
- Human Joint Motion Identification
- Video-Based Gait Analysis
- Center of Mass Estimation
- Ground Reaction Force Demonstration
- Stress-Strain Analysis of Biological Analogues
- Creep and Stress Relaxation Experiment
- Prosthetic Device Evaluation
- Joint Load Calculation
- Rehabilitation Device Case Study
- Ergonomic Assessment of a Workstation
- Finite Element Analysis of a Bone or Implant.
- Wearable Sensor Demonstration

COMPUTER AIDED MACHINE DRAWING

Course Code	**25MEE461**	**Credits**	**01**
L:T:P:S	**0:0:1:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**30**	**SEE Marks**	**50**
TW & SL / Sem	**-**	**Total Marks**	**100**
Total Hours /Sem	**30**	**Exam Hours**	**03**

Course outcomes:

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

25MEE461.1	Apply machine drawing principles and BIS/ISO standards to prepare CAD drawings of standard machine elements.
25MEE461.2	Develop Model-Based Definition (MBD) enabled CAD models incorporating dimensions, GD&T, limits and fits, and surface finish annotations.
25MEE461.3	Create assembly drawings and detailed part drawings of mechanical assemblies using CAD techniques.
25MEE461.4	Develop manufacturing documentation including MBD models, PMI (Product Manufacturing Information), assembly drawings, and Bill of Materials (BOM).

Exp. No.	List of Experiments	Hours	COs
	Prerequisite Experiments		
	• Knowledge of 2D and 3D objects dimensioning and representation • Knowledge of using software tools to create 2D objects.	2	NA
	PART-A		
1	Development of sectional views for prisms and pyramids	2	25MEE461.1
2	Development of sectional views for Riveted joints	2	25MEE461.1
3	Create 2D Drawing of threaded fasteners.	2	25MEE461.1
4	Create 2D Drawing of keys, cotters and knuckle joints	2	25MEE461.1
5	Create 2D Drawing of couplings and bearings	2	25MEE461.1
6	Develop Model-Based Definition (MBD) model by applying Product Manufacturing Information (PMI), GD&T, limits & fits, and surface finish annotations on a 3D component	2	25MEE461.2
	PART-B		
7	Prepare 3D assembly model of Screw Jack with BOM and MBD annotations	2	25MEE461.3 25MEE461.4
8	Prepare 3D assembly model of Plummer Block with BOM and PMI	2	25MEE461.3 25MEE461.4
9	Prepare 3D assembly model of Machine Vice with GD&T annotations	2	25MEE461.3 25MEE461.4
10	Prepare 3D assembly model of Connecting Rod with MBD documentation	2	25MEE461.3 25MEE461.4
11	Prepare 3D assembly model of Tailstock with PMI and BOM	2	25MEE461.3 25MEE461.4
12	Prepare 3D assembly model of Rams Bottom Safety Valve with complete MBD documentation	2	25MEE461.3 25MEE461.4
	PART-C		

Beyond Syllabus Virtual Lab Content (4 Hours)
(To be done during Lab but not to be included for CIE or SEE)

- **Projection of Solids**
  https://eg-nitk.vlabs.ac.in/exp/projections-of-solids/simulation.html
- **Sections of solids**
  https://eg-dei.vlabs.ac.in/?utm
- **Design of Connecting Rod**
  https://iitb.vlabs.co.in/?utm
- **GD&T Basics**
  https://www.gdandtbasics.com/?utm

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		30	20
L1	Remember	-	-
L2	Understand	10	-
L3	Apply	10	10
L4	Analyze	10	10
L5	Evaluate	-	-
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	10
L3	Apply	20
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:
Reference Books:

1.Machine Drawing, N. D. Bhatt, V. M. Panchal, Charotar Publishing House, 2026, ISBN: 978985039850,
2.Machine Drawing K. R. Gopalakrishna, Subhas Publications, 2007, ISBN: 9788187134010,
3.Machine Drawing, K. L. Narayana, P. Kannaiah & K. Venkata Reddy, New Age International Publishers, 2012, ISBN: 9788122433253
4.Theory and Practice, Ibrahim Zeid – CAD/CAM:, McGraw-Hill, 2009, ISBN: 9780070151340
5.Automation, Production Systems, and Computer-Integrated Manufacturing, Mikell P. Groover, Pearson, 2016, ISBN: 9789332582700
6.Product Manufacturing Information (PMI): Applying Geometric Dimensioning and Tolerancing to 3D Models, James D. Meadows. James D. Meadows & Associates / ASME Press, 2009, ISBN-13: 9780971440166
7.Geometrical Dimensioning and Tolerancing for Design, Manufacturing and Inspection: A Handbook for Geometrical Product Specification Using ISO and ASME Standards, Georg Henzold, 3rd Edition, Butterworth-Heinemann (Elsevier), 2020, ISBN-13 (Print): 9780128240618

MATLAB FOR MECHANICAL APPLICATIONS

Course Code	**25MEE462**	**Credits**	**01**
L:T:P:S	**0:0:1:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**30**	**SEE Marks**	**50**
TW & SL / Sem	**-**	**Total Marks**	**100**
Total Hours /Sem	**30**	**Exam Hours**	**03**

Course outcomes:

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

25MEE462.1	Develop MATLAB programs using fundamental programming constructs, arrays, functions, scripts, file handling and matrix operations for engineering computations.
25MEE462.2	Apply numerical methods such as root-finding, differentiation, integration and ordinary differential equations using MATLAB to solve engineering mathematics problems.
25MEE462.3	Simulate and analyse mechanical engineering systems involving heat transfer and vibrations using MATLAB and visualize results using MATLAB plotting tools.
25MEE462.4	Analyse experimental engineering datasets using MATLAB and develop basic machine learning models for prediction and fault classification.

Pgm. No.	List of Programs	Hours	COs
	Prerequisite Programs		
	• Foundation in Linear Algebra and physics fundamentals • Programming logic fundamentals	2	NA
	PART-A		
1	Engineering Problem Solving using Decision Statements and Loops in MATLAB	2	25MEE462.1
2	Material Property Management using Arrays, Structures and User-Defined Functions	2	25MEE462.1
3	Experimental Data Processing using MATLAB File Input/Output Operations	2	25MEE462.1
4	Matrix Operations and Solution of Linear Equation Systems using MATLAB	2	25MEE462.1
5	Solution of Nonlinear Engineering Equations using Root-Finding Techniques	2	25MEE462.2
6	Computation of Velocity, Acceleration and Work Done using Numerical Differentiation and Integration	2	25MEE462.2
	PART-B		
7	Transient Cooling Analysis of Engineering Systems using MATLAB ODE Solvers	2	25MEE462.2
8	Analysis of Heat Conduction through Composite Walls using MATLAB	2	25MEE462.2
9	Simulation of Single Degree-of-Freedom Vibration Systems using MATLAB	2	25MEE462.3
10	Visualization of Mechanical Engineering Experimental Data using MATLAB Graphics and Plotting Tools	2	25MEE462.3
11	Modeling of Automotive Braking Systems through Simulink: Analysis of Longitudinal Deceleration across Varying Road Surfaces and Input Forces	2	25MEE462.4
12	Simulation of Water Tank Filling and Draining System using Simulink	2	25MEE462.4
	PART-C		

