NEW HORIZON
COLLEGE OF ENGINEERING

Department of Mechanical Engineering

Academic Year 2024-25

5th and 6th Semester

Scheme & Syllabus

BATCH: 2022-26

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

PROGRAM OUTCOMES (POs)

Graduate Attributes	PO #	Program Outcomes
Engineering knowledge	1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex mechanical engineering problems
Problem Analysis	2	Identify, formulate, review research literature, and analyze complex engineering problems in Mechanical Engineering reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
Design Development of Solutions	3	Design solutions for complex engineering problems and design system components or processes of Mechanical Engineering that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
Conduct Investigations of Complex Problems	4	Use research-based knowledge and research methods including design of experiments in Mechanical Engineering, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
Modern tool usage	5	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities in Mechanical Engineering with an understanding of the limitations.
The Engineer and society	6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice in Mechanical Engineering.
Environment and Sustainability	7	Understand the impact of the professional engineering solutions of mechanical Engineering in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
Ethics	8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
Individual & team work	9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
Communication	10	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
Project management and finance	11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, manage projects and in multidisciplinary environments.
Lifelong learning	12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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

V Semester Scheme													
Sl. No.	Course and Course Code		Course Title	BoS	Credit Distribution				Overall Credits	Contact Hours	Marks		
					L	T	P	S			CIE	SEE	Total
1	HSMS	22MEE51	Operation Research and Management	ME	3	0	0	0	3	3	50	50	100
2	PCC	22MEE52	Heat Power Cycles	ME	3	0	0	0	3	3	50	50	100
3	PCCL	22MEL52	Heat Power Cycles Lab	ME	0	0	1	0	1	2	50	50	100
4	PCC	22MEE53	Theory of Machines	ME	3	0	0	0	3	3	50	50	100
5	PCCL	22MEL53	Theory of Machines Lab	ME	0	0	1	0	1	2	50	50	100
6	PEC	22MEE54X	Professional Elective Course-I	ME	3	0	0	0	3	3	50	50	100
7	AEC	22RMK55	Research Methodology and IPR	ME	1	1	0	0	2	3	50	50	100
8	AEC	22SDK56	Critical and Creative Thinking Skills	ME	0	0	1	0	1	2	50	--	50
9	UHV	22ESK57	Environmental Studies	Any Dept	1	0	0	0	1	1	50	50	100
10	PROJ	22MEE58	Mini Project-II	ME	0	0	1	0	1	0	50	50	100
11	NCMC	22NSS50	National Service Scheme (NSS)	ME	0	0	0	0	0	2	50	--	50
		22PED50	Physical Education (PE) (Sports and Athletics)	ME									
		22YOG50	Yoga	ME									
Total									**19**	**24**	**550**	**450**	**1000**

PCC: Professional Core Course, PCCL: Professional Core Course laboratory, UHV: Universal Human Value Course, NCMC: Non-Credit Mandatory Course, AEC: Ability Enhancement Course, PEC: Professional Elective Course, PROJ: Mini Project work L: Lecture, T: Tutorial, P: Practical S: SDA: Self Study for Skill Development, CIE: Continuous Internal Evaluation, SEE: Semester End Evaluation

Professional Elective Course-I			
22MEE541	Non Destructive Testing	22MEE544	Electric Vehicles and Battery Management System
22MEE542	Composite Materials	22MEE545	Competitive Coding
22MEE543	Statistics for Engineers		

22XXX51(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 Management
For Core Branches: Engineering Economics and Management / Industrial Management and Entrepreneurship

Mini-project work: Mini Project is a laboratory-oriented/hands on course that will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications etc. Based on the ability/abilities of the student/s and recommendations of the mentor. A student can do mini project as

(i) A group of 2 if mini project work is single discipline (applicable to all IT allied branches)

(ii) A group of 2- 4 if mini project work is single discipline (applicable to all Core Branches)

(iii) A group of 2 - 4 students if the Mini Project work is a multidisciplinary (Applicable to all Branches)

CIE procedure for Mini-project:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batches mates.

(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 Mini-project, shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the percentage ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses can be added to supplement the latest trend and advanced technology in the selected stream of engineering.

National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE) (Sports and Athletics), and Yoga (YOG) with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 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, and Yoga 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.

Credit Definition: 1-hour Lecture (L) per week=1Credit 2-hoursTutorial(T) per week=1Credit 2-hours Practical / Drawing (P) per week=1Credit 2-hous Self Study for Skill Development (SDA) per week = 1 Credit	03-Credits courses are to be designed for 40 hours in Teaching-Learning Session 02- Credits courses are to be designed for 25 hours of Teaching-Learning Session 01-Credit courses are to be designed for 15 hours of Teaching-Learning Sessions

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

VI Semester Scheme													
S. No.	Course and Course Code		Course Title	BoS	Credit Distribution				Overall Credits	Contact Hours	Marks		
					L	T	P	S			CIE	SEE	Total
1	PCC	22MEE61	Machine Design	ME	3	0	0	0	3	3	50	50	100
2	PCCL	22MEL61	Machine Design Lab	ME	0	0	1	0	1	2	50	50	100
3	PCC	22MEE62	Finite Element Methods	ME	3	0	0	0	3	3	50	50	100
4	PCCL	22MEL62	Finite Element Methods Lab	ME	0	0	1	0	1	2	50	50	100
5	PCC	22MEE63	Emerging Automotive Technologies	ME	2	1	0	0	3	4	50	50	100
6	PEC	22MEE64X	Professional Elective Course-II	ME	3	0	0	0	3	3	50	50	100
7	PROJ	22MEE65	Project Phase I	ME	0	0	2	0	2	0	50	50	100
8	AEC	22SDK66	Problem Solving Skills	ME	0	0	1	0	1	2	50	--	50
9	AEC	22MEE67X	Ability Enhancement Course – V	ME	If the course is a Theory						50	50	100
					1	0	0	0	1	1			
					If the course is a laboratory								
					0	0	1	0	1	2			
10	OEC	23NHOP6XX	Industrial Open Elective Course-I	Offering Dept.	3	0	0	0	3	3	50	50	100
11	NCMC	22NSS60	National Service Scheme (NSS)	NSS coordinator	0	0	0	0	0	2	50	--	50
		22PED60	Physical Education (PE) (Sports and Athletics)	Physical Education Director									
		22YOG60	Yoga	Yoga Teacher									
Total									**21**	**25/26**	**550**	**450**	**1000**

PCC: Professional Core Course, PCCL: Professional Core Course laboratory, NCMC: Non-Credit Mandatory Course, AEC: Ability Enhancement Course, PEC: Professional Elective Course, OEC: Open Elective Course, PROJ: Project work, L: Lecture, T: Tutorial, P: Practical S: SDA: Self Study for Skill Development, CIE: Continuous Internal Evaluation, SEE: Semester End Evaluation.

Professional Elective Course-II			
22MEE641	Non Traditional Machining	22MEE644	MEMS and Microsystem Technology
22MEE642	Autonomous Vehicles	22MEE645	Instrumentation Engineering
22MEE643	Mechatronics		

Ability Enhancement Course – V			
22MEE671	R-Programming	22MEE674	Introduction to Cloud Computing
22MEE672	Renewable Energy Resources	22MEE675	3D printing Technology
22MEE673	Workshop Technology		

Industrial Open Elective Courses-I:
Credit for OEC is 03 (L: T: P: S) can be considered as (3: 0: 0 : 0). The teaching and learning of these Courses will be based on hands-on. The Course Assessment will be based on CIE and SEE in practical mode. This Courses will be offered by Centre of Excellence to students of all the branches. Registration to Industrial open electives shall be documented and monitored on college level.

Project Phase-I: Students have to discuss with the mentor /guide and with their help he/she has to complete the literature survey and prepare the report and finally define the problem statement for the project work.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses can be added to supplement the latest trend and advanced technology in the selected stream of engineering.

National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE) (Sports and Athletics), and Yoga (YOG) with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 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, and Yoga 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.

Credit Definition: 1-hour Lecture (L) per week=1Credit 2-hoursTutorial(T) per week=1Credit 2-hours Practical / Drawing (P) per week=1Credit 2-hous Self Study for Skill Development (SDA) per week = 1 Credit	03-Credits courses are to be designed for 40 hours in Teaching-Learning Session 02- Credits courses are to be designed for 25 hours of Teaching-Learning Session 01-Credit courses are to be designed for 15 hours of Teaching-Learning Sessions

V Semester Syllabus

OPERATION RESEARCH AND MANAGEMENT

Course Code	**22MEE51**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**03**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

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

22MEE51.1	Apply basic principles of project management for real time projects.
22MEE51.2	Understand entrepreneurship as an individual or as a group by creating awareness on its needs and roles with respect to growth of economic development
22MEE51.3	Develop solutions for barriers in small scale industries.
22MEE51.4	Estimating the interest rates, cash flows and costing materials, production and overheads
22MEE51.5	Analyze the sequence of jobs on various machines.
22MEE51.6	Identify the significance of Game theory and determine the optimal solution.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22MEE51.1	3	2	1	-	-	-	-	-	-	-	-	-	-	2
22MEE51.2	2	1	-	-	-	-	-	-	-	-	-	-	-	2
22MEE51.3	3	3	2	1	-	-	-	-	-	-	-	-	-	2
22MEE51.4	2	2	-	-	-	-	-	-	-	-	-	-	-	2
22MEE51.5	3	2	2	-	-	-	-	-	-	-	-	-	-	2
22MEE51.6	2	1	-	-	-	-	-	-	-	-	-	-	-	2

MODULE-1	**Basics of Project Management**	**22MEE51.1**	**8 Hours**

Introduction, Definition of project, characteristics of projects, types of projects, need for project management, phases of project life cycle management, impact of delays in project completions, roles and responsibilities of project leader. Concept of Just-In-Time.

Applications	Create project management plan by taking any real time project as example.
Text Book	Text Book 1: 1.1, 1.1, 1.8, 1.9, 1.10, 1.18, 1.16.

MODULE-2	**ENTREPRENEUR AND SSI**	**22MEE51.2 22MEE51.3**	**8 Hours**

Meaning of Entrepreneur, Functions of an Entrepreneur, Types of Entrepreneur, Stages in entrepreneurial process, Role of entrepreneurs in Economic Development, Entrepreneurship in India, women entrepreneurs, Entrepreneurship and its Barriers,SSI Impact of Liberalization, Privatization, Globalization on SSI Effect of WTO/GATT Supporting Agencies of Government for SSI, Meaning, Nature of support, Objectives, Functions, Types of Help.

Case Study	Small Scale Industries which are mainly focused on women empowerment.
Text Book	Text Book 1: 2.2, 2.3, 2.4 to 2.15

MODULE-3	**PERT-CPM TECHNIQUES**	**22MEE51.4**	**8 Hours**

Network construction, determining critical path, floats, scheduling by network, project duration, variance under probabilistic models, prediction of date of completion, crashing of simple networks, time-cost trade off procedure			
Case Study	Case study on PERT- CPM by taking any real time examples.		
Text Book	Text Book 2: 2.1 to 2.10		
MODULE-4	**SEQUENCING**	**22MEE51.5**	**8 Hours**
Basic assumptions, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule- 'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing 2 jobs on 'm' machines using graphical method.			
Case Study	sequencing by taking any real time examples.		
Text Book	Text Book 3 : Chapter 11.1, 11.2, 11.3		
MODULE-5	**GAMETHEORY**	**22MEE51.6**	**8 Hours**
Formulation of games, Two person-Zero sum game, games with and without saddle point, Graphical solution (2x n, m x 2 game), dominance property.			
Case S t u d y	Game theory by taking any real time examples.		
Text Book	Text Book 3: Chapter 14.2, 14.3,14.6		

CIE Assessment Pattern (50 Marks – Theory) –

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

Suggested Learning Resources:

Text Books:

1. Contemporary Project Management, Timothy J Kloppenborg, Cengage Learning, 2 nd Edition, ISBN: 97881315187,2020
2. Operations Research: An Introduction, H A Taha,Pearson; 10th edition (17 January2017), ISBN-13: 978-1292165547,2021
3. Engineering Economy, Thuesen H.G. PHI , 2012 ISBN-13: 978-0-07-337630-1,2020
4. Operatio n Research, S D Sharma, KedarNathRamNath publication, 2014 edition,ISBN-13: 1234567142552, 2019

Reference Books

1. Engineering Economy, Riggs J.L., 4 TH ed. , McGraw Hill, 2012 ISBN:978-0070586703,2019
2. Project Management a System approach to Planning Scheduling & Controlling, Harold Kerzner, CBS Publishers and Distributors.2nd Ed., ISBN: 9788123908670,2018

Web links and Video Lectures (e-Resources):

- **https://www.youtube.com/watch?v=rBSCvPYGnTc**
- **https://www.youtube.com/watch?v=DiFTdX6-7ks**
- **https://www.youtube.com/watch?v=84Ejjd9YP8I&list=PLSGws_74K018S9XgERU9IA-M0z1l8XcFs**
- **https://www.youtube.com/watch?v=jonespBF9yk&list=PLabr9RWfBcnowGFvsQI07doSE6t8xXDTX**
- **https://www.youtube.com/watch?v=c6CpNqdJWDw**
- **https://www.youtube.com/watch?v=ky08C8uoPok**
- **https://www.youtube.com/watch?v=bln0V6lAXWg**
- **https://www.youtube.com/watch?v=fSuqTgnCVRg**
- **https://www.youtube.com/watch?v=YJvbxAvxkDc**
- **https://www.youtube.com/watch?v=KUskbAasVCY**

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

- Visit to any manufacturing/aero/auto industry/ R&D Center
- Demonstration of project management by taking any real time examples
- Demonstration of implementation of game theory in industries.
- Demonstration of application of sequencing in the industries
- Motivational videos from women entrepreneurs.
- For active participation of students, instruct the students to prepare Flowcharts and Handouts
- Organizing Group wise discussions on issues

HEAT POWER CYCLES

Course Code	**22MEE52**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**03**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22MEE52.1	Apply the theoretical knowledge of internal combustion engines to analyze the performance and emission characteristics
22MEE52.2	Understand various thermodynamic cycles used in IC engines
22MEE52.3	Design and optimize gas turbine and jet engine components and systems for improved performance, efficiency, and reliability.
22MEE52.4	Utilize software and computational tools to model and simulate thermodynamic systems and processes
22MEE52.5	Analyze the environmental impact of refrigeration and air conditioning systems, including issues related to global warming potential (GWP) and ozone depletion potential (ODP), and strategies to mitigate these impacts.
22MEE52.6	Apply the principles of conduction, convection, and radiation heat transfer to practical problems

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22MEE52.1	3	3	-	-	-	-	-	-	-	-	-	-	-	3
22MEE52.2	3	3	-	-	-	-	-	-	-	-	-	-	-	3
22MEE52.3	3	3	3	-	-	-	-	-	-	-	-	-	-	3
22MEE52.4	3	2	-	-	3	-	-	-	-	-	-	-	-	3
22MEE52.5	3	-	-	-	-	-	3	-	-	-	-	-	-	3
22MEE52.6	3	-	-	-	-	-	-	-	-	-	-	-	-	3

MODULE-1	**RECIPROCATING INTERNAL COMBUSTION ENGINES**	**22MEE52.1 22MEE52.4 22MEE52.6**	**8 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**	**22MEE52.2**	**8 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**	**22MEE52.3 22MEE52.4 22MEE52.6**	**8 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**	**22MEE52.5 22MEE52.6**	**8 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- 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**	**22MEE52.5 22MEE52.6**	**8 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 Psychrometric process, Air conditioning systems, design of Cooling towers and its parameters, duct design Problems on with and without using Psychrometric chart.			
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)	Qualitative Assessment (s)	MCQ's
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	-	-
L3	Apply	5	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	10
L2	Understand	10
L3	Apply	10
L4	Analyze	10
L5	Evaluate	10
L6	Create	--

Suggested Learning Resources:

Text Books:

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

Reference Books:

1) Applied Thermodynamics for Engineering Technologies ,Fifth Edition By T.D.EASTOP and A. McCONKEY, Pearson Education,ISBN13: 9780582091931
2) Fundamentals of Engineering Thermodynamics by Moran M. J. and H. N. Shapiro, 8th Edition, ISBN : 978-1-118-82044-5
3) Thermodynamics: An Engineering Approach by Cengel Y. A. and Boles M. A, 8th Ed, ISBN:9789339221652
4) Principles of Refrigeration by Dossat R. J. and Horan T. J.
   Refrigeration and Air-conditioning by Arora C. P, 3rd Ed, 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	**22MEL52**	**CIE Marks**	**50**
L:T:P:S	**0:0:1:0**	**SEE Marks**	**50**
Hrs / Week	**2**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**03**

Course outcomes:

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

22MEL52.1	Analyze the performance and emission characteristics of IC engines engines
22MEL52.2	Understand advanced concepts such as variable valve timing (VVT) and its role in modern engine technology.
22MEL52.3	Evaluate the performance of refrigeration and air conditioning systems
22MEL52.4	Identify, assemble and disassemble the different parts of IC engine

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22MEL52.1	3	2	2	-	2	-	2	-	-	-	-	-	-	3
22MEL52.2	3	-	-	-	2	-	-	-	-	-	-	-	-	3
22MEL52.3	3	3	2		-	-	2	-	-	-	-	-	-	3
22MEL52.4	3	-	-	-	-	-	-	-	-	-	-	-	-	3

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	Valve Timing diagram of a 4 stroke I.C. engine	2	22MEL52.2
2	Port opening Timing diagram of a 2 stroke I.C. engine	2	22MEL52.2
3	Performance Tests on I.C. Engines (multi cylinder diesel), Calculations of IP, BP, Thermal efficiencies, Volumetric efficiency, Mechanical efficiency, SFC, FP, A:F Ratio. Calculations using software tools.	2	22MEL52.1
4	Determination of Heat balance sheet for Four Stroke Diesel Engine.	2	22MEL52.1
5	Determination of Morse test for Four Stroke Diesel Engine.	2	22MEL52.1
6	Performance Tests on I.C. Engines, (single cylinder diesel), Calculations of IP, BP, Thermal efficiencies, Volumetric efficiency, Mechanical efficiency, SFC, FP, A:F Ratio for Four stroke Diesel Engine, calculations using software tools.	2	22MEL52.1
	PART-B		
7	Performance Test on a Vapour Compression Refrigeration system	2	22MEL52.3
8	Performance Test on a Vapour Compression Air – Conditioner	2	22MEL52.3
9	Assembly and disassembly of the Mult cylinder IC engine	2	22MEL52.4
10	Exhaust gas analysis of IC engine	2	22MEL52.1
11	Spray pattern test for the Bio fuels	2	22MEL52.1
12	Calibration of fuel injector	2	22MEL52.4

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/**

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
		20	30
L1	Remember	-	-
L2	Understand	5	5
L3	Apply	5	10
L4	Analyze	5	10
L5	Evaluate	5	5
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

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

THEORY OF MACHINES

Course Code	**22MEE53**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**03**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22MEE53.1	Apply the concepts of kinematics and dynamics to analyze planar mechanisms
22MEE53.2	Understand the concept of mechanism and design of different machines.
22MEE53.3	Investigate the applications of Governors based on specific requirements and and design the flywheels
22MEE53.4	Analyze the Problems involving static and dynamic balancing and develop the solutions for the same using Graphical Method.
22MEE53.5	Analyze the concept of Gyroscopic effect and Visualize the effect of Gyroscopic couple in Different Vehicles
22MEE53.6	Understand the fundamentals of Gear and the prerequisites for the gear design.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22MEE53.1	2	2	-	-	-	-	-	-	-	-	-	-	-	3
22MEE53.2	3	1	-	-	-	-	-	-	-	-	-	-	-	3
22MEE53.3	3	3	2	-	-	-	-	-	-	-	-	-	-	3
22MEE53.4	3	3	2	-	-	-	-	-	-	-	-	-	-	3
22MEE53.5	3	3	2	-	-	-	-	-	-	-	-	-	-	3
22MEE53.6	3	2	-	-	-	-	-	-	-	-	-	-	-	3

MODULE-1	**INTRODUCTION AND MECHANISMS**	**22MEE53.1 22MEE53.2**	**8 Hours**

Introduction and Mechanisms: Definitions of Link, kinematic pairs, kinematic chain, mechanism, structure, degrees of freedom, Classification of pairs. Grashoff's Law, Grubler's Criterion, Inversions of four bar chain, single slider chain and double slider chain. Straight line mechanism- Peaucellier's mechanism, Intermittent mechanism- Geneva wheel mechanism, toggles mechanism. Ackerman steering gear mechanism.