Beyond Syllabus Virtual Lab Content (4 Hours)
(To be done during Lab but not to be included for CIE or SEE)

- **MATLAB and Simulink**
  https://www.mathworks.com/videos/virtual-labs-with-matlab-and-simulink-1605544954052.html
- **MATLAB and Simulink Academic Resources for Educators**
  https://www.mathworks.com/academia/educators/resources.html
- **Mass-Spring-Damper Systems**
  https://www.mathworks.com/academia/courseware/mass-spring-damper-systems.html
- **Heat Transfer with MATLAB**
  https://www.mathworks.com/academia/courseware/heat-transfer.html

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		30	20
L1	Remember	-	-
L2	Understand	10	-
L3	Apply	10	10
L4	Analyze	10	10
L5	Evaluate	-	-
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	05
L2	Understand	05
L3	Apply	20
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Text Books:

1) Stormy Attaway, "MATLAB: A Practical Introduction to Programming and Problem Solving", 7th Edition, Publisher: Pearson, 2022, ISBN : 978-0323917506
2) William Palm, "MATLAB For Engineering Applications", Publisher: Mcgraw-Hill Education, 2022, ISBN: 978-1265139193

Reference Books:

1) Rudra Pratap, "Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers", Publisher: Oxford University Press, 2022, ISBN: 978-0198069195
2) Stephen J. Chapman, "MATLAB Programming for Engineers", 7th Edition, Publisher: Cengage Learning, 2024, ISBN: 978-8131518656

Web links and Video Lectures (e-Resources):

- **MATLAB Documentation**
  https://www.mathworks.com/help/matlab/
- **MATLAB Examples for Engineering Applications**
  https://www.mathworks.com/help/examples/
- **MATLAB Central – File Exchange and Community Resources**
  https://www.mathworks.com/matlabcentral/
- **MATLAB for Machine Learning Documentation**
  https://www.mathworks.com/solutions/machine-learning.html

- **MATLAB Data Analysis and Statistics Documentation**
  https://www.mathworks.com/help/stats/
- **MATLAB Graphics and Visualization Documentation**
  https://www.mathworks.com/help/matlab/graphics.html
- **MATLAB for Numerical Computing Tutorials**
  https://www.mathworks.com/solutions/mathematics.html
- **MATLAB for Mechanical Engineering Applications**
  https://www.mathworks.com/solutions/mechanical-engineering.html

PLC PROGRAMMING			
Course Code	**25MEE463**	**Credits**	**01**
L:T:P:S	**0:0:1:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**30**	**SEE Marks**	**50**
TW & SL / Sem	**-**	**Total Marks**	**100**
Total Hours /Sem	**30**	**Exam Hours**	**03**

Course outcomes:

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

25MEE463.1	Understand the hardware architecture, memory organization, internal relay concepts, and scanning cycles of Programmable Logic Controllers.
25MEE463.2	Apply and formulate logic designs using standard IEC 61131-3 Ladder Logic Diagrams using basic relays, latching circuits, timers, and counters.
25MEE463.3	Analyze and implement data handling blocks, math operations, and cascading industrial sequences for structural machine control processes.
25MEE463.4	Interpret the integrated automation programs combining analog signal processing, system troubleshooting, and HMI interface designs.

Pgm. No.	List of Programs	Hours	COs
	Prerequisite Programs		
	Orientation to PLC Hardware Architecture, Field I/O Wiring , Memory Mapping, and Simulation Software IDE Configuration.	2	NA
	PART-A		
1	Configure PLC Hardware Modules and Verify I/O Memory Addressing Using PLC Programming Software.	2	25MEE463.1
2	Implementation of Basic Universal Logic Gates (AND, OR, NOT, NAND, NOR, XOR) via Ladder Diagram.	2	25MEE463.1
3	Design of Software Memory Latching, Safety Interlocking Systems, and Set/Reset Instruction Control Blocks.	2	25MEE463.1
4	Implementation of Multi-Location Interlocked Industrial Plant Start/Stop Operation Control Systems.	2	25MEE463.1
5	Application and Configuration of On-Delay (TON) and Off-Delay (TOF) Timers for Scheduled Material Handling Control Loops.	2	25MEE463.2
6	Application of Retentive Timers (RTO) and Industrial Up/Down Counting Units (CTU, CTD) for Production Line Batching.	2	25MEE463.2
	PART-B		
7	Cascaded Process Sequencing: Design and Test of an Automated 4-Way Traffic Management and Crosswalk System.	2	25MEE463.2
8	Implementation of an Automated Star-Delta Induction Motor Induction Starter Control Sequence.	2	25MEE463.2
9	Data Handling and Processing: Implementation of Move, Math Blocks, and Word Comparison for Material Storage Systems.	2	25MEE463.3

10	Design and Program Execution of a Multi-Floor Industrial Car Parking Garage Tracker and Display System.	2	25MEE463.3
11	Analog Process Scaling: Configuration and Scaling of Analog Inputs (0-10V/4-20mA) for Level and Temperature Transducers.	2	25MEE463.4
12	Integrated Automation Setup: Designing an Industrial Manufacturing Loop Interface Linked with an HMI Monitor Screen Control.	2	25MEE463.4

PART-C

Beyond Syllabus Virtual Lab Content (4 Hours)

(To be done during Lab but not to be included for CIE or SEE)

- **PLC Count-Up instruction**
  https://ied-nitk.vlabs.ac.in/exp/exp-plc-count-up-nitk/simulation.html
- **Garage Shutter Opening and Closing Using PLC**
  https://ied-nitk.vlabs.ac.in/exp/exp-garage-shutter-plc-nitk/simulation.html
- **Simultaneous output interlock using PLC**
  https://ied-nitk.vlabs.ac.in/exp/exp-simultaneous-output-interlock-nitk/simulation.html
- **PLC On-Delay Timer Instruction**
  https://ied-nitk.vlabs.ac.in/exp/exp-plc-on-delay-nitk/simulation.html
- **Maximum Simultaneous Operations Limiter using PLC**
  https://ied-nitk.vlabs.ac.in/exp/exp-maximum-simultaneous-operations-limiter-nitk/simulation.html

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		30	20
L1	Remember	-	-
L2	Understand	10	-
L3	Apply	10	10
L4	Analyze	10	10
L5	Evaluate	-	-
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	05
L2	Understand	05
L3	Apply	20
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Reference Books:

1) Petruzella, Frank D., Programmable Logic Controllers, 5th Edition, McGraw-Hill Education, 2019, ISBN-978-1260129722.