Text Book	Text Book 1: 9.1 to 9.16
Case studies	To know the different mechanism and applications of it by building the models.

MODULE-2	**GOVERNORS AND FLYWHEEL**	**22MEE53.3**	**8 Hours**

Governors and flywheel: Introduction, types of governors, Centrifugal Governor, Watt Governor, Porter and Hartnell governor Stability, Sensitivity, , lift, Isochronous, Hunting, power& effort, and coefficient of insensitiveness Controlling force, Flywheel,Numericals.

Text Book	Text Book 1: 18.1-18.6.18.10,18.17
Assignment	Demonstration of various Governors in the Laboratory

MODULE-3	**BALANCING OF ROTATING MASSES**	**22MEE53.4**	**8 Hours**

Balancing of rotating masses: Static and Dynamic Balancing, Balancing of single rotating mass in a single plane. Balancing of several rotating mass in single plane and multiple planes. Numericals.

Text Book	Text Book 1: 21.1-21.6
Assignment	Demonstration of various rotating masses in same and different planes in the laboratory

MODULE-4	**GYROSCOPE**	**22MEE53.5**	**8Hours**

Introduction, Basic defnitions, Precessional angular motion, gyroscopic couple, Gyroscopic effect of a disc, ship, aero plane, two wheelers and four wheelers with vector diagrams, Numericals

Text Book	Text Book 1:14.1-14.9 Text Book 2: 10.1, 10.3, 10.5, 10.7

Assignment	Demonstration of Gyroscopic effect in the laboratory.		
MODULE-5	**SPUR GEARS GEAR TRAINS**	**22MEE53.6**	**8 Hours**

Gear Terminology, Law of Gearing, Length of arc of contact, Minimum number of teeth on a gear to avoid interference and Minimum number of teeth on a pinion to avoid Interference ,Numericals
Gear Trains: Simple,Compound gear trainsfor speed reduction, Epicyclic gear trains ,Algebraic and Tabular methods for finding velocity ratio, Torque calculations

Applications	Practical applications of Different gears in an Automobile.
Text Book	Text Book 2: 12.1 to 12.10

CIE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) Theory of machines by RS Khurmi and JK Gupta S Chand Publishers, 34th Ed, ISBN: 9788121925372
2) Mechanism and Machine Theory by Ambedkar A G, Prentice Hall IndiaLearning Private Limited ISBN : 978-81-203-3134-1

Reference Books:

1) Theory of machines by Ballaney, Khanna Publishers, 25th Ed, ISBN-1397887409122X
2) Theory of machines by Sadhu Singh, Pearson Education India, 2006. ISBN,87581279.
3) Theory of machines by S.S. Rattan Tata McGraw Hill Publications,4th Ed,ISBN:9789351343479
4) Kinematics of machines by Srinath M.K., Skyward publishers, 20, ISBN-978-93-86442-00-01

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=EVqBzOGQlkI
- https://www.youtube.com/watch?v=GF5C8dH4f5o
- https://www.youtube.com/watch?v=0MeAZFFqmek&list=PLdLe0dTcWW-u_dCcNGoAK8fx2PiS5gkVu

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

- Visit to any Design company/aero/auto industry or any power plant
- Demonstration of various Mechanisms
- Demonstration of working of Gyroscope.

- Demonstration of Balancing of rotating masses
- Video demonstration of mechanisms using Adams.
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare models of various mechanism
  - Organizing Group wise discussions on issues

THEORY OF MACHINES LAB

Course Code	**22MEL53**	**CIE Marks**	**50**
L:T:P:S	**0:0:1:0**	**SEE Marks**	**50**
Hrs / Week	**2**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**03**

Course outcomes:

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

22MEL53.1	Analyze the inversions of mechanisms for different motion transfer scenarios
22MEL53.2	Evaluate the solutions for Unbalance in rotary components of different machines.
22MEL53.3	Illustrate the parameters and variables which affect the performance of Governors
22MEL53.4	Investigate the effects of Gyroscopic couple on different applications involving Prime movers.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22MEL53.1	2	3	3	3	3	-	-	-	-	-	-	-	-	3
22MEL53.2	3	3	3	3	3	-	-	-	-	-	-	-	-	3
22MEL53.3	2	3	3	3	3	-	-	-	-	-	-	-	-	3
22MEL53.4	2	3	3	3	3	-	-	-	-	-	-	-	-	3

Exp. No	List of Experiments	Hours	COs
	Prerequisite Experiments		
	• Analysis of various mechanisms, Degrees of freedom. • Governors working principles • Gyroscopic effect of Automobile.	2	NA
	PART-A		
1	Synthesis and simulation of 4 bar mechanism using multi-body dynamics software	2	22MEL53.1
2	Synthesis and simulation of Inversions of 4 bar mechanism using multi-body dynamics software	2	22MEL53.1
3	Synthesis and simulation of Slider crank Chain using multibody dynamics software	2	22MEL53.1
4	Synthesis and simulation of Inversions of Slider crank Chain using multi-body dynamics software.	2	22MEL53.1
5	Synthesis and simulation of Whitworth Quick return motion mechanism	2	22MEL53.4
6	Synthesis and simulation of peaucellier mechanism	2	22MEL53.4
	PART-B		
7	Balancing of rotating masses in same plane using graphical Method in Solid edge.	2	22MEL53.2
8	Balancing of rotating masses in different planes using graphical method in solid edge	2	22MEL53.2
9	Determination of Sensitiveness and Controlling force of a Porter Governor	2	22MEL53.3
10	Demonstration on Practical applications of gyroscopic couple.	2	22MEL53.4

11	Demonstration on Practical applications of flywheel, gear train and cam follower	2	22MEL53.4
12	Synthesis and simulation of Beam engine	2	22MEL53.4

PART-C

Beyond Syllabus Virtual Lab Content

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

- **https://mm-nitk.vlabs.ac.in/exp/velocity-analysis-grashof/**
- **https://dom-nitk.vlabs.ac.in/exp/porter-governer/**
- **https://dom-nitk.vlabs.ac.in/exp/multiple-mass-in-single-plane/**

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		20	30
L1	Remember	-	5
L2	Understand	5	10
L3	Apply	5	5
L4	Analyze	5	5
L5	Evaluate	5	5
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	05
L2	Understand	10
L3	Apply	20
L4	Analyze	10
L5	Evaluate	05
L6	Create	-

Suggested Learning Resources:

Reference Books:

1) Theory of machines by RS Khurmi and JK Gupta S Chand Publishers, 34th Ed, ISBN: 9788121925372

2) Mechanism and Machine Theory by Ambekar A G, Prentice Hall India Learning Private Limited ISBN : 978-81-203-3134-1

REFERENCE BOOKS:

1.Theory of machines by Ballaney, Khanna Publishers, 25th Ed, ISBN-1397887409122X

2. Theory of machines by Sadhu Singh, Pearson Education India, 2006. ISBN,87581279.

3. Theory of machines by S.S. Rattan Tata McGraw Hill Publications,4th Ed, ISBN:9789351343479

4. Kinematics of machines by Srinath M.K., Skyward publishers, 20, ISBN-978-93- 86442- 00-0

NON DESTRUCTIVE TESTING

Course Code	**22MEE541**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**03**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22MEE541.1	Understand the important role in quality control and flaw detection for industries.
22MEE541.2	Identify the various NDT techniques in use.
22MEE541.3	Analyze the structural health monitoring covering wide range of industries.
22MEE541.4	Determine the basic understanding the NDT principles.
22MEE541.5	Investigate the fundamental science behind the commonly used NDT methods.
22MEE541.6	Design and analysis the process details of NDT methods.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22MEE541.1	2	-	-	-	-	-	-	-	-	-	-	-	-	2
22MEE541.2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
22MEE541.3	3	2	-	-	-	-	-	-	-	-	-	-	-	2
22MEE541.4	3	2	-	-	-	-	-	-	-	-	-	-	-	2
22MEE541.5	3	2	-	-	-	-	-	-	-	-	-	-	-	2
22MEE541.6	3	3	-	-	-	-	-	-	-	-	-	-	-	3

MODULE-1	**INTRODUCTION AND SURFACE NDT TECHNIQUES**	**22MEE541.1 22MEE541.2**	**8 Hours**

Procedure, testing and evaluation, Visual examination. Dye penetrant testing, principle, Types and methods of application, Developer. Magnetic particle testing, theory and methods of magnetism, Field indicators, Particle application.

Applications	Nondestructive Testing and traditional areas of industrial applications.
Text Book	Text Book 2: 1.5, 1.7, 4.129, 5.142

MODULE-2	**RADIOGRAPHIC TESTING**	**22MEE541.2 22MEE541.3 22MEE541.4**	**8 Hours**

Radiography principle, X-ray films, exposure, radiographic imaging, inspection standards and techniques, Radiography applications, limitations and safety.

Applications	Radiographic testing industrial applications.
Text Book	Text Book 1: 9.1, 9.2, 9.4, 9.5, 9.10

MODULE-3	**EDDY CURRENT TESTING**	**22MEE541.2 22MEE541.3 22MEE541.4**	**8 Hours**

Principle, depth of penetration, eddy current response, eddy current instrumentation, probe Configuration, applications and limitations.

Case Study	Eddy current testing and Ultrasonic testing case studies.
Text Book	Text Book 2: 6.173, 6.177, 6.184

MODULE-4	**ULTRASONIC TESTING AND ACOUSTIC EMISSION TESTING**	**22MEE541.4 22MEE541.5 22MEE541.6**	**8 Hours**

Properties of sound beam, ultrasonic transducers, inspection methods, flaw characterization technique, immersion testing. Theory of AE sources and Waves, Equipment, Signal Features, Data display, source

location.			
Applications	Applications of ultrasonic testing and Acoustic emission testing.		
Text Book	Text Book 1: 11.1, 11.2, 11.7, 2.1, 2.2, 2.3, 2.6, 2.7		
MODULE-5	**EMERGING NDT TECHNIQUES**	**22MEE541.4 22MEE541.5 22MEE541.6**	**8 Hours**
Leak testing, Holography, Thermography, Magnetic resonance Imaging, Magnetic Barkhausen Effect, In-situ metallography.			
Case Study	Emerging NDT techniques industrial applications and case studies of the same.		
Text Book	Text Book 1: 5.1, 5.2, 5.4, 9.22		

CIE Assessment Pattern (50 Marks – Theory) –

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) Introduction to Nondestructive Testing, Paul E Mix, Publisher: John Wiley, ISBN: 9780471420293, 0471420298, 2021

2) Nondestructive Testing, Louis Cartz, ASM International, ISBN-13, ISBN: 978-0-87170-517-4, 2020

Reference Books:

1) Practical Non- Destructive Testing, Baldev Raj , Narosa, 2013, ISBN-13-978-8173197970,2019

2) Nondestructive Evaluation and Quality Control, ASM Handbook, Vol. 17. ISBN-13, 978-0871700230,2020

3) Non-Destructive Testing Technique, Laodeno Rem N, Yoshida Kenichi, Publisher: LAP Lambert Academic Publishing, ISBN-13: 978-3659335587. 2017

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=U8mInQlwwN8
- https://www.youtube.com/watch?v=jv4bA5UexjU
- **https://www.youtube.com/watch?v=_CkK90CVARM**
- **https://www.youtube.com/watch?v=uzogGRDSmMA**
- **https://www.youtube.com/watch?v=uqdW25EpzXw**
- **https://www.youtube.com/watch?v=UjvUyXGAjoo**

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

- Visit to any manufacturing/aero/auto industry
- Video demonstration of latest trends in Nondestructive Testing
- For active participation of students, instruct the students to conduct Nondestructive Testing
- Organizing Group wise discussions on Nondestructive Testing issues
- Students presentation

COMPOSITE MATERIALS

Course Code	**22MEE542**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**03**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22MEE542.1	Identify the suitability of composite materials for various engineering applications.
22MEE542.2	Understand the safe and sustainable processing techniques for composite materials
22MEE542.3	Apply the modern fabrication technique for enhancement of composite properties.
22MEE542.4	Examine the micro and macro characteristics of lamina
22MEE542.5	Analyze the influence of size, shape and particle distribution in MMC'S.
22MEE542.6	Develop the suitable composite structure for specific application.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22MEE542.1	3	2	-	-	2	2	-	-	-	-	-	-	2	-
22MEE542.2	3	2	-	-	2	-	-	-	-	-	-	-	2	-
22MEE542.3	2	-	-	--	-	--	--	--	--	--	--	--	2	-
22MEE542.4	2	-	-	-	3	-	-	-	-	-	-	-	2	-
22MEE542.5	3	-	-	-	3	-	-	-	-	-	-	-	2	-
22MEE542.6	2	-	-	-	2	-	-	-	-	-	-	-	2	-

MODULE-1	**INTRODUCTION AND APPLICATIONS OF COMPOSITE MATERIALS**	**22MEE542.1, 22MEE542.2**	**8 Hours**

Introduction to Composite Materials: Definition, classification and characteristics of composite Materials – fibrous composites, laminated composites, particulate composites. Reinforcements- Fibers- Glass, Silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibers

Applications of Composites: Automobile, Aircrafts, Missiles, Space hardware, Electrical and Electronics, Marine, recreational and recreational and sports equipment, future potential of composites.

Applications	Prepare the composite materials with different weight and volume ratio.
Text Book	Text Book 1: 1.1, 1.2, 1.3, 1.5

MODULE-2	**PROCESSING OF COMPOSITE MATERIALS**	**22MEE542.2, 22MEE542.3**	**8 Hours**

Fiber Reinforced Plastic Processing: Layup and curing, fabricating process, open and closed mould process, hand layup techniques; structural laminate bag molding, production procedures for bag molding

Advanced Processing Techniques: Filament winding, pultrusion, pulforming, thermo - forming, injection, injection molding, liquid molding, blow molding.

Case-study	Prepare the composite materials with different different processing methods.
Text Book	Text Book 1: 2.2, 2.3, 2.4 to 2.15

MODULE-3	**FABRICATION AND PROPERTIES OF COMPOSITES**	**22MEE542.3, 22MEE542.4**	**8 Hours**

Fabrication of Composite Structures: Cutting, machining, drilling, mechanical fasteners and adhesive bonding, joining, computer- aided design and manufacturing, tooling, fabrication of equipment.

Mechanical Properties - Stiffness and Strength: Geometrical aspects – volume and weight fraction. Unidirectional continuous fiber, discontinuous fibers, Short fiber systems, woven reinforcements Mechanical

Testing: Determination of stiffness and strengths of unidirectional composites; tension, compression, flexure and shear

Self-study	Study the properties of composite materials.		
Text Book	Text Book 2: 2.1, 2.2, 2.3, 2.4		
MODULE-4	**METAL MATRIX COMPOSITES**	**22MEE542.4**	**8Hours**

Metal Matrix Composites: Reinforcement materials, types, characteristics and selection base metals selection. Need for production MMC's and its application.
Fabrication Process for MMCs: Powder metallurgy technique, liquid metallurgy technique and secondary processing, special fabrication techniques.

Applications	Fabricate the MMC		
Text Book	Text Book 1: 5.1, 5.2, 5.3		
MODULE-5	**PROPERTIES OF MMC**	**22MEE542.5, 22MEE542.6**	**8Hours**

Study Properties of MMC"s: Physical Mechanical, Wear, machinability and Other Properties. Effect of size, shape and distribution of particulate on properties.
Micro Mechanical Analysis of a Lamina: Introduction, Evaluation of the four elastic moduli by rule of mixture, Numerical problems. Macro Mechanics of a Lamina: Hooke's law for different types of materials, Number of elastic constant

Self Study	Study the properties of MMC and its applications.
Text Book	Text Book 2: 12.1 to 12.10

CIE Assessment Pattern (50 Marks – Theory) –

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

TEXT BOOKS:

1) Composite Science and Engineering, K. K. Chawla Springer Verlag 1998.
ISBN: 978-1-4419-3124-5
2) Mechanics of Composite Materials, Autar K. Kaw CRC Press New York. ISBN: 978-0849313431

REFERENCE BOOKS:

1) Introduction to Composite Materials, Hull and Clyne, Cambridge University Press, ISBN- 9781139170130, 2012.
2) Mechanics of Composite Materials and Structures, Madhujit Mukhopadhyay, University Press, ISBN- 978-8173714771, 2022
3) Mechanics of Composite Materials, Robert M. Jones, McGraw Hill Kogakusha Ltd, ISBN- 9781315272986, 2018

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=04K0bLwCDdM
- https://www.youtube.com/watch?v=haYuTANzzS8
  https://www.youtube.com/watch?v=nzPj3f3UjT8

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

- Visit to any manufacturing industry
- Prepare composite material with different weight ratio, volume ratio.
- Video demonstration of latest trends in composite materials

STATISTICS FOR ENGINEERS

Course Code	**22MEE543**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**3**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22MEE543.1	Understand the basic concepts of random variables and find an approximate distribution for analyzing data specific to an experiment.
22MEE543.2	Evaluate the descriptive statistics using numerical and graphical techniques.
22MEE543.3	Apply statistical methods like correlation, regression analysis in analysing, interpreting experimental data
22MEE543.4	Analyze using statistical inference that is the central to experimental research.
22MEE543.5	Apply statistical methodology and tools in reliability engineering problems
22MEE543.6	Develop R programming for statistical data

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22MEE543.1	3	-	-	-	-	-	-	-	-	-	-	-	-	3
22MEE543.2	3	2	1	-	-	-	-	-	-	-	-	-	-	3
22MEE543.3	3	2	2	-	-	-	-	-	-	-	-	-	-	3
22MEE543.4	3	2	2	-	-	-	-	-	-	-	-	-	-	3
22MEE543.5	3	2	1	-	-	-	-	-	-	-	-	-	-	3
22MEE543.6	3	2	2	-	-	-	-	-	-	-	-	-	-	3

MODULE-1	**INTRODUCTION TO STATISTICS**	**22MEE543.1**	**9 Hours**

Introduction to Statistics and Data Analysis – Measures of Central Tendency – Measures of Variability – [Moments -Skewness-Kurtosis (Concepts Only)]

Self-study	Explore the Challenges of current system variability parameter.
Text Book	Text Book 1: 1.1-1.7, 2.1-2.6,

MODULE-2	**Random Variables**	**22MEE543.2**	**9 Hours**

Introduction – Random Variables – Probability Mass Function, Distribution and Density Functions – Joint Probability Distribution and Joint Density Functions – Marginal, Conditional Distributions and Density Functions – Mathematical Expectation and its Properties – Covariance – Moment Generating Function – Characteristic Function.