2) Bolton, William, Programmable Logic Controllers, 6th Edition, Newnes (Elsevier), 2015, ISBN-978-0081001967

3) Hughes, Thomas A., Programmable Controllers: An Engineer's Guide, 4th Edition, International Society of Automation (ISA), 2005, ISBN-978-1556179844

AEROMODELLING DESIGN

Course Code	**25MEE464**	**Credits**	**01**
L:T:P:S	**0:0:1:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**30**	**SEE Marks**	**50**
TW & SL / Sem	**-**	**Total Marks**	**100**
Total Hours /Sem	**30**	**Exam Hours**	**03**

Course outcomes:

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

25MEE464.1	Understand the fundamentals of aeromodelling, aircraft components, aerodynamic forces, and flight principles.
25MEE464.2	Apply the principles of aircraft structural design and material selection to fabricate basic fixed-wing aircraft structures using suitable materials and tools
25MEE464.3	Analyze aircraft stability, control surfaces, and propulsion systems used in model aircraft.
25MEE464.4	Illustrate the design features, construction methods, and flight performance characteristics of radio-controlled (RC) aircraft models.

Exp. No.	List of Experiments	Hours	COs
	Prerequisite Experiments		
	Introduction to aeromodelling, aircraft terminology, safety procedures, aeromodelling materials, RC systems, and demonstration of fixed-wing aircraft flight.	2	NA
	PART-A		
1	Identification and study of aircraft components, control surfaces, and aerodynamic forces.	2	25MEE464.1
2	Airfoil generation and lift demonstration using simple wind flow experiments.	2	25MEE464.1
3	Design and fabrication of a simple hand-launched glider.	2	25MEE464.1
4	Study of aircraft stability and centre of gravity using model aircraft.	2	25MEE464.1
5	Fabrication of wing, fuselage, empennage, and landing gear using foam/balsa sheets.	2	25MEE464.2
6	Assembly and balancing of a fixed-wing aero model.	2	25MEE464.2
	PART-B		
7	Study and installation of brushless DC motor, ESC, propeller, battery, and receiver.	2	25MEE464.2
8	Servo motor installation and calibration of control surfaces.	2	25MEE464.2
9	Radio transmitter and receiver configuration for RC aircraft.	2	25MEE464.3
10	Static testing of propulsion system and thrust measurement.	2	25MEE464.3
11	Flight simulation and pre-flight checks using RC flight simulator software	2	25MEE464.4
12	Mini Project: Design, fabrication, testing, and flight evaluation of an RC fixed-wing aeromodel	2	25MEE464.4

PART-C

Beyond Syllabus Virtual Lab Content (4 Hours)

(To be done during Lab but not to be included for CIE or SEE)

- **Virtual Aerodynamics Laboratory – Airfoil Analysis.**
  https://www.mathworks.com/solutions/aerospace-defense.html?utm_source
- **Aircraft Stability and Control Simulation.**
  https://www.mathworks.com/solutions/aerospace-defense.html?utm_source
- **RC Flight Simulator Training Module**
  https://www.horizonhobby.com/realflight/?utm_source.
- **Propeller Performance Analysis.**
  https://www1.grc.nasa.gov/beginners-guide-to-aeronautics/propeller/?utm_source
- **Aircraft Weight and Balance Calculation.**
  https://www.simscale.com/knowledge-base/categories/aerodynamics/?utm_source

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		30	20
L1	Remember	-	-
L2	Understand	10	-
L3	Apply	10	10
L4	Analyze	10	10
L5	Evaluate	-	-
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	05
L2	Understand	05
L3	Apply	20
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Reference Books:

1. Martin Simons, "Model Aircraft Aerodynamics", Special Interest Model Books, Revised Edition, Reprint 2021, ISBN: 9781854862640.
2. David Boddington, "Radio Control Manual", Special Interest Model Books, Reprint 2021, ISBN: 9781854862381.
3. Andy Lennon, "Basics of R/C Model Aircraft Design", Air Age Publishing, Reprint 2022, ISBN: 9780911295407.
4. Michael V. Cook, "Flight Dynamics Principles", Butterworth-Heinemann, 4th Edition, 2021, ISBN: 9780081026108.

COMPUTATIONAL MECHANICS AND SIMULATION			
Course Code	**25MEE465**	**Credits**	**01**
L:T:P:S	**0:0:1:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**30**	**SEE Marks**	**50**
TW & SL / Sem	**-**	**Total Marks**	**100**
Total Hours /Sem	**30**	**Exam Hours**	**03**

Course outcomes:

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

25MEE465.1	Apply finite element analysis principles to model structural and thermal components and assign suitable boundary conditions using ANSYS/Abaqus Student Edition.
25MEE465.2	Analyse stress, strain and deformation in bars, trusses, beams and plates under static loading using finite element simulation.
25MEE465.3	Simulate steady-state and transient heat conduction problems and interpret thermal contour results for mechanical components.
25MEE465.4	Analyze the dynamic behaviour of mechanical systems through modal and harmonic analysis and compare simulation results with analytical or experimental benchmarks.

Exp. No.	List of Experiments	Hours	COs
	Prerequisite Experiments		
	• Stress-strain concepts from Strength of Materials • Heat transfer fundamentals	2	NA
	PART-A		
1	Perform static structural analysis of a cantilever beam subjected to a point load.	2	25MEE465.1
2	Analyze the stress distribution in a plate with a circular hole under axial tension.	2	25MEE465.1
3	Perform finite element analysis of a pin-jointed truss structure.	2	25MEE465.2
4	Determine the deflection and stress distribution in a simply supported beam subjected to a uniformly distributed load (UDL).	2	25MEE465.2
5	Evaluate the stress concentration in a stepped shaft under axial loading.	2	25MEE465.2
6	Perform static structural analysis of a bracket subjected to combined loading.	2	25MEE465.1
	PART-B		
7	Conduct steady-state heat conduction analysis of a composite wall.	2	25MEE465.3
8	Perform transient thermal analysis of a cooling fin.	2	25MEE465.3
9	Analyze the coupled thermal-structural behavior of an engine cylinder liner.	2	25MEE465.3
10	Determine the natural frequencies and mode shapes of a cantilever beam using modal analysis.	2	25MEE465.4
11	Perform harmonic response analysis of a simply supported shaft.	2	25MEE465.4
12	Validate finite element analysis results by comparing them with analytical solutions for a standard benchmark problem.	2	25MEE465.4

PART-C
Beyond Syllabus Virtual Lab Content (4 Hours)
(To be done during Lab but not to be included for CIE or SEE)

- **Virtual Lab Mechanical Engineering**
  https://vlab.co.in/broad-area-mechanical-engineering
- **Ansys Innovation Courses**
  https://courses.ansys.com/
- **OpenFOAM**
  https://www.openfoam.com/trainings/virtual-trainings

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		30	20
L1	Remember	-	-
L2	Understand	10	-
L3	Apply	10	10
L4	Analyze	10	10
L5	Evaluate	-	-
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	05
L2	Understand	05
L3	Apply	20
L4	Analyze	20
L5	Evaluate	-
L6	Create	-

Suggested Learning Resources:

Reference Books:

1) J. N. Reddy, "An Introduction to the Finite Element Method", 3rd Edition, Publisher: McGraw-Hill, 2006, ISBN: 9780071267614

2) Saeed Moaveni, "Finite Element Analysis: Theory and Application with ANSYS", 4th Edition, Publisher: Pearson, 2015, ISBN: 9780273774301

ENVIRONMENTAL SCIENCE PROJECT			
Course Code	**25EPP47**	**Credits**	**03**
L:T:P:S	**0:0:2:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**00**	**SEE Marks**	**50**
TW & SL / Sem	**60**	**Total Marks**	**100**
Total Hours /Sem	**60**	**Exam Hours**	**03**

Course outcomes:

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

25EPP47.1	Apply fundamental scientific principles and engineering methodologies to identify, analyze, and quantify complex environmental challenges.
25EPP47.2	Design sustainable, cost-effective, and resource-efficient technological solutions that mitigate adverse environmental and ecological impacts.
25EPP47.3	Conduct structured investigations, data collection, and physical or computational simulations to evaluate the performance of proposed environmental designs.
25EPP47.4	Utilize modern software tools, mathematical models, and laboratory techniques required for rigorous environmental monitoring and data interpretation.
25EPP47.5	Assess the societal, economic, health, safety, and legal implications of the project in compliance with current global sustainability and ethical standards.
25EPP47.6	Communicate project findings and sustainable engineering concepts effectively through comprehensive technical documentation and collaborative presentations

Environmental Science Project Roadmap: Guiding Principles for Environmental Science Project

Project Overview:

- **To study and analyze environmental issues** such as air pollution, water pollution, solid waste management, energy conservation, and natural resource utilization through surveys, observations, and data collection.

Project Milestones:

- **Set clear project milestones and deadlines for various phases, such as planning, design, implementation, testing, and presentation.**

Project Requirements:

- Data Collection and Environmental Analysis
- **Solution Design and Documentation:** Develop a feasible sustainable solution based on engineering principles and prepare a detailed project report with findings, analysis, recommendations, and conclusions.

Testing and Quality Assurance:

- Incorporate testing practices into their development process.
- Specify the types of testing (e.g., unit testing, integration testing)

Collaboration and Communication:

- If the project involves teamwork, outline expectations for collaboration, including communication channels and responsibilities within the team.

Documentation:

- Emphasize the importance of thorough documentation throughout the project.
- Require students to maintain documentation for code, design, and usage instructions.

Presentation:

- Require students to present their projects to the class, explaining their design choices, challenges faced, and how they overcame them.Top of Form

CIE Assessment Pattern (50 Marks – Theory) –

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	5	-	-
L3	Apply	10	5	5
L4	Analyze	5	5	5
L5	Evaluate	5	5	-
L6	Create	-	-	-

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	10
L3	Apply	20
L4	Analyze	10
L5	Evaluate	10
L6	Create	--

Suggested Learning Resources:

Text Books:

1. Bansal R.K., "Fluid Mechanics and Hydraulic Machines", 9th edition, Laxmi Publications (P)Ltd., New Delhi, 2018. ISBN 9788131808153

2. R.K. Rajput, "A Text Book of Fluid Mechanics and Hydraulic Machines", 6th edition, S. Chand, 2015. ISBN 9789385401374

Reference Books:

1. Yunus A. Cengel and John M. Cimbala., 'Fluid Mechanics', McGraw Hill, 4th Edition, 2017, ISBN-(13 digits): 978-9385401374

2. P.N. Modi and Seth, "Fluid Mechanics and Hydraulic Machines",22nd edition, Standard Book House, 2018.

Web links and Video Lectures (e-Resources):

- **https://onlinecourses.nptel.ac.in/noc22_ge24/preview**
- **https://biodesign.berkeley.edu/bioinspired-design-course/**
- https://www.youtube.com/watch?v=cwxXY9Qe8ss
- **https://www.youtube.com/watch?v=V2GvQXvjhLA**
- **https://nsf-gov-resources.nsf.gov/2023-03/Bio-inspired%20Design%20Workshop%20Report_2232327_October%202022_Final.508.pdf**

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Visit to any Hydraulic power plant
- Demonstration on working of Pumps /Turbines
- Demonstration on Flow measuring Devices
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare Fluid Mechanics and Machinery related Flowcharts.
  - Organizing Group wise discussions on issues

Seminars

NATIONAL SERVICE SCHEME

Course Code	**25NSS30, 25NSS40**	**Credits**	**00**
L:T:P:S	**0:0:0:0**	**CIE Marks (each Semester)**	**50**
TLP Contact Hours/sem	**15**	**SEE Marks**	**--**
TW & SL/Sem	**15**	**Total Marks**	**50 x 2 = 100**
Total Hours/sem	**30**	**Exam Hours**	**02**

Course outcomes:
At the end of the course, the student will be able to:

25NSSX0.1	Understand the importance of his / her responsibilities towards society.
25NSSX0.2	Analyse the environmental and societal problems/issues and will be able to design solutions for the same.
25NSSX0.3	Evaluate the existing system and to propose practical solutions for the same for sustainable development. Implement government or self-driven projects effectively in the field.
25NSSX0.4	Develop capacity to meet emergencies and natural disasters & practice national integration and social harmony in general.

Semester/ Course Code	CONTENT	COs	HOURS
3RD 25NSS30	1. Organic farming, Indian Agriculture (Past, Present and Future) Connectivity for marketing 2. Waste management–Public, Private and Govt organization, 5R's. 3. Developing Sustainable Water management system for rural areas and implementationapproaches. 4. Setting of the information imparting club for women leading to contribution in social and economic issues. 5. Preparing an actionable business proposal for enhancing the village income and approach for implementation. 6. Participation in Institution NSS Unit Cell campaigns.	25NSS30.1, 25NSS30.2, 25NSS30.3, 25NSS30.4	26 HRS
4TH 25NSS40	1. Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/ vocational education. 2. Contribution to any national level initiative of Government of India. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill developmentprograms etc. 3. Spreading public awareness under rural outreach programs. (minimum 5 programs). 4. Organize National integration and social harmony events / workshops / seminars. (Minimum TWO programs). 5. Govt. school Rejuvenation and helping them to achieve good infrastructure.	25NSS40.1, 25NSS40.2, 25NSS40.3, 25NSS40.4	26 HRS

	6. Participation in Institution NSS Unit Cell campaigns.		

CIE Assessment Pattern (50 Marks – Activity based) –

CIE component for every semester	Marks
Presentation - 1 Selection of topic, PHASE - 1	10
Commencement of activity and its progress - PHASE - 2	10
Case study-based Assessment Individual performance	10
Sector wise study and its consolidation	10
Video based seminar for 10 minutes by each student at the end of semester with Report.	10
Total marks for the course in each semester	**50**

- Implementation strategies of the project (NSS work).
- The last report should be signed by NSS Officer, the HOD and Principal.
- At last report should be evaluated by the NSS officer of the Institute.
- Finally, the consolidated marks sheet should be sent to the university and also to be made available at LIC visit.

Suggested Learning Resources:

Reference Books:

1. NSS Course Manual, Published by NSS Cell, VTU Belagavi.
2. Government of Karnataka, NSS cell, activities reports and its manual.
3. Government of India, NSS cell, Activities reports and its manual.