Self-study	Desirable identification of systems with covariance and joint probability distribution.
Text Book	Text Book 1: 2.1-2.8

MODULE-3	**Correlation and Regression**	**22MEE543.3, 22MEE543.4**	**9Hours**

Correlation and Regression – Rank Correlation – Partial and Multiple Correlation – Multiple Regression

Self-study	Explore the problems with capabilities of correlation and regression.
Text Book	Text Book 1: 11.1-11.13

MODULE-4	**Hypothesis Testing – I**	**22MEE543.5**	**9 Hours**

Testing of Hypothesis – Introduction – Types of Errors – Critical Region – Procedure of Testing Hypothesis – Large Sample Tests – Z-Test for Single Proportion, Difference of Proportions, Single Mean and Difference of Means

Case Study	Identify hypothesis with typical errors

Text Book	Text Book 2:11.1-11.8		
MODULE-5	**Hypothesis Testing – II**	**22MEE543.6**	**8 Hours**

Small Sample Tests – Student's t-Test – F-Test – Chi-Square Test – Goodness of Fit – Independence of Attributes – Design of Experiments – Analysis of Variance – One and Two Way Classifications - CRD-RBD- LSD

Case Study	Identify hypothesis with variance(DOE)
Text Book	Text Book 2: 13.1-13.6

CIE Assessment Pattern (50 Marks – Theory)

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) Probability and Statistics for engineers and scientists, R.E.Walpole, R.H.Myers, S.L.Mayers and K.Ye, 9th Edition, Pearson Education (2012). ISBN 978-0-321-62911-1

2) Applied Statistics and Probability for Engineers, Douglas C. Montgomery, George C. Runger, 6th Edition, John Wiley & Sons (2016). ISBN: 9788126562947

Reference Books:

1) Reliability Engineering, E.Balagurusamy, Tata McGraw Hill, Tenth reprint 2017.
2) Probability and Statistics, J.L.Devore, 8th Edition, Brooks/Cole, Cengage Learning (2012).
3) Probability and Statistics for Engineers, R.A.Johnson, Miller Freund's, 8th edition, Prentice Hall India (2011)

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc21_ma74/preview
- https://nptel.ac.in/courses/110107114
- https://onlinecourses.nptel.ac.in/noc23_ge25/preview

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

- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to enroll various Nptel courses
  - Organizing Group wise solutions for issues

ELECTRIC VEHICLES AND BATTERY MANAGEMENT SYSTEM

Course Code	**22MEE544**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**03**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22MEE544.1	Understand Basic of hybrid and electric vehicles
22MEE544.2	Explain Different energy storage devices
22MEE544.3	Describe different Characteristics of Fuel Cells
22MEE544.4	Analyze the Performance of electric vehicles
22MEE544.5	Understand Concepts of hybrid electric drive train
22MEE544.6	Analyze the thermal management in batteries and Classify Electric motors and controllers

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22MEE544.1	2	1	-	-	-	-	1	-	-	-	-	-	-	3
22MEE544.2	2	1	-	-	-	-	1	-	-	-	-	-	-	3
22MEE544.3	2	1	-	-	-	-		-	-	-	-	-	-	3
22MEE544.4	2	2	1	-	-	-	1	-	-	-	-	-	-	3
22MEE544.5	2	1	-	-	-	-		-	-	-	-	-	-	3
22MEE544.6	2	2	-	-	-	-	1	-	-	-	-	-	-	3

MODULE-1	**Introduction to need for Alternative System**	**22MEE544.1**	**8 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. Limitations of electric vehicles. Specification of different electric and hybrid vehicles.

Case Study	Investigate the challenges of electric and hybrid vehicles. Compare with traditional areas of automobile engineering.
Text Book	Text Books 1: 1.1, 1.2, 1.3

MODULE-2	**Energy Storage Devices and Fuel Cells**	**22MEE544.2**	**8 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

Self-study	Investigate life and reliability of energy storage devices and fuel cells in EV and their applications.
Text Book	Text Books 1: 2.1, 2.4, 2.6

MODULE-3	**Electric Vehicles**	**22MEE544.4**	**8 Hours**

Electric Vehicles: Electric vehicle layout, performance of electric vehicles – 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.

Applications	Explore the performance of electric vehicles.
Text Book	Text Books 2: 5.1, 5.2, 5.3, 5.4

MODULE-4	**Hybrid Vehicles**	**22MEE544.5**	**8 Hours**

Hybrid Vehicles: 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	Investigate the hybrid electric vehicle drive train design.
Text Book	Text Books 3: 2.3, 2.4, 2.5

MODULE-5	**Battery Management System, Propulsion Motors and Controllers:**	**22MEE544.6**	**8 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.
Battery Management System: definition, parts, power module, battery, DC/DC converter, load, communication channel, battery pack safety, battery standards and tests.
Propulsion Motors and Controllers: Types of electric motors – working principle of AC and DC motors.

Case Study	Case study on thermal management of batteries.
Text Book	Text Books 4: 8.1, 8.2, 8.3, 8.4

CIE Assessment Pattern (50 Marks – Theory)

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) Jack Erjavec and Jeff Arias, "Hybrid, Electric and Fuel Cell Vehicles", Cengage Learning, 2012.ISBN 9781133430211
2) Jack Erjavec and Jeff Arias, "Alternative Fuel Technology – Electric, Hybrid and Fuel Cell Vehicles", Cengage Learning Pvt. Ltd., New Delhi, 2007, ISBN 9781401872402
3) Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2009.

4) Ibrahim Dinçer, Halil S. Hamut and Nader Javani, "Thermal Management of Electric Vehicle Battery Systems", John Wiley and Sons Ltd., 2016.

Reference Books:

1) Wei Liu, "Hybrid Electric Vehicle System Modeling and Control", General Motors, USA, John Wiley and Sons, Inc., 2017.
2) Teresa Donateo, "Hybrid Electric Vehicles", ExLi4EvA, 2017.
3) Gianfranco Pistoia Consultant, "Electric and Hybrid Vehicles Power Sources, Models, Sustainability, Infrastructure and the Market", Rome, Italy, Elsevier Publications, 2017.
4) Jack Erjavec, "Hybrid, Electric and Fuel-Cell Vehicles", Delmar, Cengage Learning.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/108/103/108103009/
- https://www.youtube.com/watch?v=7WNIDLFX7Xk
- https://www.youtube.com/watch?v=iihYXx79QiE
- https://www.youtube.com/watch?v=cS5tkvbC4ts
- https://new.nsf.gov/news/retired-electric-vehicle-batteries-could-be-used

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

- Visit to any manufacturing/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
- 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

COMPETITIVE CODING

Course Code	**22MEE545**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**3**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22MEE545.1	Use advanced pointer techniques and dynamic memory functions effectively.
22MEE545.2	Summarize the concepts of complex data structures and illustrate their applications in various scenarios.
22MEE545.3	Implement advanced linked lists and arrays in the real time projects.
22MEE545.4	Differentiate between various advanced tree and graph algorithms and contrast their performance.
22MEE545.5	Judge the efficiency of different sorting and searching algorithms by measuring their time and space complexities.
22MEE545.6	Formulate solutions for optimization problems using dynamic programming and devise efficient algorithms.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22MEE545.1	3	3	-	-	-	-	-	-	-	-	-	3	3	3
22MEE545.2	3	3	-	-	3	-	-	-	2	-	-	3	3	3
22MEE545.3	3	3	-	-	3	-	-	-	2	-	-	3	3	3
22MEE545.4	3	-	2	2	3	-	-	-	2	-	-	3	3	3
22MEE545.5	3	3	-	-	3	-	-	-		-	-	3	3	3
22MEE545.6	3	3	2	2	-	-	-	-	-	-	-	3	3	3

MODULE-1	**Advanced Pointers and Dynamic Memory Management**	**22MEE545.1**	**8 Hours**

Pointers and Double Pointers: Pointer Arithmetic, Double Pointer, Function Pointers, Pointers to Functions Returning Pointers, Dynamic Memory Allocation using Pointers.

Dynamic memory management: Functions for dynamic memory management: malloc, calloc, realloc, and free, Memory Leaks and their prevention, memory pools and custom allocators.

Applications	Given a large dataset that needs to be processed in chunks. Write a C program that dynamically allocates memory for each chunk, processes the data, and then frees the memory. Ensure that the program handles memory allocation failures gracefully.
Text Book	Text Book 1: Chapter 11, 12, 13, 14

MODULE-2	**Advanced Structures and Unions**	**22MEE545.2**	**8 Hours**

Nested Structures, Self-referential Structures, Bit-fields in Structures, Unions and their applications, Anonymous Unions and Structures, Creating and using bit-fields in structures, Enumerated Types and their uses.

Applications	Develop a system to manage student records. Each student has a name, roll number, and marks in three subjects. Use nested structures to store this information. Additionally, use an enumerated type to represent the grade (A, B, C, D, F) based on the average marks. Write a program to input student details, calculate the average marks, assign a grade, and display the student information.
Text Book	Text Book 2: Chapter 10, 11, 12

MODULE-3	**Advanced Linked Lists and Arrays**	**22MEE545.2 22MEE545.3**	**8 Hours**

Advanced Linked List: Circular Linked Lists, Skip Lists, XOR Linked Lists.

Advanced Arrays: Dynamic Arrays and Resizable Arrays, Multi-dimensional Arrays and their Applications, Sparse Arrays

Applications	Develop a scheduling system for a round-robin tournament. Each team plays every other team exactly once, and the schedule needs to be managed efficiently. Implement a circular linked list to store the schedule of matches. Write functions to add a match, remove a match, and display the schedule in a loop.
Text Book	Text Book 3: Chapter 3, 4, 5, 6, 7, 8

MODULE-4	**Trees and Graphs**	**22MEE545.4**	**8 Hours**

Binary Trees and Binary Search Trees: AVL Trees, Red-Black Trees, and Splay Trees, B-Trees and B+ Trees, Trie and Suffix Trees

Graph Representations: Adjacency Matrix, Adjacency List, Graph Traversal Algorithms- Depth-first and breadth-first search algorithms.

Applications	Develop a spell-checking application that uses a trie to store a dictionary of valid words. Implement a trie to store the dictionary and write functions to insert words, delete words, and check if a word is valid. Additionally, implement a function to suggest corrections for misspelled words by finding the closest matches in the trie..
Text Book	Text Book 3: Chapter 9, 10, 11

MODULE-5	**Advanced Algorithms**	**22MEE545.5 22MEE545.6**	**8 Hours**

Sorting Algorithms: Merge Sort and Heap Sort, **Searching Algorithms**: Binary Search and Ternary Search, **Dynamic Programming:** Knapsack Problem, Longest Common Subsequence

Applications	Develop a resource allocation system for a project management tool. Each task has a specific importance and resource requirement. Implement the knapsack problem to allocate resources to the tasks in a way that maximizes the total importance within the given resource constraints. Write functions to solve the problem using dynamic programming and display the optimal allocation
Text Book	Text Book 3: Chapter 12

CIE Assessment Pattern (50 Marks – Theory) –

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) K. N. King, "C Programming: A Modern Approach", ISBN: 978-0393979503, Publisher: W. W. Norton & Company, 2nd Edition, 2022
2) E. Balagurusamy , Programming in ANSI C" ISBN: 978-9353165130, McGraw Hill Education, 8th Edition, 2019
3) Mark Allen Weiss, Data Structures and Algorithm Analysis in C, ISBN: 978-0201498400, Pearson, 2nd Edition, 2019

Reference Books:

1) Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, Introduction to Algorithms" , 4th Edition, ISBN: 978-0262046305, The MIT Press, 2022
2) **Donald E. Knuth, "The Art of Computer Programming" ,** 3rd Edition, ISBN: 978-0201896831, Addison-Wesley Professional

Web links and Video Lectures (e-Resources):

- **Learn C: Pointers and Memory | Codecademy**
- **C Programming: Pointers and Memory Management - 4 | Coursera**
- **C Unions (With Examples) (programiz.com)**
- **Structures & Unions in C (Solved Problem) - YouTube**
- **Linked Lists vs. Arrays - Data Structures for Coding Interviews in C++ (educative.io)**
- **AlgoDaily - Merge Sort vs. Quick Sort vs. Heap Sort**

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

- Practical based learning: Provide students with coding exercises that require implementing dynamic programming solutions. Use online coding platforms like LeetCode, HackerRank, or Codeforces for practice.
- Have students exchange their code with peers for review. Each student will review and debug their peer's code, providing feedback and suggestions for improvement.
- Encourage students to participate in online competitive programming contests that feature dynamic programming problems. Platforms like Codeforces, AtCoder, and TopCoder host regular contests.
- Use software tools to visually represent the state space, decision tree, and memorization table for dynamic programming problems. Encourage students to draw these visual aids themselves.

RESEARCH METHODOLOGY AND IPR

Course Code	**22RMK55**	**CIE Marks**	**50**
L: T: P: S	**1:1:0:0**	**SEE Marks**	**50**
Hours / Week	**03**	**Total Marks**	**100**
Credits	**02**	**Exam Hours**	**03**

Course outcomes:

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

22RMK55.1	Understand a research problem and formulate research questions
22RMK55.2	Demonstrate the various processing techniques of research
22RMK55.3	Choose appropriate methods to formulate research objectives
22RMK55.4	Develop advanced critical thinking skills and enhance writing skills
22RMK55.5	Understand the statutory provisions of different forms of IPRs in simple forms
22RMK55.6	Identify the significance of practice and procedure of patents

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
22RMK55.1	3	3	2	2	1	-	-	-	1	2	-	-
22RMK55.2	3	3	2	2	2	-	-	-	1	2	-	-
22RMK55.3	3	3	2	2	1	-	-	-	1	2	-	-
22RMK55.4	3	2	2	-	1	-	-	-	1	2	-	-
22RMK55.5	3	3	2	1	-	-	-	1	1	2	-	-
22RMK55.6	3	3	2	1	-	-	-	1	1	2	-	-

MODULE-1	**FORMULATION OF RESEARCH PROBLEM**	**22RMK55.1, 22RMK55.2**	**6 Hours**

Research– Meaning and Objectives – Criteria of Good Research–Problems Encountered by Researchers –Types of Research–Research Approaches-Research Process–Literature Review– Significance of Literature Review–Review of Selected Literature– Research Problem– Identification and Defining the Research Problem.

Text Book	Text Book 1: Ch. 1, 2

MODULE-2	**RESEARCH DESIGN PROCEDURES**	**22RMK55.2, 22RMK55.3**	**6 Hours**

Meaning of Research Design – Need for Research design – Features of a Good Design –Concepts Related to Research Design– Different Research Designs – Basic Principles of Experimental Designs.

Case Study	To find the solution for the given research problem using different types of research methods
Text Book	Text Book 1: Ch. 3

MODULE-3	**INTERPRETATION AND REPORT WRITING**	**22RMK55.4**	**6 Hours**

Meaning and Technique of Interpretation – Precautions in interpretation – Significance of Report Writing – Different Steps in Report Writing – Layout of a Research Report– Types of Report – Mechanics of Writing a Research Report –Conclusion-Referencing in Academic Writing –Bibliography.

Text Book	Text Book 2: Ch. 14

MODULE-4	INTRODUCTION TO IPR	22RMK55.5	6 Hours
Introduction and Significance of Intellectual Property Rights –Types of Intellectual Property Rights–Need for IPR –Rationale for Protection of IPR–IPR in India and Abroad–Forms of IPR – Royalty – Copyright – Trademark – Patents – Industrial Designs – Trade Secrets – Geographical Indications – Application of Different Forms of IPR– Future Aspects of IPR– Some Examples of IPR.			
Text Book	Text Book 2: Ch. 1 and 2		
MODULE-5	**BASICS OF PATENTS**	**22RMK55.5, 22RMK55.6**	**6 Hours**
Patents and its Basics – Patentable and Non-Patentable Inventions–Patent Application Process (National and International level) – Searching a Patent-Drafting and Filing a Patent –Types of Patent Applications–Patent Documents– Specification and Claims–Assignment, Licensing, Infringement–Different Layers of International Patent System–Some Examples of Patent – forms requirement for patent application with charges			
Case Study	Analyze different domains of filed patents		
Text Book	Text Book 2: Ch. 1 and 2		

CIE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) Kothari, C.R.,Research Methodology: Methods and Techniques, New Age International, 2018, ISBN-13: 978-8122436235
2) Ramakrishna Chintakunta, A Text book of Intellectual Property rights, Blue Hill Publication, ASIN: B09T6YDB5N, 2022

Reference Books:

1) Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K, An Introduction to Research Methodology, RBSA Publishers. 2015, ISBN-13:978-8176111652
2) Ranjith Kumar, Research methodology, Saga publications,4th edition, 2014, ISBN-13- 978-9351501336
3) Sinha, S.C. and Dhiman, A.K., Research Methodology, EssEss Publications. 2 volumes, 2012. ISBN : 81-7000-324-5, 81-7000-334-2
4) Asha Vijay Durafe, Dhanashree K. Toradmalle , Intellectual Property Rights, Dreamtech Press,2020, ISBN:9390395917

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=GSeeyJVD0JU
- https://www.youtube.com/watch?v=nv7MOoHMM2k
- https://www.youtube.com/watch?v=BGSgZ1J8-yQ

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

- Organizing Group Wise Discussions
- Seminars

CRITICAL AND CREATIVE THINKING SKILLS

Course Code	**22SDK56**	**CIE Marks**	**50**
L:T:P:S	**0:0:1:0**	**SEE Marks**	**-**
Hrs / Week	**2**	**Total Marks**	**50**
Credits	**1**	**Exam Hours**	**01**

Course outcomes:

Upon successful completion of this course, the student will be able to:

22SDK56.1	Demonstrate proficiency in solving quantitative aptitude problems using fundamental concepts
22SDK56.2	Apply advanced quantitative techniques to address and solve complex real-world problems.
22SDK56.3	Develop and enhance logical reasoning skills essential for problem-solving in various competitive examinations.
22SDK56.4	Cultivate critical and creative thinking skills necessary for analytical reasoning and problem-solving.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
22SDK56.1	3	3	-	-	2	-	-	-	-	-	-	2
22SDK56.2	3	3	-	-	2	-	-	-	-	-	-	2
22SDK56.3	3	3	-	-	2	-	-	-	-	-	-	2
22SDK56.4	3	3	-	-	2	-	-	-	-	-	-	2

MODULE-1	**CRITICAL THINKING THROUGH QUANTITATIVE ANALYSIS**	**22SDK56.1 22SDK56.2**	**6 Hours**

Number systems: LCM and HCF of numbers, Squaring and Cubing Techniques, Multiplication Tricks, Divisibility rules, Digit sum method, Speed Math, Simplifications, Approximations.