Pre-requisites to take this Course:

1. Students should have a service-oriented mindset and social concern.
2. Students should have dedication to work at any remote place, anytime with available resources and proper time management for the other works.
3. Students should be ready to sacrifice some of the time and wishes to achieve service-oriented targets on time.

Pedagogy:

- In every semester from 3rd semester to 4th semester, each student should do activities according to the scheme and syllabus.
- At the end of every semester student performance has to be evaluated by the NSS officer for the assigned activity progress and its completion.
- State the need for NSS activities and its present relevance in the society and provide real-life examples.
- Support and guide the students for self-planned activities.
- NSS coordinator will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress in real activities in the field.
- Encourage the students for group work to improve their creative and analytical skills.

Plan of Action:

- Student/s in individual or in a group Should select any one activity in the beginning of each semester till end of that respective semester for successful completion as per the instructions of NSS officer with the consent of HOD of the department.
- At the end of every semester, activity report should be submitted for evaluation.
- Practice Session Description:
    - Lecture session by NSS Officer

- Students Presentation on Topics
- Presentation - 1, Selection of topic, PHASE – 1
- Commencement of activity and its progress - PHASE – 2
- Execution of Activity
- Case study-based Assessment, Individual performance
- Sector/ Team wise study and its consolidation
- Video based seminar for 10 minutes by each student at the end of semester with Report.

Sl No	Topic	Groupsize	Location	Activity execution	Reporting	Evaluation of the Topic
1.	Organic farming, IndianAgriculture (Past, Present and Future) Connectivity for marketing.	May be individual or team	Farmers land/Villages/ roadside / Community area / College campus	Site selection /proper consultation/ Continuous monitoring/ Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
2.	Waste management– Public, Private and Govtorganization, 5 R's.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus	Site selection /proper consultation/ Continuous monitoring/ Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
3.	Developing SustainableWater management system for rural areas and implementation approaches.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus	site selection/pro per consultation/ Continuous monitoring/ Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
4.	Setting of the information imparting club for women leading to contributionin social and economic issues.	May be individual or team	Women empowerment groups/ Consulting NGOs & Govt Teams / College campus	Group selection/pro per consultation/ Continuous monitoring/ Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer

5.	Preparing an actionable business proposal for enhancing the village income and approach for implementation.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus	Group selection/proper consultation/ Continuous monitoring/ Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
1.	Helping local schools toachieve good results and enhance their enrolment in Higher/ technical/ vocational education.	May be individual or team	Local government / private/ aided schools/Government Schemes officers	School selection/proper consultation/ Continuous monitoring/ Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
2.	Contribution to any national level initiative of Government of India.For eg. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme,Skill development programs etc.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus	Group selection/proper consultation/ Continuous monitoring / Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
3.	Spreading public awareness under ruraloutreach programs. (minimum5 programs)	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus	Group selection/proper consultation/ Continuous monitoring / Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer

4.	Organize National integration and socialharmony events / workshops / seminars. (Minimum 02 programs).	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus	Place selection/proper consultation/ Continuous monitoring / Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
5.	Govt. school Rejuvenation and helping them to achieve good infrastructure.	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/ Government Schemes officers/ campus	Place selection/proper consultation/ Continuous monitoring / Information board	Report should be submitted byindividual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer

PHYSICAL EDUCATION AND SPORTS

Course Code	**25PED30, 25PED40**	**Credits**	**00**
L:T:P:S	**0:0:0:0**	**CIE Marks (each Semester)**	**50**
TLP Contact Hours/sem	**15**	**SEE Marks**	**--**
TW & SL/Sem	**15**	**Total Marks**	**50 x 2= 100**
Total Hours/sem	**30**	**Exam Hours**	**02**

Course outcomes:
At the end of the course, the student will be able to:

25PEDX0.1	Understand the fundamental concepts and skills of Physical Education, Health, Nutrition and Fitness
25PEDX0.2	Create consciousness among the students on Health, Fitness and Wellness in developing and maintaining a healthy lifestyle
25PEDX0.3	Perform in the selected sports or athletics of student's choice and participate in the competition at regional/state / national / international levels.
25PEDX0.4	Understand the roles and responsibilities of organization and administration of sports and games

Semester	CONTENT	COs	HOURS
3RD 25PED30	**Module 1: Orientation** A. Lifestyle, B. Fitness C. Food & Nutrition D. Health & Wellness E. Pre-Fitness test. **Module 2: General Fitness & Components of Fitness** A. Warming up (Free Hand exercises) B. Strength – Push-up / Pull-ups C. Speed – 30 Mtr Dash D. Agility – Shuttle Run E. Flexibility – Sit and Reach F. Cardiovascular Endurance – Harvard step Test **Module 3:** **Fitness Components:** Meaning and Importance, Fit India Movement, Definition of fitness, Components of fitness, Benefits of fitness, Types of fitness and Fitness tips. **Practical Components:** Speed, Strength, Endurance, Flexibility, and Agility **Athletics**: **Games (Anyone to be selected by the student)** A. Track -Sprints: 1. Starting Techniques: Standing start and Crouch start (its variations) use of Starting Block. 2. Acceleration with proper running techniques. 3. Finishing technique: Run Through, Forward Lunging and Shoulder Shrug.	25PED30.1, 25PED30.2, 25PED30.3, 25PED30.4	26 HRS

	B. Track -110 Mtrs and 400Mtrs: 1. Hurdling Technique: Lead leg Technique, Trail leg Technique, Side Hurdling, Over the Hurdles 2. Crouch start (its variations) use of Starting Block. 3. Approach to First Hurdles, In Between Hurdles, Last Hurdles to Finishing. C. Jumps- 1. Long Jump: Approach Run, Take-off, Flight in the air (Hang Style/Hitch Kick) and Landing 2. High jump: Approach Run, Take-off, Bar Clearance (Straddle) and Landing. D. Throws- 1. Discus Throw: Holding the Discus, Initial Stance Primary Swing, Turn, Release and Recovery (Rotation in the circle). 2. Shot Put: Holding the Shot, Placement, Initial Stance, Glide, Delivery Stance and Recovery (Perry O'Brien Technique)		
4TH 25PED40	**Module 1: Ethics and Moral Values** A. Ethics in Sports B. Moral Values in Sports and Games **Module 2: Recreational Activities** A. Postural deformities. B. Stress management. C. Aerobics D. Traditional Games. **Module 3: Role of Organization and administration** **Module 4: Specific Games (Anyone to be selected by the student)** **Handball:** A. Fundamental Skills 1. Catching, Throwing and Ball control, 2. Goal Throws: Jumpshot, Centershot, Diveshot, Reverseshot. 3. Dribbling: High and low. 4. Attack and counter attack, simple counter attack, counter attack from two wings and center. 5. Blocking, Goal Keeping and Defensive skills. 6. Game practice with application of Rules and Regulations. B. Rules and their interpretations and duties of officials **Ball badminton:** A. Fundamental Skills 1. Basic Knowledge: Various parts of the Racket and Grip. 2. Service: Short service, Long service, Long-high service. 3. Shots: Overhead shot, Defensive clearshot, Attacking clearshot, Dropshot, Netshot, Smash. 4. Game practice with application of Rules and Regulations. B. Rules and their interpretation and duties of officials. **Football:** A. Fundamental Skills 1. Kicking: Kicking the ball with inside of the foot, Kicking the ball with Full Instep of the foot, Kicking the ball with Inner Instep of the foot, Kicking the ball with Outer Instep of the foot and Lofted Kick.	25PED40.1, 25PED40.2, 25PED40.3, 25PED40.4	26 HRS