Percentages: Conversion of Fraction to Percentage Table, Percentage Change, Net percentage change/Effective percentage change, Successive Percentage, Concept of more/less percentage, Percentage of percentage, Product constancy, Increased/decreased by P%, Percentage Changes in Numerator and Denominator, Successive Percentage.

Averages: Basic concept, Consecutive Numbers, Non-Consecutive Numbers, Equation Concept, True/False concept, Including/Excluding concept, Replacement concept, Average Speed concept.

MODULE-2	**NUMERICAL TECHNIQUES FOR PROBLEM SOLVING**	**22SDK56.1 22SDK56.2**	**6 Hours**

Profit and Loss: Basic concept, Profit Percentage, Loss Percentage, Profit/Loss Percentage, Overall Profit/Loss, Dishonest shopkeeper, More/less loss concept.

Discounts: Successive discounts, Buy X and Get Y Free, Profit after allowing discount, True Discount, Difference between percentage profit and percentage discount.

Ratio and Proportion: Concept Explanation, Duplicate Ratio, Triplicate Ratio, Direct Proportion, Indirect Proportion, Double rule of three or compound proportion, Ratio in investment, Ratio in partnership, Ratio in averages, Ratio in profit and loss, Ratio in interest rates.

Time and Work: Unit work, Combined work, Individual efficiency, Group efficiencies, Time taken by an individual or a group, Work done by an individual or a group, Total work done, Chain Rule Concept, Pipes and Cisterns, 4 Rules of Pipes and Cistern.

MODULE-3	ADVANCED QUANTITATIVE TECHNIQUES	22SDK56.1 22SDK56.2	6 HOURS

Algebra: Simple Arithmetic Operations, Linear equation is one, Two and three variables, Methods of solving linear equations, Methods of solving quadratic equations, Surds and indices, Logarithms.

Series and Progressions: Arithmetic Sequences, Geometric Sequences, Harmonic Sequences, Fibonacci Numbers.

Geometry: Concepts of Angles, Different polygons like triangles, rectangle, square, right-angle triangle, Pythagorean Theorem, Perimeter and Area of Triangle, Rectangle, and circles.

Statistics: Mean, Median, Mode, Standard Deviation, Variance.

MODULE-4	ANALYTICAL REASONING AND CREATIVE PROBLEM SOLVING	22SDK56.3 22SDK56.4	6 Hours

Number Series - Missing numbers, Incomplete series - Odd-even series, primes, Fibonacci series, Arithmetic progression, Geometric progression, Harmonic progression, Squares and cubes, Operations on digits, Exponential series, Increasing multiplication, Hybrid series.

Alphabetical Series- Missing alphabets, incomplete letter series - series of words, series of letters, arrangement of words/letters, letters marked with corresponding numbers sequence, positions of letters, ranking of the word in dictionary; Mixed Series - Missing numbers and words/letters, complete the series.

Analogies: Alphabet Classification, Word Classification, Number Classification.

Coding and Decoding: Coding based on order, Letter to Letter Mapping, Letter to number mapping, Letter to digit mapping, Re-ordering sequences; Word sequencing, Match the word to code, Symbol Coding.

MODULE-5	PROBLEM SOLVING THROUGH LOGICAL ANALYSIS	22SDK56.3 22SDK56.4	6 Hours

Directions: Eight Directions, Distance, Displacement, Starting and ending points, Referential directions, Directions of shadows, Axis based problems, Actual and conditional directions.

Seating Arrangements: Linear arrangement, Square Arrangement, Rectangular Arrangement, Circular arrangement, Vertical arrangement, Seating arrangement in a photograph, Tabular arrangement, Hexagonal Seating Arrangement, Complex arrangement, Miscellaneous arrangements.

Blood Relations: Relations defined, Generation Verticals, Family Tree, Single Person Blood Relations, Mixed/Chain Blood Relations, Symbol based Blood Relation.

CIE Assessment Pattern (50 Marks – Theory)

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

Text Books:

1."Critical Thinking: A Student's Introduction" by Gregory Bassham, William Irwin, Henry Nardone, James M. Wallace , ISBN: 978-0078038280

2. Thinking Skills: Critical Thinking and Problem Solving" by John Butterworth, Geoff Thwaites ISBN: 978-1107606302

Reference Books:

1. The Art of Thinking: A Guide to Critical and Creative Thought" by Vincent Ruggiero ISBN: 978-0205315426
2. "Critical Thinking" by Richard Paul, Linda Elder ISBN: 978-0133115284

ENVIRONMENTAL STUDIES

Course Code	**22ESK57**	**CIE Marks**	**50**
L:T:P:S	**1:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**1**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**02**

Course outcomes:

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

22ESK57.1	Understand the concepts of Environment, ecosystem and biodiversity.
22ESK57.2	Explain the strategies for management of natural resources to achieve sustainability
22ESK57.3	Analyze the control measures of Environmental pollution and global Environmental issues.
22ESK57.4	Apply the knowledge of Environment Impact Assessment, Technology, Environmental acts and laws in protecting Environment and human health.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO100	PO11	PO12
22ESK57.1	-	-	-	-	-	3	3	-	-	-		-
22ESK57.2	-	-	-	-	-	3	3	-	-	-	-	3
22ESK57.3	-	-	-	-	-	3	3	3	-	3	-	3
22ESK57.4	-	-	-	-	1	3	3	3	-	3	-	3

MODULE 1	**INTRODUCTION TO ENVIRONMENT, ECOSYSTEM AND BIODIVERSITY**	**22ESK57.1**	**3hrs**

Environment: Definition, Components of Environment; Ecosystem: Types & Structure of Ecosystem, Energy flow in the ecosystem; Biodiversity: Types, Hot-spots, Threats and Conservation of biodiversity.

Self-study / Case Study / Applications	Case study on environmental eco systems and its types.
Text Book	Text Book 1: Ch. 1 , 3 & 4

MODULE 2	**NATURAL RESOURCES**	**22ESK57.2**	**3hrs**

Advanced Energy resources (Hydrogen, Solar, OTEC, Tidal and Wind), merits and demerits, Water resources – cloud seeding, Mineral resources, Forest resources. Strategies of management, concept of sustainability.

Self-study / Case Study / Applications	Self-study on different natural resources and its applications
Text Book	Text Book 1: Ch. 2

MODULE 3	**ENVIRONMENTAL POLLUTION**	**22ESK57.3**	**3hrs**

Definition, Causes, effects and control measures of Air Pollution, Water Pollution, soil Pollution and Noise pollution. Solid wastes and its management. Role of society, NGO and Govt. agencies in prevention of pollution

Self-study / Case Study / Applications	Case Study on the different environmental pollution
Text Book	Text Book 1: Ch. 5,6, Text Book 2: Ch. 5

MODULE 4	**GLOBAL ENVIRONMENTAL ISSUES, ENVIRONMENT ACTS AND AMENDMENTS**	**22ESK57.3**	**3hrs**

Fluoride problem in drinking water, Acid Rain, Ozone layer depletion, Global warming and climate change. National forest policy, Environmental laws and acts. International agreements and protocols.

Self-study / Case Study / Applications	Case Study on global environmental issues.

Text Book	Text Book 1: Ch. 6, Text Book 2: Ch. 6		
MODULE 5	**HUMAN POPULATION AND ENVIRONMENT IMPACT ASSESSMENT**	**22ESK57.4**	**3hrs**
Population growth & explosion, Population pyramids. Negative impact of agriculture and urbanization, Role of Technology in protecting environment and human health. Environment Impact Assessment.			
Self-study / Case Study / Applications	Self-Study about the impact of population on environment.		
Text Book	Text Book 1: Ch. 7		

CIE Assessment Pattern (50 Marks – Theory) –

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

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	15
L2	Understand	15
L3	Apply	20
L4	Analyze	--
L5	Evaluate	--
L6	Create	--

Suggested Learning Resources:

Text Books:

1. Environmental studies by Benny Joseph, Tata McGraw Hill Education Private Limited, 2009, ISBN: 9870070648135.
2. "Environmental Studies: Basic Concepts" by Ahluwalia, V. K. The Energy and Resources Institute (TERI) Publication, 2nd edition, 2016. ISBN: 817993571X, 9788179935712.

Reference Books:

1. Handbook of Environmental Engineering by Rao Surampalli, Tian C. Zhang, Satinder Kaur Brar, Krishnamoorthy Hegde, Rama Pulicharla, Mausam Verma; McGraw Hill Professional, 2018. ISBN: 125986023X, 9781259860232
2. Environmental Science and Engineering by P. Venugopala, Prentice Hall of India Pvt. Ltd, New Delhi, 2012 Edition. ISBN: 978-81-203-2893-8.
3. Elements of Environmental Science and Engineering by P. Meenakshi, Prentice Hall of India Pvt. Ltd, 2005 Edition. ISBN: 8120327748, 9788120327740

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/120/108/120108004/
- https://archive.nptel.ac.in/courses/103/107/103107215/

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

- Visit to any company to study the initiative taken for environmental impact.
- Case study based learning on engineering approaches for pollution prevention.
- Video/ model / charts based learning
- Activities/awareness program for preventing environmental pollution

MINI PROJECT-II			
Course Code	**22MEE58**	**CIE Marks**	**50**
L: T:P:S	**0:0:1:0**	**SEE Marks**	**50**
Hrs / Week	**0**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**03**
Course outcomes: At the end of the course, the student will be able to:			
22MEE58.1	Identify an open ended problem in area of mechanical engineering		
22MEE58.2	Identify the methods and materials required for the project work		
22MEE58.3	Apply the theoretical concepts to solve industrial problems with teamwork and multidisciplinary approach.		
22MEE58.4	Formulate and implement innovative ideas for social and environmental benefit		
22MEE58.5	Analyze the results to come out with concrete solutions		
22MEE58.6	Demonstrate professionalism with ethics; present effective communication skills and relate engineering issues to broader societal context		
Mini Project Roadmap: Guiding Principles for Mini Project Success			

Project Overview:

- Clearly define the project's scope, objectives, and expected outcomes.
- Provide a brief description of the problem the project aims to solve or the functionality it should implement.

Project Milestones:

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

Project Requirements:

- List the specific features or functionality that students need to implement in their projects.
- Clearly state any constraints or limitations they should be aware of during development.

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.

Text Book	Text Book 1 & 2

CIE Assessment Pattern (50 Marks – Reviews as per the rubric statements defined)

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1. Kothari, C.R., 2018. Research Methodology: Methods and Techniques. New Age International. ISBN-13: 978-8122436235

2) Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2015, An introduction to Research Methodology, RBSA Publishers. ISBN-13: 978-8176111652

3) Ranjithkumar, 2014, research methodology, saga publications,4th edition ISBN-13- 978- 9351501336

Reference Books:

1.Anderson, T. W., 2011, An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi. ISBN-13: 978-8126524488

2) Montgomary, Douglas C. &Runger, George C. (2016) 6/e, Applied Statistics & probability for Engineers (Wiley India) ISBN-13: 978-1118539712

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=YScxVF6ZcYI
- https://www.youtube.com/watch?v=9WMgaulAJ-0

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

These challenging mini project activities can provide students with opportunities to think critically, apply their knowledge, and develop problem-solving skills in a practical context.

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

These challenging mini project activities can provide students with opportunities to think critically, apply their knowledge, and develop problem-solving skills in a practical context.

Interdisciplinary Projects:

- Encourage collaboration among students from different disciplines to work on projects that require diverse expertise.

Prototype Development:

- Challenge students to create a prototype of a product or device.

Simulation and Modelling:

- Task students with creating computer simulations or mathematical models to solve complex problems or simulate real-world scenarios.

1.Humanitarian and Social Impact Projects:

1.**Environmental Sustainability Projects:**

Challenge students to propose and implement sustainability initiatives or renewable energy projects.

2.Scientific Research Projects:

Assign students to conduct scientific research experiments, gather data, and present findings.

VI Semester Syllabus

MACHINE DESIGN

Course Code	**22MEE61**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**03**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

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

22MEE61.1	Understand the concept of stresses, failure theories in a 2d and 3d plane by solving the numerical.
22MEE61.2	Determine and evaluate the stress in a machine element by considering stress concentration in curved beams.
22MEE61.3	Analyze the size of the threaded fastener by validating the selection of threaded fastener through design analysis.
22MEE61.4	Design the load carrying elements such as load carrying elements, such as ropes, chains, and screws.
22MEE61.5	Design the power transmission elements such as spur gear and bevel gear, by considering static, dynamic and wear load analysis.
22MEE61.6	Apply the design skills towards the engineering component design.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22MEE61.1	3	3	3	-	-	-	-	-	-	-	-		-	3
22MEE61.2	3	3	3	-	-	-	-	-	-	-	-		-	3
22MEE61.3	3	3	3	-	-	-	-	-	-	-	-		-	3
22MEE61.4	3	3	3	-	-	-	-	-	-	-	-		-	3
22MEE61.5	3	3	3	-	-	-	-	-	-	-	-		-	3
22MEE61.6	3	3	3	-	-	-	-	-	-	-	-		-	3

MODULE-1	**STATIC, MODES AND THEORIES OF FAILURE**	**22MEE61.1 22MEE61.6**	**8 Hours**

Introduction to normal, shear, biaxial and tri axial stresses, Stress tensor, Codes and Standards (only theory) Numerical on Principal Stresses (2D only).
Static strength: Numerical on Axial load, Bending load and Torsion load.
Modes and Theories of Failure: Modes of Failure: Fatigue, creep, Ductile, Brittle, Wear, Corrosion. (theory), Definition of Maximum normal stress theory, Maximum shear stress theory, Distortion energy theory, Coulomb mohr's theory. Numerical on Maximum normal stress theory, Maximum shear stress theory, Distortion energy theory.

Case Study / Applications	Investigation on the types of load application in a 2d elements (sheet metal)
Text Book:	Text Book 1: 4.1, 4.2, 4.3, 4.4, 4.5, 4.6 Text Book 1: 4.14, 4.15, 4.16, 4.17, 4.18

MODULE-2	**STRESS CONCENTRATION AND CURVED BEAMS**	**22MEE61.2 22MEE61.6**	**8 Hours**

Stress concentration: Determination of stress concentration factor
Curved Beams: Stresses in curved beams of standard cross sections used in crane hook, punching presses & clamps, closed rings and links.

Case Study / Applications	Application of stress concentration – Case study.

Text Book:	Text Book 1: 4.22 Text Book 1: 5.1, 5.2, 5.3		
MODULE-3	**DESIGN OF THREADED FASTENERS, FATIGUE STRENGTH**	**22MEE61.3, 22MEE61.6**	**8 Hours**
Design of threaded fasteners: Stresses in threaded fasteners due to initial load and applied load, Numerical on axial load, eccentric load and shear load on threaded fasteners for circular and rectangular brackets Fatigue strength design: Introduction to S-N Diagram and Endurance limit, Fatigue strength under fluctuating stresses (soderberg& Goodman criteria), stresses due to combined loading and numerical.			
Case Study	Case study: To identify the types of threaded fasteners used in IC engines		
Text Book	Text Book 1: 7.1, 7.2, 7.7, 7.8, 7.10, 7.11, 7.12, 7.13, 7.14 Text Book 1: 5.15		
MODULE-4	**DESIGN OF POWER SCREWS, ROPES, AND CHAINS**	**22MEE61.4, 22MEE61.6**	**8 Hours**
Design of power screws: Stresses in power screws, efficiency and self-locking. Design of Ropes, Chains: Ropes and chains for different applications and numerical			
Case Study / Applications	Determination of the screw diameters, pitch of power screws used in lathe machines and UTM		
Text Book	Text Book 1: 6, 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8, 6.9 Text Book 1: 14.1, 14.2, 14.6, 14.7		
MODULE-5	**DESIGN OF SPUR GEAR AND HELICAL GEAR**	**22MEE61.5, 22MEE61.6**	**8 Hours**
Design of spur gear and Bevel gear: Definitions, stresses in gear tooth, Lewis equation and form factor, Design for strength, Dynamic load and wear load. Helical Gears: Definitions, formative number of teeth, Design based on strength, dynamic and wear loads.			
Case Study / Applications	Identification of the gear parameters physically by using gear tooth vernier		
Text Book	Text Book 1: 17, 17.1, 17.2 to 17.22 Text Book 1: 19, 19.1, 19.2 to 19.7		

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Marks Distribution		
		Test (s)	Qualitative Assessment (s)	MCQ's
		25	15	10
L1	Remember	5	-	-
L2	Understand	5	-	-
L3	Apply	5	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**	10
L2	**Understand**	10
L3	**Apply**	10
L4	**Analyze**	10
L5	**Evaluate**	10
L6	**Create**	--

Suggested Learning Resources:

Text Books:

1. Shigley's Mechanical Engineering Design ,by Richard G Budynas and Keith J Nisbett,McGraw Hill International edition, 9 th Edition,ISBN:9780071077835,2015
2. Design of Machine Elements, V. B Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi,4th Ed. ISBN:9789339221126, 2021

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Reference Books:

1. Machine Design, Robert L. Norton, Pearson Education . 5th edition,ISBN: 9780133356717
2. Design of Machine Elements, M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayram and C. V. Venkatesh, Pearson Education, 8th edition.2020
3. Schaum's Outline of Machine Design , Hall, Holowenko, Laughlin (Schaum's Outlines series) Adapted by S.K. Somani, Tata McGraw Hill Publishing Company Ltd., New Delhi, Special Indian Edition, 1st edition,ISBN:9780070634589.,2018

Web links and Video Lectures (e-Resources):

- **https://archive.nptel.ac.in/courses/112/105/112105125/**
- **http://www.nptelvideos.com/course.php?id=791**
- **https://www.coursera.org/learn/machine-design1**

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

- Visit to any design / manufacturing/aero/auto industry or any power plant
- Present case studies of notable machine design projects, highlighting both successful and failed designs.
- Include a failure analysis activity where students examine a failed machine component to determine the cause of failure and suggest improvements.
- For active participation of students, instruct the students to prepare Flowcharts and Handouts
- Organizing Group wise discussions on issues
- Seminars

MACHINE DESIGN LAB

Course Code	**22MEL61**	**CIE Marks**	**50**
L:T:P:S	**0:0:1:0**	**SEE Marks**	**50**
Hrs / Week	**02**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**03**

Course outcomes:

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

22MEL61.1	Understand the concepts of natural frequency, logarithmic decrement, damping and damping ratio.
22MEL61.2	Analyze the concept of the critical speed of a rotating shaft.
22MEL61.3	Evaluate the stress concentration for Photo elastic materials.
22MEL61.4	Illustrate the principles of pressure development in an oil film of a hydrodynamic journal bearing.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22MEL61.1	2	2	2	-	-	-	-	-	-	-	-	-	3	-
22MEL61.2	3	2	2	-	-	-	-	-	-	-	-	-	3	-
22MEL61.3	3	3	2	-	-	-	-	-	-	-	-	-	3	-
22MEL61.4	3	2	2	-	-	-	-	-	-	-	-	-	3	-

Exp. No.	List of Experiments	Hours	COs
	Prerequisite Experiments **NA**	**-**	**-**
	PART-A		
1	Determination of natural frequency of simple pendulum	2	22MEL61.1
2	Determination of natural frequency of compound pendulum	2	22MEL61.1
3	Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom of torsional vibrating systems.	2	22MEL61.1
4	Determination of logarithmic decrement, damping ratio, damping frequency and natural frequency of a cantilever beam under free vibration	2	22MEL61.1
5	Determination of critical speed of a rotating shaft	2	22MEL61.2
6	To determine the logarithmic decrement, damping ratio, damping frequency and natural frequency of a fixed beam under free vibration	2	22MEL61.1
	PART-B		
7	Determination of Fringe constant of Photo-elastic material using Circular disc subjected to diametral compression.	2	22MEL61.3
8	Determination of Fringe constant of Photo-elastic material using Circular disc subjected to pure bending specimen (four-point bending).	2	22MEL61.3
9	Determination of stress concentration using Photo-elasticity for simple components like plate with a hole under tension or bending, circular disk with circular hole under compression, 2D Crane hook	2	22MEL61.3

10	Determination of Pressure distribution in Journal bearing	2	22MEL61.4
11	Determination of Principal Stresses and strains in a member subjected to combined loading using strain gauge rosette	2	22MEL61.3
12	Determination of stresses in Curved beam using strain gauge.	2	22MEL61.3

PART-C

Beyond Syllabus Virtual Lab Content

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

- **https://mdmv-nitk.vlabs.ac.in/exp/exp-cantilever-beam-nitk/**
- **https://mdmv-nitk.vlabs.ac.in/exp/exp-rotating-unbalance-nitk/**
- **https://mdmv-nitk.vlabs.ac.in/exp/exp-simply-supported-beam-nitk/**

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		20	30
L1	Remember	-	5
L2	Understand	5	10
L3	Apply	5	5
L4	Analyze	5	5
L5	Evaluate	5	5
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	05
L2	Understand	10
L3	Apply	20
L4	Analyze	10
L5	Evaluate	05
L6	Create	-

Reference Books:

1) "Shigley's Mechanical Engineering Design", Richards G. Budynas and J. Keith Nisbett, McGraw-Hill Education, 10th Edition, 2015. ISBN 9780073398204
2) "Design of Machine Elements", V.B. Bhandari, TMH publishing company Ltd. New Delhi, 2nd Edition 2007. ISBN 9780070634141

FINITE ELEMENT METHODS

Course Code	**22MEE62**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**3**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22MEE62.1	Understand the concept of FEM, FE procedure, Interpolations, paraphrase numerical methods
22MEE62.2	Evaluate the desirable characteristics of one dimensional and 2-D element
22MEE62.3	Analyze the problem for applying boundary conditions for 1D elements
22MEE62.4	Apply suitable boundary conditions to a global equation for trusses
22MEE62.5	Determine the unknown field variables Deflection in Beams.
22MEE62.6	Evaluate dynamic problems Eigen values for the given application

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22MEE62.1	3	3	3	3	-	-	-	-	-	-	-	-	-	3
22MEE62.2	3	3	3	3	-	-	-	-	-	-	-	-	-	3
22MEE62.3	3	3	3	3	-	-	-	-	-	-	-	-	-	3
22MEE62.4	3	3	3	3	-	-	-	-	-	-	-	-	-	3
22MEE62.5	3	3	3	3	-	-	-	-	-	-	-	-	-	3
22MEE62.6	3	3	3	3	-	-	-	-	-	-	-	-	-	3

MODULE-1	**INTRODUCTION TO FINITE ELEMENT METHODS**	**22MEE62.1**	**8 Hours**

Introduction to Finite Element Methods**:**

Basic Concept, Historical background, General and Engineering applications of the FEM, Advantages, Classification, Basic steps, Types of elements based on Geometry, bandwidth, Variation formulations using Rayleigh Ritz method and weighted residual methods. Basic Equations and Potential Energy Functional, Numericals.

Interpolation Models: Introduction, Polynomial form of interpolation function, Simplex, Complex, and Multiplex elements, Interpolation polynomial in terms of nodal DOF, Selection of the order of the interpolation polynomial, Convergence requirements, coordinate systems

Text Book	Text Book 1: 1.1 to 1.15
Case Study	Problem solving on Numerical Integration.

MODULE-2	**DERIVATIONS OF 1-D AND 2-D ELEMENTS:**	**22MEE62.2**	**8 Hours**

Shape functions and its properties, Derivation of Shape functions in Global, Local and Natural Co-ordinate systems. Shape functions for Triangular and Quadrilateral element. Strain Displacement matrix for Triangular and Quadrilateral Elements, Numericals on Isoparametric Formulation and Jacobian Matrix.

Text Book	Text Book 1: 3.1to 3.11,6.1-6.4
Case Study	Derivation of Shape functions for various Higher order elements.

MODULE-3	**SOLUTION OF 1-D PROBLEMS:**	**22MEE62.3**	**8 Hours**

Definition, Properties of a stiffness matrix and derivation of Stiffness matrix for 1-D bar element, Essential and Non Essential Boundary conditions, Problems using Elimination and Penalty approach on various loading conditions for Constant cross section ,Tapered cross section and bar with a Gap, Temperature effect on Bar

Text Book	Text Book 1:3.1-3.10
Application	Evaluation of Stresses and field variables of structures using ANSYS software.

MODULE-4	STRUCTURAL ANALYSIS THROUGH FEM FOR BEAMS AND TRUSSES:	22MEE62.4 22MEE62.5	8 Hours

Beams: 2-Noded beam element, Finite element formulation, load vector, point load, UDL, shear force and bending moment, Deflection equation, shape functions and stiffness matrixes.
Trusses: Includes study of problems with one, two, three and four bar elements, Equation of truss, stiffness matrix derivation, and assumptions.

Text Book	Text Book 1: 4.1-4.5,5.1-5.3 Text Book 2: 10.1, 10.3, 10.5, 10.7
Case Study	Determination of Field variables related to Frames and Axisymmetric problems.

MODULE-5	FEM FOR DYNAMIC ANALYSIS	22MEE62.6	8 Hours

FEM for Dynamic: System of springs, Formulation for point mass and distributed masses, Consistent element mass matrix of one dimensional bar element, truss element, quadrilateral element, beam element. Lumped mass matrix, Evaluation of Eigen values and Eigen vectors, Applications to bars, stepped bars, and beams.

Applications	Practical applications of Dynamic analysis in spring mass system.
Text Book	Text Book 1: 11.1-11.6

CIE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) Chandrupatla T. R. "Introduction to Finite Elements in engineering"- 4th Edition, Pearson, ISBN-13: 978-0132162746, 2016
2) Lakshmi Narayana H. V.,"Finite Elements Analysis"– Procedures in Engineering, Universities Press, ISBN-13: 978-83714764,2014

Reference Books:

1) Rae S. S. "Finite Elements Method in Engineering"- 4th Edition, Elsevier, ISBN: 9780750678285 ,2014
2) P.Seshu, "Textbook of Finite Element Analysis" -PHI, ISBN : 978-81-203-2315-5, 2007
3) J.N.Reddy,"Finite Element Method"-McGraw-Hill International Edition. 3rd Ed,ISBN: 9780070607415, 2019
4) Bathe K. J. "Finite Elements Procedures"- PHI, ISBN : 978-81-203-1075-9 5) Cook R. D., et al., "Concepts and Application of Finite Element Method" John Wiley & Sons INC 4th edition, ISBN-13: 978-0471356059, 2012

Web links and Video Lectures (e-Resources):

- **https://www.youtube.com/watch?v=UOp6JEiJctA&list=PLSGws_74K018SmggufD-pbzG3thPIpF94**
- **https://www.youtube.com/watch?v=0VNIEfX0m4A&list=PLSGws_74K018SmggufD-pbzG3thPIpF94&index=3**
- **https://www.youtube.com/watch?v=jQPwabwnBpg&list=PLSGws_74K018SmggufD-pbzG3thPIpF94&index=27**
- **https://www.youtube.com/watch?v=1JOMM-ytOyU&list=PLSGws_74K018SmggufD-pbzG3thPIpF94&index=4**

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

- Visit to any Design company/aero/auto industry
- Demonstration of Structures using ANSYS software.
- Video demonstration of Stress concentration factor for a plate with a hole.
- Problem solving approaches for the Approximation methods.
- Contents related activities (Activity-based discussions)
- For active participation of students, instruct the students to solve the matrix related numericals.
- Organizing Group wise discussions on issues
- Seminars

FINITE ELEMENT METHOD LAB

Course Code	**22MEL62**	**CIE Marks**	**50**
L:T:P:S	**0:0:1:0**	**SEE Marks**	**50**
Hrs / Week	**2**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**03**

Course outcomes:

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

22MEL62.1	Apply the modern tools to formulate and create geometry for solving problems of bars with different loading condition
22MEL62.2	Analyze boundary condition to determine stress with different loading conditions of a rectangular plate with a hole
22MEL62.3	Analysis of truss members to find displacements and stresses with different loading Conditions and to demonstrate the deflection of beams subjected to draw shear force and bending moment diagrams
22MEL62.4	Evaluate the Temperature Distribution and Temperature gradient across the Composite wall .

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22MEL62.1	3	2	2	-	3	-	-	-	-	-	-	-	-	3
22MEL62.2	3	3	3	-	3	-	-	-	-	-	-	-	-	3
22MEL62.3	3	3	3	-	3	-	-	-	-	-	-	-	-	3
22MEL62.4	3	3	3	-	3	-	-	-	-	-	-	-	-	3

Exp. No.	List of Experiments	Hours	COs
	Prerequisite Experiments		
	• Stress analysis of various structures • Meshing the structures using various analysis softwares • Shear Force and Bending Moment Diagrams	2	NA
	PART-A		
1	Introduction To FEA Package And Stress Analysis	2	22MEL62.1
2	Bars Of Constant Cross Section	2	22MEL62.1
3	Bars Of Tapered Cross Section And Stepped Bar	2	22MEL62.1
4	Stress Analysis Of A Rectangular Plate With A Hole	2	22MEL62.2
5	Problems With 2 bar Trusses.	2	22MEL62.3
6	Problems With 3 bar Trusses	2	22MEL62.3
	PART-B		
7	Beams: Cantilever With Various Loading Conditions	2	22MEL62.3
8	Beams: Simply Supported Beams With Different Load Ng Conditions	2	22MEL62.3
9	Thermal Analysis of a Composite wall with the given boundary conditions.	2	22MEL62.4
10	Heat flux analysis of a given Composite wall.	2	22MEL62.4
11	Temperature gradient analysis of a Composite wall.	2	22MEL62.4
12	Thermal Analysis of a fins with the given boundary conditions.		
	PART-C **Beyond Syllabus Virtual Lab Content** **(To be done during Lab but not to be included for CIE or SEE)**		

- https://mech.l3.nitk.ac.in/course/applied-finite-element-method
- https://mech.nitk.ac.in/course/finite-element-analysis

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		20	30
L1	Remember	-	5
L2	Understand	5	10
L3	Apply	5	5
L4	Analyze	5	5
L5	Evaluate	5	5
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	05
L2	Understand	10
L3	Apply	20
L4	Analyze	10
L5	Evaluate	05
L6	Create	-

Suggested Learning Resources:

Text Books:

1) Rae S. S. "Finite Elements Method in Engineering"- 4th Edition, Elsevier, ISBN: 9780750678285
2) P.Seshu, "Textbook of Finite Element Analysis" -PHI, ISBN : 978-81-203-2315-5
3) J.N.Reddy,"Finite Element Method"-McGraw-Hill International Edition. 3rd Ed,ISBN: 9780070607415
4) Bathe K. J. "Finite Elements Procedures"- PHI, ISBN : 978-81-203-1075-9
5) Cook R. D., et al., "Concepts and Application of Finite Element Method" John Wiley & Sons INC 4th edition, ISBN-13: 978-0471356059

EMERGING AUTOMOTIVE TECHNOLOGIES

Course Code	**22MEE63**	**CIE Marks**	**50**
L:T:P:S	**2:1:0:0**	**SEE Marks**	**50**
Hrs / Week	**4**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22MEE63.1	Understand the functions of IC engine components and fuel supply systems.
22MEE63.2	Investigation of the Super and Turbo Chargers for enhancing the power output.
22MEE63.3	Study of the different ignition systems used in IC engines.
22MEE63.4	Design and Development of various transmission system, braking and safety Mechanisms
22MEE63.5	Analyze the concept of Electric Vehicles, Energy Storage and Automotive Emission Control System.
22MEE63.6	Implement the Automotive Applications for Modern Technology.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22MEE63.1	3	-	-	-	-	-	-	-	-	-	-	-	-	3
22MEE63.2	3	3	-	-	-	-	-	-	-	-	-	-	-	3
22MEE63.3	3	2	-	-	-	-	-	-	-	-	-	3	-	3
22MEE63.4	3	2	3	-	-	-	-	-	-	-	-	3	-	3
22MEE63.5	3	3	2	-	-	-	2	-	-	-	-	3	-	3
22MEE63.6	3	-	-	-	2	-	-	-	-	-	-	3	-	3

MODULE-1	**ENGINE COMPONENTS, MODERN FUEL SUPPLY SYSTEMS**	**22MEE63.1 22MEE63.6**	**8 Hours**

Engine Components and Modern Fuel Supply Systems: cylinder – arrangements and their relatives merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, Combustion chamber Design in SI and CI engines.

Modern Fuel Supply Systems Electronic Fuel CV Injection (EFI) system, merits and demerits of EFI system, multi-point fuel injection system, D-MPFI system, L-MPFI system, Common rail injection system, i-V TECH, VVT.

Applications	List the applications of different suspension systems in vehicles.
Text Book	Text Book 2: 12.14, 13.18, 17.22

MODULE-2	**IGNITION SYSTEMS, SUPERCHARGERS AND TURBOCHARGERS**	**22MEE63.2 22MEE63.3 22MEE63.5**	**8 Hours**

Ignition Systems: Battery Ignition systems, magneto Ignition system, Transistor assist contacts. Electronic Ignition, Automatic Ignition advance systems.

Superchargers And Turbochargers: Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger construction and operation, Intercooler, Turbocharger lag.

Applications	List the Ignition system applications for different automobiles.
Text Book	Text Book 2: 1.3, : 2.15, 28.378, 29.399

MODULE-3	**POWER TRAINS , DRIVE TO WHEELS**	**22MEE63.4**	**8 Hours**

Power Trains: Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Over drive, fluid flywheel, torque converter

Drive To Wheels: Propeller shaft and universal joints, differential, steering geometry, camber, king pin inclination, included angle, castor, toe in & toe out, condition for exact steering, steering gears, power steering, general arrangements of links and stub axle, over steer, under steer and neutral steer.

Self-study	Self-study on advanced steering systems
Text Book	Text Book 2: 3.32, 11.123, 28.378

MODULE-4	**BRAKES AND AUTOMOTIVE EMISSION CONTROL SYSTEMS**	**22MEE63.4 22MEE63.5**	**8 Hours**

Brakes: Types of brakes, mechanical compressed air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, Antilock – Braking systems.

Automotive Emission Control Systems: Controlling crankcase emissions, Controlling evaporative emissions, Exhaust gas recirculation, Catalytic converter, Treating the exhaust gas, Air- injection system, Air-aspirator system, Emission Standards : BS-I,BS-II, BS-III, BS-IV,BS-VI

Case Study	Emission control Systems.
Text Book	Text Book 2: 7.68, 8.89, Text Book 1: 35.448

MODULE-5	**HYBRID VEHICLES AND AUTONOMOUS VEHICLES**	**22MEE63.4 22MEE63.6**	**8 Hours**

Hybrid Electric Vehicles (HEVs): History of electric and hybrid vehicles. Need of electric and hybrid vehicles – comparative study of diesel, petrol, electric and hybrid vehicles. Limitations of electric vehicles. Specification of different electric and hybrid vehicles

Autonomous Vehicles: levels of autonomy from Level 0 (no automation) to Level 5 (full automation), focusing on sensor technologies (radar, lidar, cameras), artificial intelligence algorithms for decision-making and regulatory challenges, Electronic Stability program

Applications	Hybrid Vehicles applications and case studies on Electric Vehicles.
Text Book	Text Book 2: 26.345,27.362

CIE Assessment Pattern (50 Marks – Theory) –

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) Automotive mechanics, William H Crouse & Donald L Anglin, 10th Edition Tata McGraw Hill Publishing Company Ltd., 2007, ISBN 9780070636381.
2) Automotive Mechanics Srinivasan, 2nd Ed., Tata McGraw Hill 2003, ISBN 9780070585220

Reference Books:

1) Automotive mechanics: Principles and Practices, Joseph Heitner, D Van Nostrand Company, Inc ISBN 9780442254187.
2) Fundamentals of Automobile Engineering, K.K.Ramalingam, Scitech Publications (India) Pvt. Ltd.
3) Automobile Engineering, R. B. Gupta, SatyaPrakashan, 4th edn. 1984.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=ZQvfHyfgBtA
- https://www.youtube.com/watch?v=SzyswSQD1Sc
- https://www.youtube.com/watch?v=SyD0xtXrRIo&t=109s
- https://www.youtube.com/watch?v=665YfCieiH8
- https://www.youtube.com/watch?v=RCbZjPHC1gg

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

- Visit to any Automotive industry
- Video demonstration of latest trends in Automotive technologies
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to collect Automotive parts
  - Organizing Group wise discussions on issues in Automotive technologies
  - Seminars

NON TRADITIONAL MACHINING

Course Code	**22MEE641**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**03**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22MEE641.1	Identify the uses of Nontraditional machines for modern manufacturing industries.
22MEE641.2	Understand the uses of chemical & electro chemical process.
22MEE641.3	Apply the modern finishing process in NTM.
22MEE641.4	Evaluate the methods of hybrid non- traditional machining.
22MEE641.5	Analyze the process of Laser beam machining.
22MEE641.6	Develop the suitable applications of traditional NTM, Nano, and laser beam machining for NTM.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22MEE641.1	2	2	-	-	-	-	-	-	-	-	-	-	2	-
22MEE641.2	2	2	-	-	-	-	-	-	-	-	-	-	2	-
22MEE641.3	3	2	-	-	-	-	-	-	-	-	-	-	2	-
22MEE641.4	3	3	-	-	-	-	-	-	-	-	-	-	2	-
22MEE641.5	3	2	-	-	-	-	-	-	-	-	-	-	2	-
22MEE641.6	3	3	-	-	-	-	-	-	-	-	-	-	2	-

MODULE-1	**INTRODUCTION NON TRADITIONAL MACHINING**	**22MEE641.1,**	**8 Hours**

Introduction to Non-traditional machining, Need for Non-traditional machining process, Comparison between traditional and non-traditional machining, general classification Nontraditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes.