	2. Trapping: Trapping- the Rolling ball, and the Bouncing ball with sole of the foot. 3. Dribbling: Dribbling the ball with Instep of the foot, Dribbling the ball with Inner and Outer Instep of the foot. 4. Heading: In standing, running and jumping condition. 5. Throw-in: Standing throw-in and Running throw-in. 6. Feinting: With the lower limb and upper part of the body. 7. Tackling: Simple Tackling, Slide Tackling. 8. Goal Keeping: Collection of Ball, Ball clearance-kicking, throwing and deflecting. 9. Game practice with application of Rules and Regulations. B. Rules and their interpretation and duties of officials. **Hockey:** A. Fundamental Skills 1. Passing: Short pass, Longpass, pushpass, hit 2. Trapping. 3. Dribbling and Dozing 4. Penalty stroke practice. 5. Penalty corner practice. 6. Tackling: Simple Tackling, Slide Tackling. 7. Goal Keeping, Ball clearance- kicking, and deflecting. 8. Game practice with application of Rules and Regulations. B. Rules and their interpretation and duties of officials		

CIE Assessment Pattern (50 Marks – Practical) –

CIE to be evaluated every semester end based on practical demonstration of Sports and Athletics activities learnt in the semester.

CIE	Marks
Participation of student in all the modules	10
Quizzes – 2, each of 7.5 marks	15
Final presentation / exhibition / Participation in competitions/ practical on specific tasks assigned to the students	25
Total	50

Suggested Learning Resources:

Reference Books:

1. Saha, A.K. Sarir Siksher Ritiniti, Rana Publishing House, Kalyani.
2. Bandopadhyay, K. Sarir Siksha Parichay, Classic Publishers, Kolkata.
3. Petipus, et.al., Athlete's Guide to Career Planning, Human Kinetics.
4. Dharma, P.N. Fundamentals of Track and Field, Khel Sahitya Kendra, New Delhi.
5. Jain, R. Play and Learn Cricket, Khel Sahitya Kendra, New Delhi.
6. Vivek Thani, Coaching Cricket, Khel Sahitya Kendra, New Delhi.
7. Saha, A.K. Sarir Siksher Ritiniti, Rana Publishing House, Kalyani.
8. Bandopadhyay, K. Sarir Siksha Parichay, Classic Publishers, Kolkata
9. Naveen Jain, Play and Learn Basketball, Khel Sahitya Kendra, New Delhi.

10. Dubey H.C., Basketball, Discovery Publishing House, New Delhi.
11. Rachana Jain, Teach Yourself Basketball, Sports Publication.
12. Jack Nagle, Power Pattern Offences for Winning basketball, Parker Publishing Co., New York.
13. Renu Jain, Play and Learn Basketball, Khel Sahitya Kendra, New Delhi.
14. SallyKus, Coaching Volleyball Successfully, Human Kinetics.

YOGA

Course Code	**25YOG30, 25YOG40**	**Credits**	**00**
L:T:P:S	**0:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours/sem	**15**	**SEE Marks**	**--**
TW & SL/Sem	**15**	**Total Marks**	**50 x 2 = 200**
Total Hours/sem	**30**	**Exam Hours**	**02**

Course outcomes:
At the end of the course, the student will be able to:

25YOGX0.1	Understanding the origin, history, aim and objectives of Yoga
25YOGX0.2	Become familiar with an authentic foundation of Yogic practices
25YOGX0.3	Practice different Yogic methods such as Suryanamaskara, Pranayama and some
25YOGX0.4	Use the teachings of Patanjali in daily life.

Semester / Course Code	CONTENT	COs	HOURS
3rd 25YOG30	**Introduction of Yoga:** Aim and Objectives of yoga, Prayer: Yoga, its origin, history and development. Yoga, its meaning, definitions. Different schools of yoga, importance of prayer **Brief introduction of yogic practices for common man:** Yogic practices for common man to promote positive health **Rules and regulations:** Rules to be followed during yogic practices by practitioner **Misconceptions of yoga:** Yoga its misconceptions, Difference between yogic and non-yogic practices. **Suryanamaskara:** 1. Suryanamaskar prayer and its meaning, Need, importance and benefits of Suryanamaskar. 2. Suryanamaskar 12 count,2rounds **Kapalabhati:** 40strokes/min 3rounds **Different types of Asanas with Brief introduction and importance:** 1. Sitting: Padmasana, Vajrasana, Sukhasana 2. Standing: Vrikshana, Trikonasana, Ardhakati Chakrasana 3. Prone line: Bhujangasana, Shalabhasana 4. Supineline: Utthitadvipadasana, Ardhahalasana	25YOG30.1, 25YOG30.2, 25YOG30.3, 25YOG30.4	26 Hrs
4TH 25YOG40	**Suryanamaskara:** Suryanamaskar 12 count,4rounds **Brahmari Pranayama** **Different types of Asanas with Brief introduction and importance:** 1. Sitting: Paschimottanasana, Ardha Ushtrasana, Vakrasana, Aakarna Dhanurasana 2. Standing: Parshva Chakrasana, Urdhva Hastothanasana, Hastapadasana 3. Prone line: Dhanurasana 4. Supine line: Sarvangasana, Chakraasana 5. Balancing: Sheershasana **Patanjali's Ashtanga Yoga**: Asana, Pranayama	25YOG40.1, 25YOG40.2, 25YOG40.3, 25YOG40.4	26 Hrs

	Pranayama: Chandra Bhedana, Nadishodhana, Surya Bhedana **Shat Kriyas:** Jalaneti and sutraneti, Sheetkarma Kapalabhati		

CIE Assessment Pattern (50 Marks – Practical)

CIE to be evaluated every semester based on practical demonstration of Yogasana learnt in the semester and internal tests (objective type)

CIE	Marks
Avg of Test 1 and Test 2	25
Demonstration of Yogasana	25
Total	**50**

Suggested Learning Resources:

Reference Books:

4. Swami Kuvulyananda: Asma (Kavalyadhama, Lonavala)
5. Tiwari, O P: Asana Why and How
6. Ajitkumar: Yoga Pravesha (Kannada)
7. Swami Satyananda Saraswati: Asana Pranayama, Mudra, Bandha (Bihar School of yoga, Munger)
8. Swami Satyananda Saraswati: Surya Namaskar (Bihar School of yoga, Munger)
9. Nagendra H R: The art and science of Pranayama
10. Tiruka: Shatkriyegalu (Kannada)
11. Iyengar B K S: Yoga Pradipika (Kannada)
12. Iyengar B K S: Light on Yoga (English)

Web links and Video Lectures (e-Resources):