Self Study	Study about nontraditional machining
Text Book	Text Book 1: Ch. 1, 2

MODULE-2	**CHEMICAL AND ELECTRO-CHEMICAL ENERGY-BASED PROCESSES**	**22MEE641.2, 22MEE641.3**	**8 Hours**

Principles, equipment's, effect of process parameters, applications, advantages and limitations of Chemical machining, Electro-chemical machining, Electrochemical honing, Electrochemical grinding, Electro chemical deburring.

Case-study	Electro chemical energy process
Text Book	Text Book 3 Ch.3,4,5

MODULE-3	**NANO FINISHING PROCESSES**	**22MEE641.3, 22MEE641.4**	**8 Hours**

Principles, equipment's, effect of process parameters, applications, advantages and limitations of Abrasive flow machining – Chemo mechanical polishing, Magnetic abrasive finishing, Magnetorheological finishing, Magneto rheological abrasive flow finishing.

Self-study	Study the nano finishing equipment's

Text Book	Text Book 3,4: Ch. 3-4,5: 4-5,6		
MODULE-4	**HYBRID NON-TRADITIONAL MACHINING PROCESSES**	**22MEE641.4**	**8Hours**
Introduction – Various hybrid non-traditional machining processes, their working principles, equipments, effect of process parameters, applications, advantages and limitations. Selection and comparison of different non-traditional machining processes.			
Applications	Study the applications of Hybrid NTM Machines		
Text Book	Text Book 3,4: Ch. 3-8,9 : 4-7,8		
MODULE-5	**LASER BEAM MACHINING**	**22MEE641.5, 22MEE641.6**	**8Hours**
LASER BEAM MACHINING (LBM): Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, Advantages & limitations. ELECTRON BEAM MACHINING (EBM): Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations.			
Self Study	Study the process of Laser beam machining		
Text Book	Text Book 2: Ch.10		

CIE Assessment Pattern (50 Marks – Theory) –

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

TEXT BOOKS:

1)Modern Machining Process by P.C Pandey and H S Shah Mc Graw Hill Education India Pvt. Ltd. ISBN-13 978-0070965539, 2013

Production technology HMT McGraw Hill Education India Pvt. Ltd 2015.

2)Adithan. M., "Unconventional Machining Processes", Atlantic, New Delhi, India, 2009. ISBN 13: 9788126910458.

3)Anand Pandey, "Modern Machining Processes", Ane Books Pvt. Ltd., New Delhi, India, 2019.

REFERENCE BOOKS:

1) Benedict, G.F., "Non-traditional Manufacturing Processes", Marcel Dekker Inc., New York 1987. ISBN-13: 978-0824773526.
2) Carl Sommer, "Non-Traditional Machining Handbook", Advance Publishing., United States, 2000, ISBN-13: 978-1575373256.
3) Golam Kibria, Bhattacharyya B. and Paulo Davim J., "Non-traditional Micromachining Processes: Fundamentals and Applications", Springer International Publishing., Switzerland, 2017, ISBN:978-3-319-52008-7.
4) Jagadeesha T., "Non-Traditional Machining Processes", I.K. International Publishing House Pvt. Ltd., New Delhi, India, 2017, ISBN-13: 978-9385909122.
5) Kapil Gupta, Neelesh K. Jain and Laubscher R.F., "Hybrid Machining Processes: Perspectives on Machining and Finishing", 1st edition, Springer International Publishing., Switzerland, 2016, ISBN 13: 978-3319259208.

Web links and Video Lectures (e-Resources):

- https://in.video.search.yahoo.com/yhs/search?fr=yhs-sz-002&ei=UTF-8&hsimp=yhs-002&hspart=sz&param1=2486481154&p=non+traditional+machining+video+links+youtube&vm=r&type=type80160-848365615#id=0&vid=059506308eba0918daad1037ea08844a&action=click
- https://in.video.search.yahoo.com/yhs/search?fr=yhs-sz-002&ei=UTF-8&hsimp=yhs-002&hspart=sz&param1=2486481154&p=non+traditional+machining+video+links+youtube
- https://in.video.search.yahoo.com/yhs/search?fr=yhs-sz-002&ei=UTF-8&hsimp=yhs-002&hspart=sz&param1=2486481154&p=non+traditional+machining+video+links+youtube

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

- Visit the manufacturing Industry and study about the usage of modern machines.
- Visit any industrial exhibition centre and know about the modern machines.
- Conver any manufacturing operated machines into CNC machines by developing codes or use of AI code.

AUTONOMOUS VEHICLES

Course Code	**22MEE642**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**03**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22MEE642.1	Understand key concepts of the perception-planning-controlling-control pipeline for autonomous driving
22MEE642.2	Apply autonomous vehicles in various fields of transportation
22MEE642.3	Analyze basic technical enablers for autonomous vehicles.
22MEE642.4	Evaluate technical requirements that are required for autonomous vehicles.
22MEE642.5	Identify people perspective regarding driverless/pilotless vehicles.
22MEE642.6	Analyze legal and ethical aspects in autonomous vehicles

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22MEE642.1	3	3	-	-	2	-	-	-	1	1	-	2	3	-
22MEE642.2	3	3	-	-	2	-	-	-	1	1	-	2	3	-
22MEE642.3	3	3	-	-	2	-	-	-	1	1	-	2	3	-
22MEE642.4	3	3	-	-	2	-	-	-	1	1	-	2	3	-
22MEE642.5	3	3	-	-	2	-	-	-	1	1	-	2	3	-
22MEE642.6	3	3	-	-	2	-	-	-	1	1	-	2	3	-

MODULE-1	**INTRODUCTION TO AUTONOMOUS VEHICLES**	**22MEE642.1**	**8 Hours**

Introduction To Connected, Automated And Intelligent Cars Introduction to Connected, automated and Intelligent cars- Automotive Electronics Overview, Advanced Driver Assistance Electronic Systems, Connected Car Technology- Connectivity Fundamentals, Navigation and Other Applications, Connected and Autonomous Vehicle Technology Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory.

Self-study	Investigate the Challenges of Autonomous vehicles, Compare with traditional areas of science and engineering.
Text Book	Text Book 1:1.1-1.3

MODULE-2	**SENSOR TECHNOLOGY**	**22MEE642.2**	**8 Hours**

Sensor Technology for Advanced Driver Assistance Systems- Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Sensor Technology for Driver Impairment Detection, Transfer of Control Technology

Case Study	Investigate sensor technology for different fields of applications.
Text Book	Text Book 1: 3.1-3.5

MODULE-3	**INTRODUCTION TO SELF-DRIVING VEHICLE TECHNOLOGY**	**22MEE642.3, 22MEE642.4**	**8 Hours**

Fundamentals of state-of-the-art SLAM, multi-sensor data fusion, and other SDV algorithms. Robot Operating System (ROS) and Open Source Car Control (OSCC). Wireless System Standards and Standards Organizations Wireless Networking and Applications to Vehicle Autonomy: Basics of Computer Networking – the Internet of Things, Wireless Networking Fundamentals, Integration of Wireless Networking and On-Board Vehicle Networks

Self-study	Explore the different kinds of operating and networking systems.
Text Book	Text Book 1 : 6.1-6.4

MODULE-4	**ETHICS OF AUTONOMOUS VEHICLES**	**22MEE642.5**	**8 Hours**

Acceptance, Security and Ethics Of Autonomous Driving Why Ethics Matters for Autonomous Driving, Opportunities and Risks Associated with Autonomous Driving, User / public Acceptance of Autonomous Driving Regulations, Policies And Standards Of Autonomous Driving Regulatory bodies for highly automated and autonomous driving, Policies and policy making in autonomous driving, Autonomous driving, standardization bodies and standards

Case Study	Scrutinize the Different types of Optimization techniques of autonomous vehicles.
Text Book	Text Book 2: 2

MODULE-5	**DRIVER ASSISTANCE SYSTEM**	**22MEE642.6**	**8 Hours**

Basics of Theory of Operation, Applications – Legacy, Applications – New Future Applications Integration of ADAS Technology into Vehicle Electronics, System Examples, Role of Sensor Data Fusion, Recent Driver Assistance System Technology applied in various automobile companies dealing with Non-Passenger Car

Applications	Survey on Driver Assistance System, design, applications and case studies of the same.
Text Book	Text Book 2: 3

CIE Assessment Pattern (50 Marks – Theory) –

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1.George Dimitrakopoulos, Aggelos Tsakanikas, Elias Panagiotopoulos, "Autonomous Vehicles Technologies, Regulations, and Societal Impacts", Elsevier Publications, 2021. ISBN 9780323913298

2.Dietmar P.F. Möller, Roland E. Haas, Guide to Automotive Connectivity and Cybersecurity: Trends, Technologies, 2019, Springer Publications.

3.Hanky Sjafrie, "Introduction to Self-Driving Vehicle Technology", 1st Edition, Published December 11, 2019 by Chapman and Hall/CRC

Reference Books:

1. 1.G. Mullett, Wireless Telecommunications Systems and Networks, Thomson – Delmar Learning, ISNB#1-4018-8659-0, 2006

2. G. Mullett, Basic Telecommunications: The Physical Layer, Thomson – Delmar Learning, ISBN#1-4018-4339-5, 2003

3.Tom Denton, Automobile Electrical and Electronic Systems, 3rd Edition Elsevier Publications 2004.

Web links and Video Lectures (e-Resources):

- **https://rb.gy/zwo8oi**
- **https://rb.gy/83968n**
- **https://rb.gy/h6k28o**

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

- Investigate the Challenges of autonomous vehicles, Compare with traditional applications.
- Conduct a Survey on autonomous vehicles and study the recent advancement.
- Investigate the application of scaling the autonomous vehicles, research and development.
- Explore the application of autonomous vehicles in design, thermal and manufacturing industries.

MECHATRONICS

Course Code	**22MEE643**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**3**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22MEE643.1	Explain the basics of mechatronics and sensors
22MEE643.2	Understand the concept of signal conditioning and data acquisition system
22MEE643.3	Identify the type of electro mechanical drives for given application
22MEE643.4	Apply the concept of microprocessor and its programming
22MEE643.5	Summarize the principal and working of automotive mechatronic systems
22MEE643.6	Apply the mechatronic approach for different systems

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22MEE643.1	3	2	2	-	-	-	-	-	-	-	-	1	2	2
22MEE643.2	3	2	2	-	-	-	-	-	-	-	-	1	2	2
22MEE643.3	3	2	2	-	-	-	-	-	-	-	-	1	2	2
22MEE643.4	3	2	2	-	-	-	-	-	-	-	-	1	2	2
22MEE643.5	3	2	2	-	-	-	-	-	-	-	-	1	2	2
22MEE643.6	3	2	2	-	-	-	-	-	-	-	-	1	2	2

MODULE-1	**INTRODUCTION TO MECHATRONICS SYSTEMS:**	**22MEE643.1**	**8 Hours**

Definitions, multi-disciplinary scenario, origin of mechatronics, engineering system, mechatronics system, Measurement and its elements, control systems open loop and closed loop control system, their elements and functions, Microprocessor based controllers. Program logic controller (PLC). Review of sensors and transducers, classification of sensors and transducers, light sensors, proximity sensors, hall effect sensors, optical encoders

Self-study / Case Study / Applications	Self-study of vision sensors
Text Book	Text Book 1: 1.1 to 1.14, 2.1 to 2.8, 2.15

MODULE-2	**SIGNAL CONDITIONING AND ELECTRO MECHANICAL DRIVES**	**22MEE643.2 22MEE643.3**	**8 Hours**

Signal Conditioning: Introduction to signal conditioning, necessity, methods, amplifying signals using OP amps, Protection, Filtering, Digital signals, Analog to digital conversion, multiplexers, Data acquisition systems, Control and data acquisition (SCADA)

Electro Mechanical Drives: Relays and Solenoids, Stepper Motors, DC brushed motors, DC brushless motors, DC servo motors

Self-study / Case Study / Applications	Case study on the type of motors used in industrial robots.
Text Book	Text Book 1: 3.3, 3.5, 3.6 to 3.10 Text Book 2: 3.1 to 3.9, 7.1 to 7.7

MODULE-3	**MICROPROCESSOR & MICROCONTROLLERS:**	**22MEE643.4**	**8 Hours**

Introduction to microprocessors, Microcontrollers, Difference between Microprocessor and Microcontrollers, INTEL 8085 Microprocessor architecture and terminology, INTEL 8085-Data and Address buses, Instruction set of 8085, Instruction flow cycle, Programming the 8085, Assembly language programming.

Self-study / Case Study / Applications	Explore the latest advancements in microprocessor
Text Book	Text Book 1: 5.1 to 5.3, 6.5 to 6.7, 7.1 to 7.3 Text Book 2: 15.1 to 15.5

MODULE-4	**AUTOMOTIVE MECHATRONIC SYSTEMS**	**22MEE643.5**	**8 Hours**

Engine Management Systems (EMS), EMS sensors, Traction control system, electronic brake force distribution, electronic stability control, Anti-Lock braking system, Tire pressure monitoring system, Active suspension system, Air bags, Seat belt tensioners, Adaptive headlamps, Central locking, Telematics.

Self-study / Case Study / Applications	Case study of comparison of EMS of different vehicles
Text Book	Text Book 2: 10.1, 10.3, 10.5, 10.7

MODULE-5	**CASE STUDIES OF MECHATRONIC SYSTEM:**	**22MEE643.6**	**8 Hours**

Traditional and mechatronic approach examples and case studies of Auto focus Camera, Mechatronics control in automated manufacturing, pick and place robot, ph control system, De-icing temperature control system, Thermal fatigue test, Automatic washing machine, CNC machines, etc.,

Self-study/ Case Study	Case studies of various mechatronic systems
Text Book	Text Book 2: 22.1 to 22.3 Text Book 3: 8.1 to 8.3

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Test (s)	NPTEL
		25	**25**
L1	**Remember**	5	**-**
L2	**Understand**	10	5
L3	**Apply**	10	10
L4	**Analyze**	-	10
L5	**Evaluate**	-	-
L6	**Create**	**-**	**-**

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) Mechatronics and Microprocessors, K. P. Ramchandran, G. K. Vijay Raghavan, M.S. Balasundran, Wiley, 1st Ed, 2009. ISBN :81-203-1180-9

2) Mechatronics, W. Bolton, Longman, 6 th Ed, Pearson Publications, ISBN10: 1292076682

3) "Mechatronics System Design", Devdas shetty, Richard A. Kolkm PWS Publishing Company, 2 nd Ed, ISBN-13: 978-1439061985

Reference Books:

1) Mechatronics-Principles Concepts and Applications Nitaigour Premchand Mahalik Tata McGraw Hill 1stEdition, 2003

2) 1 Mechatronics HMT Ltd Tata Mc Graw Hill 1st Edition, 2000 ISBN:978007 46364353

3) 3 Introduction to Mechatronics and Measurement Systems David G. Aldatore, Michael B. Histand McGraw-Hill Inc USA, 2003

Web links and Video Lectures (e-Resources):

- **https://nptel.ac.in/courses/112107298**
- **https://nptel.ac.in/courses/112103174**
- **https://www.youtube.com/playlist?list=PLLy_2iUCG87BNHXRb6L2pWEpMcLoFaY_U**
- **https://www.youtube.com/@HowToMechatronics**

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

- Visit to any manufacturing/aero/auto industry
- Video demonstration of latest trends in mechatronics
- 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

MEMS AND MICROSYSTEM TECHNOLOGY

Course Code	**22ME644**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**3**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22ME644.1	Apply new materials, science and technology for MEMS applications.
22ME644.2	Design and fabrication processes involved with MEMS
22ME644.3	Analyse the Dynamics and modelling of Microsystems using suitable to mathematical models
22ME644.4	Evaluate various scaling laws in Miniaturization involved with MEMS
22ME644.5	Analyse the state-of-the-art lithography techniques for MEMS System
22ME644.6	Understand application of micro sensors and micro actuators for designing sustainable MEMS system

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22ME644.1	3	2	2	-	-	-	-	-	-	-	-	-	1	
22ME644.2	3	3	2	-	-	-	-	-	-	-	-	-	1	
22ME644.3	3	2	-	-	-	-	-	-	-	-	-	-	-	2
22ME644.4	3	3	2	-	-	-	-	-	-	-	-	-		2
22ME644.5	3	3	2	-	-	-	-	-	-	-	-	-		2
22ME644.6	3	-	-	-	-	-	-	-	-	-	-	-		2

MODULE-1	**OVERVIEW OF MEMS AND MICROSYSTEMS**	**22ME644.1**	**8 Hours**

MEMS and Micro system, Typical MEMS and Microsystems Products, Evolution of Micro fabrication, Microsystems and Microelectronics, Multidisciplinary Nature of Microsystems, Miniaturization. Applications and Markets.

Self-study	Investigate the Challenges of MEMS and Microsystem products, Compare with traditional applications.
Text Book	Text Book 1: Chapter 1 : 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9

MODULE-2	**WORKING PRINCIPLES OF MICROSYSTEMS**	**22ME644.2**	**8 Hours**

Working Principles of Microsystems: Introduction, Micro sensors, Micro actuation, MEMS with Micro actuators, Micro accelerometers, and Micro fluidics.

Engineering Science for Microsystems Design and Fabrication: Introduction, Molecular Theory of Matter and Inter-molecular Forces, Plasma Physics, Electrochemistry

Self-study	Investigate the application and working of micro systems in different design and manufacturing industries.
Text Book	Text Book 1: Chapter 2 : 2.1,2.2,2.3,2.4,2.5,2.6 Text Book1: Chapter 3 : 3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8

MODULE-3	**ENGINEERING MECHANICS FOR MICROSYSTEMS DESIGN**	**22ME644.3, 22ME644.4**	**8 Hours**

Engineering Mechanics for Microsystems Design: Introduction, Static Bending of Thin Plates, Mechanical Vibration, Thermo mechanics, Fracture Mechanics, Thin Film Mechanics, Overview on Finite Element Stress Analys

Self-study	Explore the application of MEMS and microsystem in the field of design, thermal and manufacturing.		
Text Book	Text Book 1: Chapter 4 : 4.1,4.2,4.3,4.4,4.5,4.6,4.7		
MODULE-4	**SCALING LAWS IN MINIATURIZATION**	**22ME644.5**	**8 Hours**
Scaling laws in miniaturization: Introduction, Scaling in Geometry, Scaling in Rigid-Body Dynamics, Scaling in Electrostatic Forces, Scaling in Fluid Mechanics, Scaling in Heat Transfer.			
Self-study	Investigate the application of scaling law in the field of research and development.		
Text Book	Text Book 1: Chapter 6 : 6.1,6.2,6.3,6.4,6.5,6.6,6.7,6.8		
MODULE-5	**OVERVIEW OF MICRO MANUFACTURING**	**22ME644.6**	**8 Hours**
Overview of micro manufacturing: Introduction, Bulk Micro manufacturing, Surface Micromachining, The LIGA Process, Summary on Micro manufacturing.			
Self-study	Conduct a Survey on micro-manufacturing and study the recent advancement.		
Text Book	Text Book 1: Chapter 9 : 9.1,9.2,9.3,9.4,9.5		

CIE Assessment Pattern (50 Marks – Theory) –

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1. Tai-Ran Hsu, MEMS and Micro systems: Design, Manufacture and Nanoscale Engineering, 2nd Ed, Wiley. ISBN 9781118966583
2. Hans H. Gatzen, Volker Saile, JurgLeuthold, Micro and Nano Fabrication: Tools and Processes, Springer, 2015.
3. Dilip Kumar Bhattacharya, Brajesh Kumar Kaushik, Microelectromechanical Systems (MEMS), Cenage Learning.

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%20Design%20Workshop%20Report_2232327_October%202022_Final.508.pdf

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

- Investigate the Challenges of MEMS and Microsystem products, Compare with traditional applications.
- Conduct a Survey on micro-manufacturing and study the recent advancement.
- Investigate the application of scaling law in the field of research and development.
- Explore the application of MEMS and microsystem in design, thermal and manufacturing industries.

INSTRUMENTATION ENGINEERING

Course Code	**22ME645**	**CIE Marks**	**50**
L:T:P:S	**3:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**03**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course outcomes:

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

22ME645.1	Understand the working principle, construction, operation, characteristics and features of sensors and transducers.
22ME645.2	Analyze the performance of various sensors and transducers
22ME645.3	Develop sensors and transducers for measurement applications
22ME645.4	Evaluate sensor/transducer circuits for measurement of physical parameters.
22ME645.5	Analyze the types of fluid flow
22ME645.6	Apply the various measuring equipment's for Flow measurement.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22ME645.1	3	1	1	-	-	-	-	-	-	-	-	-	-	2
22ME645.2	3	2	2	-	-	-	-	-	-	-	-	-	-	2
22ME645.3	3	2	1	-	-	-	-	-	-	-	-	-	-	2
22ME645.4	3	2	2	-	-	-	-	-	-	-	-	-	-	2
22ME645.5	3	2	2	-	-	-	-	-	-	-	-	-	-	2
22ME645.6	3	2	-	-	-	-	-	-	-	-	-	-	-	2

MODULE-1	**Displacement and Speed Measurement**	**22ME645.1**	**8 Hours**

Need of sensors and transducers, transducers definition, classification, performance characteristics and selection criteria. Displacement Measurement: resistive-potentiometers, inductive-LVDT and RVDT, capacitive, piezoelectric, ultrasonic, hall effect, optical and proximity sensors. Speed Measurement: Tachometer, Magnetic pickups, Encoders, Photoelectric pickups, Stroboscopes, Shaft speed measurement. Vibration Measurement: Piezoelectric, Seismic, Potentiometric, and LVDT

Self-study	Determine characteristics LVDT for displacement measurement
Text Book	Text Book 1: 1.2, 1.3, 1.4, 1.13, 1.15, 1.16

MODULE-2	**Force and Torque measurement**	**22ME645.2**	**8 Hours**

Elastic elements, strain gauges, load cells, piezoelectric, vibrating string, strain gauge torque meter, inductive torque meter, magneto-restrictive transducers, torsion bar dynamometers

Case Study	Compare performance of encoder and tachometer for speed measurement.
Text Book	Text Book 1: 2.2, 2.3, 2.4 to 2.15

MODULE-3	**Pressure measurement and Temperature measurement**	**22ME645.3, 22ME645.4**	**8 Hours**

Units and their relations, manometers and their types, elastic sensors, piezoelectric secondary transducers, differential pressure sensors, capacitive (delta cell), high-pressure gauges, vacuum gauges, dead weight tester and vacuum gauge tester. Temperature scales, units and their relations, classification of temperature sensors, bimetallic thermometer, Resistance temperature detectors (RTD), types of RTD, lead wire compensation, thermistors, Thermocouples, thermocouple tables, cold junction compensation techniques, thermopiles, thermo well, pyrometers, temperature IC sensor LM35, design of signal conditioning circuits for RTD and Thermocouple.

Case Study	Compare performance of thermocouple and RTD for temperature measurement		
Text Book	Text Book 2: 3.1, 3.3, 3.5, 3.7, 3.10		
MODULE-4	**Flow Measurement**	**22ME645.5**	**8 Hours**
Units, Newtonian and non-Newtonian fluids, Reynolds's number, laminar and turbulent flows, velocity profile, Bernoulli's equation for incompressible flow, head type flow meters (orifice, venture meter and pitot tube), variable area type, turbine, electro-magnetic , ultrasonic , vortex shedding, anemometers , mass flow meter: Coriolis flow meter.			
Self-study	Compare performance of Orifice and Venture for flow measurement.		
Text Book	Text Book 3: 6.1, 6.3, 6.5, 6.7, Text Book 2: 10.1, 10.3, 10.5, 10.7		
MODULE-5	**Level and Miscellaneous Measurement**	**22ME645.6**	**8 Hours**
Level Measurement: Float, Bubbler, DP cell, Ultrasonic, Capacitive, radioactive type, radar, solid level detectors. Viscosity: Saybolt, Searle's rotating cylinder, Cone and plate, Falling and rolling ball, Rotameter. Density: Chain-balanced float type, Hydrometer (Buoyancy type), U tube type, Hydrostatic Head (Air bubbler, DP Cell). Humidity: resistive and capacitive type sensors Miscellaneous Sensors: pH sensors, Conductivity sensors.			
Case Study	Design a signal conditioning circuit for temperature measurement using Thermocouple. Design a signal conditioning circuit for temperature measurement using RTD		
Text Book	Text Book 4: 12.1 to 12.10		

CIE Assessment Pattern (50 Marks – Theory) –

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1. Principle of Industrial Instrumentation by D. Patranabis, Tata McGraw Hill, 2nd Ed. ISBN 9780074638090
2. Instrumentation and Measurement Principles by . D.V.S. Murty, PHI, New Delhi, 2nd Ed. ISBN 9788120347128
3. Electrical and Electronics Measurement and Instrumentation by A.K. Sawhney, Dhanpat Rai & Co, 2nd Ed.
4. Process control instrumentation technology by Curtis D. Johnson, PHI learning Pvt. Ltd, 07th Ed

Reference Books:

1. Measurement Systems by E.O. Doebelin, McGraw Hill, 06th Ed.
2. Process Measurement & Analysis by B.G. Liptak, CRC press, 04th Ed.

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%20Design%20Workshop%20Report_2232327_October%202022_Final.508.pdf**

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

- Compare performance of Orifice and Venture for flow measurement.
- Level measurement using ultrasonic sensors.
- Evaluate performance characteristics of capacitive/ resistive/ air purge method for level measurement.
- Design a signal conditioning circuit for temperature measurement using Thermocouple.
- Design a signal conditioning circuit for temperature measurement using RTD.
- Determine temperature using LM35.
- Compare performance of thermocouple and RTD for temperature measurement

PROJECT PHASE-I

Course Code	**22MEE65**	**CIE Marks**	**50**
L: T:P:S	**0:0:2:0**	**SEE Marks**	**50**
Hrs / Week	**02**	**Total Marks**	**100**
Credits	**02**	**Exam Hours**	**03**

Course outcomes:

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

22MEE65.1	Identify an open ended problem in area of mechanical engineering.
22MEE65.2	Identify the methods and materials required for the project work
22MEE65.3	Apply the theoretical concepts to solve industrial problems with teamwork and multidisciplinary approach.
22MEE65.4	Formulate and implement innovative ideas for social and environmental benefit
22MEE65.5	Analyze the results to come out with concrete solutions
22MEE65.6	Demonstrate professionalism with ethics; present effective communication skills and relate engineering issues to broader societal context

Project Roadmap: Guiding Principles for Mini Project Success

Project Overview:

- Clearly define the project's scope, objectives, and expected outcomes.
- Provide a brief description of the problem the project aims to solve or the functionality it should implement.

Project Milestones:

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

Project Requirements:

- List the specific features or functionality that students need to implement in their projects.
- Clearly state any constraints or limitations they should be aware of during development.

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.

Text Book	Text Book 1 & 2

CIE Assessment Pattern (50 Marks – Reviews as per the rubric statements defined)

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1)Kothari, C.R., 2018. Research Methodology: Methods and Techniques. New Age International. ISBN-13: 978-8122436235
2) Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2015, An introduction to Research Methodology, RBSA Publishers. ISBN-13: 978-8176111652
3) Ranjithkumar, 2014, research methodology, saga publications,4th edition ISBN-13- 978- 9351501336

Reference Books:

1.Anderson, T. W., 2011, An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi. ISBN-13: 978-8126524488
2) Montgomary, Douglas C. &Runger, George C. (2016) 6/e, Applied Statistics & probability for Engineers (Wiley India) ISBN-13: 978-1118539712

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=YScxVF6ZcYI
- https://www.youtube.com/watch?v=9WMgaulAJ-0

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

These challenging project activities can provide students with opportunities to think critically, apply their knowledge, and develop problem-solving skills in a practical context.

Interdisciplinary Projects:

- Encourage collaboration among students from different disciplines to work on projects that require diverse expertise.

Prototype Development:

- Challenge students to create a prototype of a product or device.

Simulation and Modelling:

- Task students with creating computer simulations or mathematical models to solve complex problems or simulate real-world scenarios.

Humanitarian and Social Impact Projects:

- Challenge students to develop projects that address social or humanitarian issues, such as providing clean water solutions, designing low-cost healthcare devices, or improving education in underserved communities.

Environmental Sustainability Projects:

- Challenge students to propose and implement sustainability initiatives or renewable energy projects.

Scientific Research Projects:

Assign students to conduct scientific research experiments, gather data, and present findings.

PROBLEM SOLVING SKILLS

Course Code	**22SDK66**	**CIE Marks**	**50**
L:T:P:S	**0:0:1:0**	**SEE Marks**	**-**
Hrs / Week	**3**	**Total Marks**	**50**
Credits	**1**	**Exam Hours**	**1**

Course outcomes:

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

22SDK66.1	Infer the complex problems using the concepts of data structures and C programming
22SDK66.2	Apply object-oriented programming concepts in C++and Java to solve real time problem statements.
22SDK66.3	Solve real-world problem using python and C#
22SDK66.4	Develop the skills of handling data base queries and procedures

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22SDK66.1	3	3	3	2	2	-	-	-	-	-	-	2	2	2
22SDK66.2	3	3	3	2	2	-	-	-	-	-	-	2	2	2
22SDK66.3	3	3	3	2	2	-	-	-	-	-	-	2	2	2
22SDK66.4	3	3	3	2	2	-	-	-	-	-	-	2	2	2

MODULE-1	**PROBLEM SOLVING ON DATA STRUCTURES AND C**	**22SDK66.I**	**6 Hours**

Data Structures using C: Stack and queues, list, graph, tree, sorting and searching, Hash functions
Advanced C programming: Pointers, Recursion, Functions, Structure, Union, C Preprocessor

MODULE-2	**PROBLEM SOLVING ON OBJECT ORIENTED PROGRAMMING USING CPP**	**22SDK66.2**	**6 Hours**

Object Oriented Programming: Inheritance, Polymorphism, Exception handling, File Handling, Predefined function, Void function, Name spaces, Input and output streams.

MODULE-3	**PROBLEM SOLVING ON JAVA AND XML**	**22SDK66.2**	**6 Hours**

Object oriented programming using Java: Inheritance, Polymorphism, Abstract class and Interface, Collections, Exception handling, Streams, Functional Interface.
XML: DTD, Schema, Server Path, DOM, XSLT, Name Space, AJAX.

MODULE-4	**PROBLEM SOLVING USING C # AND PYTHON**	**22SDK66.3**	**6 Hours**

Python: Functions, iterators, Object oriented Programming, Exception Handling, Packages, Frame works- Django, Collections.
C#: Object oriented Programming, Delegate, Collections and generic, Name space.

MODULE-5	**SCENARIO BASED PROBLEMS ON DBMS**	**22SDK66.4**	**6 Hours**

ER Model, SQL- DDL, DML, TCL, DCL, Joins, subquery, PL/SQL-Index, Sequence, procedures and functions, normalization, B tree, B+ tree, Forms.

CIE Assessment Pattern (50 Marks – Theory)

RBT Levels		Test (s)
		50
L1	Remember	5
L2	Understand	10
L3	Apply	20
L4	Analyze	15
L5	Evaluate	
L6	Create	-

Suggested Learning Resources:

Reference Books:

1. Martin C Brown, "Python-The Complete Reference", Mc Graw Hill, 4th edition, 2020 ISBN: 978-9387572942.
2. Reema Tharega, "Data Structures using C", Oxford University Press, 2020, ISBN: 9789354977190
3. Ullakirch-Prinz, "A complete guide to program in C++", Jonas and Bartlett Learning, 2022
4. Kathy Sierra, "Headfirst Java", O'reilly Media, 2021
5. Andrew Stellman, "Headfirst C#", O'reilly Media, 2021

Web links and Video Lectures (e-Resources):

- **https://www.learncpp.com/**
- **https://www.programiz.com/dsa**
- **https://code.visualstudio.com/Docs/languages/csharp**
- **https://www.udemy.com/course/the-complete-java-course-from-basics-to-advanced/?couponCode=ST16MT70224**
- **https://www.codecademy.com/learn/paths/c**

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

- Analysis of industry relevant use cases
- Problem solving on scenario-based questions
- Placement portal practice sessions

R PROGRAMMING

Course Code	**22MEE671**	**CIE Marks**	**50**
L:T:P:S	**1:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**01**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**02**

Course outcomes:

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

22MEE671.1	Understand the fundamentals, standards of Functions and capabilities of R-Language
22MEE671.2	Evaluate Learning of the basic R-Language Constructs
22MEE671.3	Apply Simulation in R-Language, Math functions and files processing
22MEE671.4	Analyze about the Principals of Graphics and R-Base Graphics
22MEE671.5	Develop applications and performing T-Testing
22MEE671.6	Design and build Linear optimization

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
22MEE671.1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
22MEE671.2	2	2	2	-	-	-	-	-	-	-	-	-	-	3
22MEE671.3	2	2	-	-	-	-	-	-	-	-	-	-	-	3
22MEE671.4	2	2	1	-	-	-	-	-	-	-	-	-	-	2
22MEE671.5	3	3	2	-	-	-	-	-	-	-	-	-	-	3
22MEE671.6	3	3	2	-	-	-	-	-	-	-	-	-	-	3

MODULE-1	**INTRODUCTION OF R-LANGUAGE**	**22MEE671.1**	**8 Hours**

Introduction, how to run R, R Sessions and Functions, Basic Math, Variables, Data Types, Vectors, Advanced Data Structures, Data Frames, Lists, Matrices, Arrays, Classes

Applications	Writing and executing simple programs
Text Book	Text Book 1: Chapter 1, 2

MODULE-2	**FUNCTIONS AND STRUCTURES**	**22MEE671.2**	**8 Hours**

R Programming Structures, Control Statements, Loops, - Looping Over Non-vector Sets, If-Else, Arithmetic and Boolean Operators, Default Values for Argument, Return Values, Functions with No Pointers in R, Recursion, Sorting and Searching

Self-study	Programming R Programming Structures
Text Book	Text Book 2: Chapter 1, 2

MODULE-3	**R-BASE GRAPHICS**	**22MEE671.3 22MEE671.4**	**8 Hours**

Graphics, Creating Graphs, The Workhorse of R Base Graphics, the plot() Function Customizing Graphs, Saving Graphs to Files.

Case Study	Programming R Programming Graphs & Graphics
Text Book	Text Book 2: Chapter 3, 4

MODULE-4	**T-TESTING**	**22MEE671.5**	**8 Hours**

Probability Distributions, Normal Distribution- Binomial Distribution- Poisson Distributions , Basic Statistics, Correlation and Covariance, T-Tests,-ANOVA.

Case Study	Simulating T Tests
Text Book	Text Book 1,2: Chapter 5, 6

MODULE-5	**LINEAR OPTIMIZATION**	**22MEE671.6**	**8 Hours**

Linear Models, Simple Linear Regression and Multiple Regression, Generalized Linear Models, Nonlinear Models, Splines- Decision- Random Forests.	
Applications	Design and program optimization Techniques
Text Book	Text Book 1,2: Chapter 5, 6

CIE Assessment Pattern (50 Marks – Theory)

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

SEE Assessment Pattern (50 Marks – Theory)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	10
L2	Understand	20
L3	Apply	10
L4	Analyze	5
L5	Evaluate	5
L6	Create	--

Suggested Learning Resources:

Text Books:

1. The Art of R Programming, Norman Matloff, Cengage Learning: Efficient R Programming: A Practical Guide to Smarter Programming 1st Edition - Colin Gillespie & Robin Lovelace - First Edition.2018 ISBN 1593273843
2. Jared P. Lander, R for Everyone: Advanced Analytics and Graphics, Second Edition 2017. ISBN 978-0134546926

Reference Books:

1. R Cookbook, PaulTeetor, Oreilly: R Cookbook [R CKBK] [Paperback] R Cookbook [RKBK] [Paperback]Mar 31, 2011 by Paul Teetor.
2. R in Action, Rob Kabacoff, Manning: R in Action: Data Analysis and Graphics with RNov 5, 2018 | Unabridged by Robert Kabacoff and Dale Ogden

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=_V8eKsto3Ug
- https://www.youtube.com/watch?v=eR-XRSKsuR4
- https://www.youtube.com/watch?v=fDRa82lxzaU
- https://www.youtube.com/watch?v=yZ0bV2Afkjc
- https://www.youtube.com/watch?v=BvKETZ6kr9Q

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

- Visit to any R-Programming implemented Firms/industry
- Demonstration of Functions And Structures
- Demonstration of R-Base Graphics
- Demonstration of T-Testing applied to a typical real time scenario
- Video demonstration of latest trends in R-Programming Implementations
- 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

RENEWABLE ENERGY SOURCES

Course Code	**22MEE672**	**CIE Marks**	**50**
L:T:P:S	**0:0:1:0**	**SEE Marks**	**50**
Hrs / Week	**02**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**02**

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

22MEE672.1	Understand the basic concepts of Renewable Energy sources
22MEE672.2	Apply the principle of renewable energy conversion system to design sytems
22MEE672.3	Develop the skills to analyse ,implement and manage sustainable Energy systems
22MEE672.4	Analyze the engineering principles for the effective management of Renewable Energy systems.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22MEE672.1	3	2	-	-	-	-	-	-	-	-	-	-	3	-
22MEE672.2	3	2	-	-	-	-	-	-	-	-	-	-	2	-
22MEE672.3	3	3	3	-	-	-	-	-	-	-	-	-	3	-
22MEE672.4	3	3	3	-	-	-	-	-	-	-	-	-	3	-

Exp. No.	List of Experiments	Hours	COs
	Prerequisite Experiments/ Demo		
	NA	-	NA
	PART-A		
1	Study of worldwide renewable energy availability, renewable energy availability in India	2	22MEE672.1
2	Studies on the working of p-n junction diode under forward bias and reverse bias	2	22MEE672.1
3	Study on green energy-hydrogen energy	2	22MEE672.2
4	Comparison studies on liquid dominated and vapor dominated geothermal power conversion System.	2	22MEE672.2
5	Analysis of bio-mass energy	2	22MEE672.2
6	Study of Ocean Thermal Energy Conversion		
	PART-B		
7	Energy audit of the class rooms of sardar vallabhbhaipatel block- NHCE	2	22MEE672.3
8	Performance analysis of 25kW Solar photovoltaic power plant.	2	22MEE672.3
9	Study on the performance of 2kW Hybrid (Wind-Solar) energy plant.	2	22MEE672.3
10	Performance analysis of Hydraulic turbines- Kaplan turbine	2	22MEE672.4
11	Demonstration of Geothermal Energy resource	2	22MEE672.4
12	Demonstration of solar radiation at ground level	2	22MEE672.4