- **https://youtu.be/KB-TYlgd1wE**
- **https://youtu.be/aa-TG0Wg1Ls**

MUSIC			
Course Code	**25MUS30, 25MUS40**	**Credits**	**00**
L:T:P:S	**0:0:0:0**	**CIE Marks (each Semester)**	**50**
TLP Contact hours/sem	**15**	**SEE Marks**	**--**
TW & SL /sem	**15**	**Total Marks**	**50 x 2 = 100**
Total Hours/sem	**30**	**Exam Hours**	**2**

Course outcomes:
At the end of the course, the student will be able to:

25MUSX0.1	Identify and understand the origins and evolution of the Indian music system and its fundamental concepts
25MUSX0.2	Analyze and practice various types of compositions in Carnatic music and relate to different musical traditions
25MUSX0.3	Demonstrate knowledge of major composers and their contributions to Indian classical music
25MUSX0.4	Classify and understand various musical instruments and their construction

Semester / Course Code	CONTENT	COs	HOURS
3rd 25MUS30	**Origin of Indian Music** - Evolution of the Indian music system, Understanding of Shruthi, Nada, Swara, Taya, Raga, Tala, and Mla. Study of the fundamental concepts that form the foundation of Carnatic music. **Compositions in Carnatic Music** - Introduction to types of compositions including Geethe, Jathi, Swara, Swarajathi, Varna, Krithi, and Thillana. Understanding of notation systems and their application in musical compositions. **Composers and Their Contributions** - Biography and musical contributions of Purandaradasa (founder of Carnatic music pedagogy), Thyagaraja (prolific composer and saint), and Mysoro Vasudevacharya. Study of their impact on Indian classical music traditions. **Abhyasa Gana - Practical Training**- Singing of Sarale Varase exercises and notation writing. Introduction to Suladi Sapthatala. Singing of 2 Geethe in Malahiri. Foundation for practical music experience.	25MUS30.1, 25MUS30.2, 25MUS30.3, 25MUS30.4	26 Hrs

4TH 25MUS40	**Classification of Musical Instruments** - Classification and construction of string instruments (Veena, Sitar), wind instruments (Flute, Shehnai), percussion instruments (Mridangam, Tabla), and Idiophones (Ghana Vaadya - Gongs, Cymbals). Examples and characteristics of each class of instruments. **Abhyasa Gana - Practical Training**- Continuation of singing exercises including Sarale Varase at varying speeds. Complete notation writing for Sarale Varase and Suladi Sapthatala in Mayamalavagowla Raga. Singing of 2 additional Geethe in Malahiri, one Jathi Swara, and one Krithi in a Mela raga. Advanced practical music training.	25MUS40.1, 25MUS40.2, 25MUS40.3, 25MUS40.4	26 Hrs

CIE Assessment Pattern (50 Marks – Practical)

CIE to be evaluated every semester based on practical demonstration of Singing/Playing learnt in the semester and internal tests (MCQ type)

CIE	Marks
Avg of Test 1 and Test 2	20
Practical test on: a. Recite one Sarale Varase mentioned by the examiner in three speeds. b. Sing/Play the Geethe in Malahari. c. Singing/Playing Jathi Swara/Krithi.	30
Total	**50**

Textbooks:

1.Vidushi Vasantha Madhavi, "Theory of Music", Prism Publication, 2007.

2.T Sachidevi and T Sharadha (Thirumalai Sisters), Karnataka Sangeetha Dharpana - Vol.1 (English), Shreenivaas Prakaashana, 2018.

References:

1. Lakshminarayana Subramiam, Viji Subramaniam, "Classical Music of India: A Practical Guide", Tranqueber 2018.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=ihFDT8ZBPxE
- https://www.youtube.com/watch?v=4XXl5tTXa0I
- **https://www.youtube.com/watch?v=n-60gfzGa1E**
- **https://www.youtube.com/watch?v=Vv_K7J7gx6M**
- **https://www.youtube.com/watch?v=BovAAPumYUo**
- **https://www.youtube.com/watch?v=F_aWPATb8V4**
- **https://www.youtube.com/watch?v=DPPCRWA3hXo**
- **https://www.youtube.com/watch?v=TuP00NK9eTM**
- **https://www.youtube.com/watch?v=LlolyBzZtdg**

BASIC APPLIED MATHEMATICS - II

Course Code	**25DMAT41**	**Credits**	**0**
L:T:P:S	**0:0:0:0**	**CIE Marks**	**50**
TLP Contact Hours / Sem	**15**	**SEE Marks**	**--**
TW & SL / Sem	**15**	**Total Marks**	**50**
Total Hours /Sem	**30**	**Exam Hours**	**--**

Course outcomes:

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

25DMAT41.1	Understand the least squares method to fit linear, quadratic, and exponential curves to experimental data.
25DMAT41.2	Solve first-order and first-degree differential equations and interpret their solutions in engineering and scientific applications.
25DMAT41.3	Analyze higher-order linear differential equations solutions encountered in engineering systems.
25DMAT41.4	Apply the double and triple integrals concepts to compute the areas and volumes of engineering domains.
25DMAT41.5	Analyze the Laplace transforms and apply their properties to simplify mathematical models of engineering systems.
25DMAT41.6	Apply Laplace transform techniques to solve linear differential equations arising in the engineering applications.

MODULE-1	**STATISTICAL ANALYSIS**	**25DMAT41.1**	**3 Hours**

Fitting of the linear curves, quadratic curves and exponential curves by least square method. Correlation, Coefficient of correlation and Lines of Regression.

Self-study	Fitting of the geometric curves.
Text Book	Text Book 1: 24.5, 25.12, 25.13, 25.14

MODULE-2	**ORDINARY DIFFERENTIAL EQUATIONS**	**25DMAT41.2 25DMAT41.3**	**3 Hours**

Solution of first order and first-degree differential equations – Exact differential equations. Solution of second and higher order homogeneous and non-homogeneous (e^{ax}, $\sin ax$, $\cos ax$) linear differential equations.

Self-study	Solution of first order linear differential equations
Text Book	Text Book 1: 11.11, 11.12, 13.5

MODULE-3	**INTEGRAL CALCULUS**	**25DMAT41.4**	**3 Hours**

Evaluation of double integrals, evaluation of double integrals by change of order of integration, double integrals in polar coordinates, Area enclosed by plane curves, Evaluation of triple integrals.

Self-study	Evaluation of double integrals over the region of integration.
Text Book	Text Book 1: 7.1, 7.2, 7.3.

MODULE-4	**LAPLACE TRANSFORMS**	**25DMAT41.5**	**3 Hours**

Definition and Laplace transform of simple functions, Properties of Laplace transforms -Shifting property problems, Laplace transform of Periodic functions problems.

Self-study	Laplace transform of elementary functions
Text Book	Text Book 1: 21.3, 21.4, 21.5, Text Book 2: 6.1.

MODULE-5	**INVERSE LAPLACE TRANSFORMS**	**25DMAT41.6**	**3 Hours**

Inverse Laplace Transform by partial fractions and completing square forms. Solution of linear differential equations using Laplace Transform techniques.

Self-study	Inverse Laplace transform of simple functions
Text Book	Text Book 1: 21.12, 21.15, Text Book 2: 6.4.

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	AAT1	AAT2
		25	15	10
L1	Remember	-	-	-
L2	Understand	5	-	-
L3	Apply	10	5	5
L4	Analyze	10	5	5
L5	Evaluate	-	5	-
L6	Create			-

Suggested Learning Resources:

Text Books:

1) B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, Forty fourth Edition, 2022, 9788193328491.
2) Erwin Kreyszig, Advanced Engineering Mathematics, Wiley-India Publishers, Tenth Edition, Reprint ISBN: 9788126554232.

Reference Books:

1) Glyn James, Advanced Modern Engineering Mathematics, Pearson Education, Fourth Edition, 2015, 9780273719236
2) B. V. Ramana, Higher Engineering Mathematics, McGraw Hill Education (India) Private Limited, 4th E 2017, ISBN: 9780070634190
3) H. K. Dass, Advanced Engineering Mathematics, S. Chand & Company Ltd., Twenty Second Edition, 2018 9789352533831
4) N. P. Bali and Manish Goyal, A Text Book of Engineering Mathematics, Laxmi Publications (P) Ltd., 9th Ed 2014, ISBN: 9788131808320

Web links and Video Lectures (e-Resources):

- https://youtu.be/SaNDPSk1UVM?si=FRxMnRi1btCUIscK
- https://youtu.be/HxrLu-qRJKc?si=pKc9XOCllBx-H4Wp
- https://youtu.be/ma1QmE1SH3I?si=Hoo3_cjiIds203os
- https://youtu.be/TKBXey91Gc4?si=JjZfQvJxdxN8I6YQ
- https://youtu.be/1THkFmuIPXM?si=pc9VvmZ-9cQe_Wr_
- https://youtu.be/m7jH0jfRf2I?si=OOEWttfQhieJ9wih
- https://youtu.be/qFnoRfZknBY?si=BeMrhMF3LML4hBGa
- https://youtu.be/n9XP6pljtw8?si=3gU-XKgt5JIZe9LE

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Problem solving Approach
- Organizing Group wise discussions on related topics
- Seminars

Appendix A: List of Assessment Patterns

S.NO	Pattern of Assessments
1	Assignments
2	Group Discussions
3	Case Study / Caselets
4	Practical-Orientation on Design Thinking
5	Participatory & Industry-Integrated Learning
6	Practical Activities / Problem Solving Exercises
7	Class Presentations
8	Analysis of Industry / Technical / Business Reports
9	Reports on Industrial Visit
10	Industrial / Social / Rural Projects
11	Participation in external seminars / Workshops
12	Any Other Academic Activity
13	Online / Offline Quizzes

APPENDIX B: Outcome Based Education

Outcome-based education (OBE) is an educational theory that bases each part of an educational system around goals (outcomes). By the end of the educational experience each student should have achieved the goal. There is no specified style of teaching or assessment in OBE; instead classes, opportunities, and assessments should all help students achieve the specified outcomes.

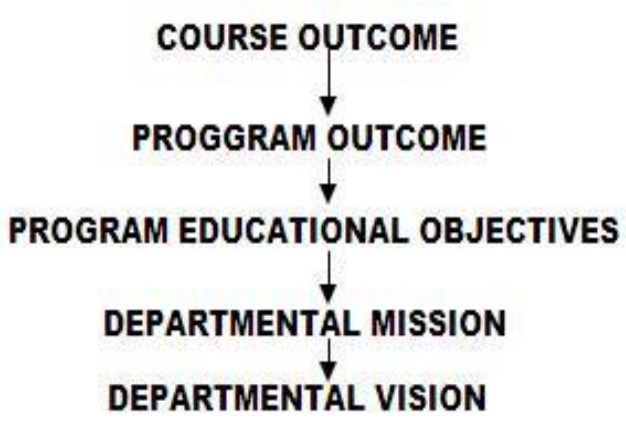
There are three educational Outcomes as defined by the National Board of Accreditation:

Program Educational Objectives: The Educational objectives of an engineering degree program are the statements that describe the expected achievements of graduate in their career and also in particular what the graduates are expected to perform and achieve during the first few years after graduation. [nbaindia.org]

Program Outcomes: What the student would demonstrate upon graduation. Graduate attributes are separately listed in Appendix C

Course Outcome: The specific outcome/s of each course/subject that is a part of the program curriculum. Each subject/course is expected to have a set of Course Outcomes

Mapping of Outcomes



APPENDIX C: The Graduate Attributes of NBA

Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5).

Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)..

Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6).

The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7) .

Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9).

Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

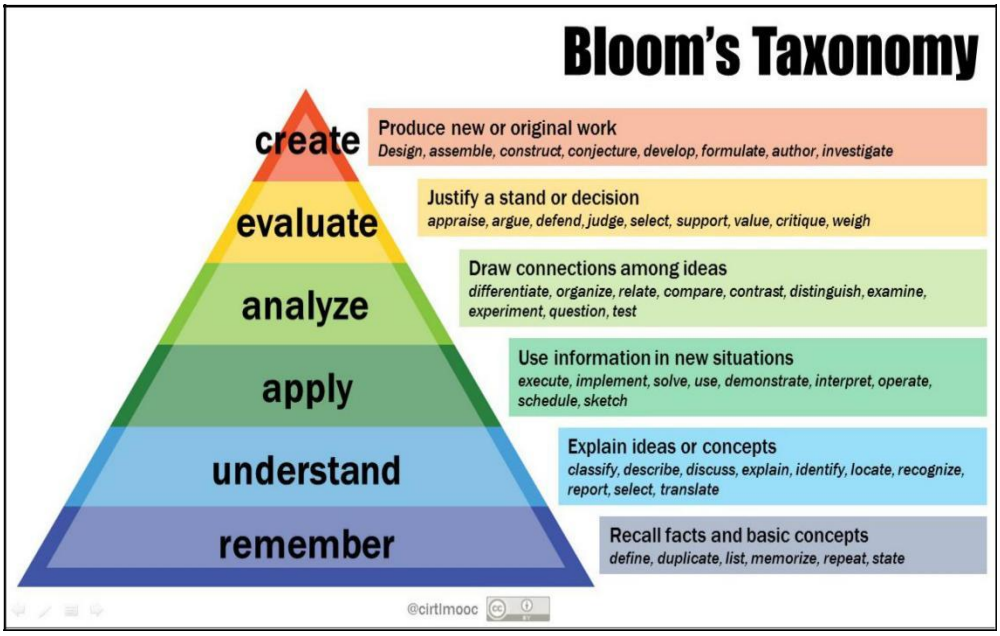
Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.

Project management and finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments..

Life-long learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8).

APPENDIX D: BLOOM'S TAXONOMY

Bloom's taxonomy is a classification system used to define and distinguish different levels of human cognition—i.e., thinking, learning, and understanding. Educators have typically used Bloom's taxonomy to inform or guide the development of assessments (tests and other evaluations of student learning), curriculum (units, lessons, projects, and other learning activities), and instructional methods such as questioning strategies.



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