PART-C

Beyond Syllabus Virtual Lab Content

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

- https://www.teachengineering.org/activities/view/csm_regionallocal_activity1
- https://www.pbs.org/wgbh/nova/labs/lab/energy/

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		20	30
L1	Remember	-	-
L2	Understand	5	5
L3	Apply	5	10
L4	Analyze	5	10
L5	Evaluate	5	5
L6	Create		-

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	05
L2	Understand	05
L3	Apply	10
L4	Analyze	20
L5	Evaluate	10
L6	Create	-

Suggested Learning Resources:

Reference Books:

1) G.D Rai ,Non-Conventional Energy Sources Khanna Publishers (2003), ISBN 9788174091076
2) S.P Sukhatme and J.K Nayak, Solar Energy : Principles of Thermal Collection and storage. McGraw-Hill(2009), ISBN 9780070669151.
3) A. Duffie and W.A. Beckmann, Solar Engineering of Thermal Processes-John Wiley (1980).
4) B H Khan ,Non-Conventional Energy Sources ,McGraw-Hill(2017)

WORKSHOP TECHNOLOGY

Course Code	**22MEE673**	**CIE Marks**	**50**
L:T:P:S	**0:0:1:0**	**SEE Marks**	**50**
Hrs / Week	**02**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**02**

Course outcomes:

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

22MEE673.1	Analyze the basic need for the fitting and make various models of fitting
22MEE673.2	Apply the concept of developments of lateral surfaces to develop the sheet metal models
22MEE673.3	Apply the various welding techniques to make the welding models
22MEE673.4	Apply the various Brazing & Soldering techniques to make the respective models

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22MEE673.1	3	3	2	2	-	-	-	-	-	-	-	-	3	-
22MEE673.2	3	3	2	2	-	-	-	-	-	-	-	-	3	-
22MEE673.3	3	3	2	2	-	-	-	-	-	-	-	-	3	-
22MEE673.4	3	3	2	2	-	-	-	-	-	-	-	-	3	-

Exp. No. / Pgm. No.	List of Experiments / Programs	Hours	COs
	Prerequisite Experiments / Programs / Demo		
	NA	NA	NA
	PART-A		
1	Study of fitting tools, fitting operations & joints	2	22MEE673.1
2	Fitting Model1: Rectangular Joint , Semicircular Joint	2	22MEE673.1
3	Fitting Model2: Triangular Joint, Dovetail Joint	2	22MEE673.1
4	Introduction to development of lateral surfaces, types, section plane concepts	2	22MEE673.2
5	Development of regular pentagonal, square & hexagonal prism models	2	22MEE673.2
6	Development of truncated right circular cone model & frustum of cone model	2	22MEE673.2
	PART-B		
7	Development of pyramid & frustum of pyramid models	2	22MEE673.2
8	Development of cylinder and truncated cylinder models	2	22MEE673.2
9	Welding: Introduction, types of welding, Model 1, 2 (Lap, Butt joints)	2	22MEE673.3
10	Welding Models 3, 4 (T, L joints)	2	22MEE673.3
11	Brazing: Introduction and Model	2	22MEE673.4
12	Soldering: Introduction and Model	2	22MEE673.4

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

- https://www.youtube.com/watch?v=VM1yKGRjqSo&list=PLIhUrsYr8yHwdB96ft6c0Uwc4SDCLuG1v
- https://www.youtube.com/watch?v=3LUFZLWBB1Y&list=PLIhUrsYr8yHwdB96ft6c0Uwc4SDCLuG1v&index=10
- https://www.youtube.com/watch?v=OWThL97tq3k
- https://www.youtube.com/watch?v=Qps9woUGkvI

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		20	30
L1	Remember	-	5
L2	Understand	5	5
L3	Apply	5	10
L4	Analyze	5	5
L5	Evaluate	5	5
L6	Create	-	-

SEE Assessment Pattern (50 Marks – Lab)

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

Suggested Learning Resources:

Text Books:

1) Elements of workshop Technology- Vol1 & 2, S.K.H Choudhury, A.K.H Choudhury, Nirjhar Roy, Media promotors and publishers, 2018 ISBN 9789381075037
2) Computer Aided Engineering Drawing - K. R. Gopalakrishna, Subash Publishers, 2017

INTRODUCTION TO CLOUD COMPUTING

Course Code	**22MEE674**	**CIE Marks**	**50**
L:T:P:S	**1:0:0:0**	**SEE Marks**	**50**
Hrs / Week	**1**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**02**

Course outcomes:

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

22MEE674.1	Understand the strengths and limitations of cloud computing.
22MEE674.2	Identify the architecture, infrastructure and delivery models of cloud computing.
22MEE674.3	Evaluate the working of VM and VMM on cloud platform.
22MEE674.4	Apply the cloud services and virtualization for real time.
22MEE674.5	Analyze the different storage technology.
22MEE674.6	Analyze the threats, risks, vulnerabilities and privacy issues associated with Cloud based IT services.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22MEE674.1	3	1	-	-	-	-	-	-	-	-	-	-	-	2
22MEE674.2	2	1	1	-	-	-	-	-	-	-	-	-	-	2
22MEE674.3	2	2	1	-	-	-	-	-	-	-	-	-	-	2
22MEE674.4	3	2	1	-	-	-	-	-	-	-	-	-	-	2
22MEE674.5	3	3	1	1	-	-	-	-	-	-	-	-	-	2
22MEE674.6	3	3	1	1	-	-	-	-	-	-	-	-	-	2

MODULE-1	**INTRODUCTION**	**22MEE674.1 22MEE674.6**	**8 Hours**

Cloud infrastructure, Cloud computing, Cloud computing delivery models & services, Ethical issues, Cloud vulnerabilities.

Self-study	Comparing cloud computing delivery models.
Text Book	Text Book 1: 1.1, 1.2, 1.3, 1.4, 1.13, 1.15, 1.16.

MODULE-2	**CLOUD COMPUTING PLATFORM**	**22MEE674.2**	**8 Hours**

Cloud computing at Amazon, Cloud computing at Google, Microsoft Windows Azure and online services, Open source software platforms for private clouds.

Case Study	Oracle cloud offerings, Software licensing.
Text Book	Text Book 1: 3.1, 3.2, 3.3, 3.4, 3.5, 3.10.

MODULE-3	**CLOUD VIRTUALIZATIONS**	**22MEE674.3, 22MEE674.4**	**8 Hours**

Cloud resource virtualization, layering and virtualization, Virtual machines, Virtual machine monitors, performance and security isolation, Full virtualization and para virtualization

Case Study	VMM based para virtualization.
Text Book	Text Book 1: 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.11.

MODULE-4	**CLOUD STORAGE SYSTEM**	**22MEE674.5**	**8 Hours**

Evolution of storage technology, Storage models, File systems, Databases, Distributed file systems, General parallel file system, Google file system.

Applications	Memory based checking point.
Text Book	Text Book 1: 8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.10.

MODULE-5	**CLOUD STORAGE**	**22MEE674.6**	**8 Hours**

Cloud storage, Risks, Security, Cloud users, Privacy & impact, Trust, Operating system security, virtual machine security, Security of virtualization.	
Case Study	Potential problems due to virtualization on public, private and hybrid clouds.
Text Book	Text Book 1: 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7, 9.9.

CIE Assessment Pattern (50 Marks – Theory)

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) Cloud Computing: Theory & practice, Dan C Marinescu Elsevier (MK), 2013.ISBN:978-0124046276

Reference Books:

1) Rajkumar Buyya, James Broberg, Andrzej Goscinski: Cloud Computing Principles and Paradigms, Willey, 2014. ISBN:978-8126541256

2) Soyata, Tolga, "Enabling Real-Time Mobile Cloud Computing through Emerging Technologies", IGI Global, 2015, ISBN: 978-1-4666-8662-5

3) Cloud Computing Implementation, Management and Security John W Rittenhouse, James F Ransome, CRC Press, 2013. ISBN:978-00706835

Web links and Video Lectures (e-Resources):

- https://www.javatpoint.com/cloud-computing-tutorial
- https://www.tutorialspoint.com/cloud_computing/index.htm
- https://www.digimat.in/nptel/courses/video/106105167/L01.html (Video Lectures)

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

- Video demonstration of latest trends in Cloud Computing.
- Contents related activities (Activity-based discussions).
- Group wise discussions.
- Seminars.

3D PRINTING TECHNOLOGY

Course Code	**22MEE675**	**CIE Marks**	**50**
L:T:P:S	**0:0:1:0**	**SEE Marks**	**50**
Hrs / Week	**02**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**02**

Course outcomes:

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

22MEE675.1	Understand the overall process of Design of the3D models using the basic and advanced commands.
22MEE675.2	Apply the extraction of the different types of views and the preparatory commands for 3D Printing process
22MEE675.3	Analyze the process parameters of the modelling tool and RP machines.
22MEE675.4	Evaluate the advanced level design tools and manufacturing techniques using 3D Printing technology, in industries.

Mapping of Course Outcomes to Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
22MEE675.1	3	1	-	-	-	-	-	-	-	-	-	-	3	3
22MEE675.2	3	3	2	-	3	-	-	-	-	-	-	-	3	3
22MEE675.3	3	3	2	1	3	-	-	-	-	-	-	-	3	3
22MEE675.4	3	3	3	3	3	-	-	-	-	-	-	-	3	3

Exp. No. / Pgm. No.	List of Experiments / Programs	Hours	COs
	Prerequisite Experiments / Programs / Demo		
	• Verification of basic gates using IC Trainer board • Basic gate implementation using Verilog code.	2	NA
	PART-A		
1	Introduction to 3D Printing Technology	2	22MEE675.1
2	3D Modelling software	2	22MEE675.1
3	Modelling of Nut and Bolt Combination	2	22MEE675.2
4	Modelling of Helical Gear	2	22MEE675.2
5	Modelling of Pipe Elbow joint	2	22MEE675.3
6	Modelling of Pipe T-Joint	2	22MEE675.3
	PART-B		
7	Modelling and 3D printing of Pen stand	2	22MEE675.3
8	Modelling and 3D printing of Cup and Saucer	2	22MEE675.3
9	Modelling and 3D printing of Mobile Stand	2	22MEE675.3
10	Modelling and 3D printing of Miniature Table	2	22MEE675.3
11	Modelling and 3D printing of Miniature Chair	2	22MEE675.4
12	Modelling and 3D printing of Sports Trophy	2	22MEE675.4

PART-C

Beyond Syllabus Virtual Lab Content

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

1. https://3dp-dei.vlabs.ac.in/exp/simulation-anatomy-fdm/
2. https://3dp-dei.vlabs.ac.in/exp/simulation-cartesian-system/
3. https://3dp-dei.vlabs.ac.in/exp/simulation-modelling-process/
4. https://3dp-dei.vlabs.ac.in/exp/simulation-post-processing/

CIE Assessment Pattern (50 Marks – Lab)

RBT Levels		Test (s)	Weekly Assessment
		20	30
L1	Remember	-	-
L2	Understand	-	5
L3	Apply	5	10
L4	Analyze	5	5
L5	Evaluate	5	5
L6	Create	5	5

SEE Assessment Pattern (50 Marks – Lab)

RBT Levels		Exam Marks Distribution (50)
L1	Remember	-
L2	Understand	05
L3	Apply	10
L4	Analyze	20
L5	Evaluate	10
L6	Create	05

Suggested Learning Resources:

Reference Books:

1. C. P. Paul, A. N. Jinoop, Additive Manufacturing, Publisher: Mc Graw Hill, 2021, 1st Edition 9390727480 · 9789390727483

2. T.S. Srivatsan, T.S. Sudarshan, Additive Manufacturing, Publisher: CRC Press, 2020, 1st Edition ISBN-13 978-0367737788

NATIONAL SERVICE SCHEME (NSS)

Course Code	**22NSS30, 22NSS40, 22NSS50, 22NSS60**	**CIE Marks (each Semester)**	**50**
L:T:P:S	**0:0:0:0**	**SEE Marks**	**--**
Hrs / Week	**2**	**Total Marks**	**50 x 4 = 200**
Credits	**00**	**Exam Hours**	**02**

Course outcomes:

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

22NSSX0.1	Understand the importance of his / her responsibilities towards society.
22NSSX0.2	Analyse the environmental and societal problems/issues and will be able to design solutions for the same.
22NSSX0.3	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.
22NSSX0.4	Develop capacity to meet emergencies and natural disasters & practice national integration and social harmony in general.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
22NSSX0.1	-	-	-	-	-	3	3	-	2	-	-	1
22NSSX0.2	-	-	-	-	-	3	3	-	2	-	-	1
22NSSX0.3	-	-	-	-	-	3	3	-	2	-	-	1
22NSSX0.4	-	-	-	-	-	3	3	-	2	-	-	1

Semester/ Course Code	CONTENT	COs	HOURS
3RD 22NSS30	1. Organic farming, Indian Agriculture (Past, Present and Future) Connectivity for marketing 2. Waste management–Public, Private and Govt organization, 5R's. 3. Setting of the information imparting club for women leading to contribution in social and economic issues.	22NSS30.1, 22NSS30.2, 22NSS30.3, 22NSS30.4	30 HRS
4TH 22NSS40	4. Water conservation techniques – Role of different stakeholders– Implementation. 5. Preparing an actionable business proposal for enhancing the village income and approach forimplementation. 6. Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/ vocational education.	22NSS40.1, 22NSS40.2, 22NSS40.3, 22NSS40.4	30 HRS
5TH 22NSS50	7. Developing Sustainable Water management system for rural areas and implementationapproaches. 8. Contribution to any national level initiative of Government of India. Foreg. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill developmentprograms etc. 9. Spreading public awareness under rural outreach programs. (minimum 5 programs).	22NSS50.1, 22NSS50.2, 22NSS50.3, 22NSS50.4	30 HRS
6TH 22NSS60	10. Organize National integration and social harmony events / workshops / seminars. (Minimum TWO programs). 11. Govt. school Rejuvenation and helping them to achieve good infrastructure.	22NSS60.1, 22NSS60.2, 22NSS60.3, 22NSS60.4	30 HRS

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 6th 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.
- At last, in 6th semester consolidated report of all activities from 3rd to 6th semester, compiled report should be submitted as per the instructions.
- 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/Co ntinuous 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.	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
4.	Water conservation techniques – Role of different stakeholders– Implementation.	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

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
6.	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
7.	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/properconsultation/ 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
8.	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

9.	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/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
10.	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/prope r 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
11.	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/prope r 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 (PE) (SPORTS AND ATHLETICS)

Course Code	**22PED30, 22PED40, 22PED50, 22PED60**	**CIE Marks (each semester)**	**50**
L:T:P:S	**0:0:0:0**	**SEE Marks**	**--**
Hrs / Week	**2**	**Total Marks**	**50 x 4= 200**
Credits	**00**	**Exam Hours**	**02**

Course outcomes:

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

22PEDX0.1	Understand the fundamental concepts and skills of Physical Education, Health, Nutrition and Fitness
22PEDX0.2	Create consciousness among the students on Health, Fitness and Wellness in developing and maintaining a healthy lifestyle
22PEDX0.3	Perform in the selected sports or athletics of student's choice and participate in the competition at regional/state / national / international levels.
22PEDX0.4	Understand the roles and responsibilities of organization and administration of sports and games

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
22PEDX0.1	-	-	-	-	-	2	-	3	3	-	-	2
22PEDX0.2	-	-	-	-	-	2	-	3	3	-	-	2
22PEDX0.3	-	-	-	-	-	2	-	3	3	-	-	2
22PEDX0.4	-	-	-	-	-	2	-	3	3	-	-	2

Semester	CONTENT	COs	HOURS
3RD 22PED30	**Module 1: Orientation** A. Lifestyle, B. Fitness C. Food & Nutrition D. Health & Wellness E. Pre-Fitness test.	22PED30.1, 22PED30.2	5 HRS
	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	22PED30.2, 22PED30.3	15 HRS
	Module 3: Recreational Activities A. Postural deformities. B. Stress management. C. Aerobics. D. Traditional Games.	22PED30.3, 22PED30.4	10 HRS
4TH 22PED40	**Module 1: Ethics and Moral Values** A. Ethics in Sports B. Moral Values in Sports and Games	22PED40.1, 22PED40.2	5 HRS
	Module 2: Specific Games (Anyone to be selected by the student) A. Volleyball – Attack, Block, Service, Upper Hand Pass and Lower hand Pass.	22PED40.3	20 HRS

	B. Throwball – Service, Receive, Spin attack, Net Drop & Jump throw. C. Kabaddi – Hand touch, Toe Touch, Thigh Hold, Ankle hold and Bonus. D. Kho-Kho – Giving Kho, Single Chain, Pole dive, Pole turning, 3-6 Up. E. Table Tennis – Service (Fore Hand & Back Hand), Receive (Fore Hand & Back Hand), Smash. F. Athletics (Track / Field Events) – Any event as per availability of Ground.		
	Module 3: Role of Organization and administration	22PED40.4	5 HRS
5TH 22PED50	**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**: 1. Track -Sprints: • Starting Techniques: Standing start and Crouch start (its variations) use of Starting Block. • Acceleration with proper running techniques. • Finishing technique: Run Through, Forward Lunging and Shoulder Shrug. 2. Jumps- Long Jump: Approach Run, Take-off, Flight in the air (Hang Style/Hitch Kick)and Landing 3. Throws- Shot Put: Holding the Shot, Placement, Initial Stance, Glide, Delivery Stance and Recovery (Perry O'Brien Technique) **Handball OR Ball Badminton** **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.	22PED50.1, 22PED50.2, 22PED50.3, 22PED50.4	Total 30 Hrs/ Semester 2 Hrs/week
6TH 22PED60	**Athletics**: 1. Track -110 Mtrs and 400Mtrs: • Hurdling Technique: Lead leg Technique, Trail leg	22PED60.1, 22PED60.2, 22PED60.3,	Total 30 Hrs/ Semester

	Technique, Side Hurdling, Over the Hurdles • Crouch start (its variations)use of Starting Block. • Approach to First Hurdles, In Between Hurdles, Last Hurdles to Finishing. 2. Jumps- High jump: Approach Run, Take-off, Bar Clearance (Straddle) and Landing. 3. Throws- Discus Throw: Holding the Discus, Initial Stance Primary Swing, Turn, Release and Recovery (Rotation in the circle). **Football OR Hockey** **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. 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. A. 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	22PED60.4	2 Hrs/week

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	**22YOG30, 22YOG40, 22YOG50, 22YOG60**	**CIE Marks**	**50**
L:T:P:S	**0:0:0:0**	**SEE Marks**	**--**
Hrs / Week	**2**	**Total Marks**	**50 x 4 = 200**
Credits	**00**	**Exam Hours**	**02**

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

22YOGX0.1	Understanding the origin, history, aim and objectives of Yoga
22YOGX0.2	Become familiar with an authentic foundation of Yogic practices
22YOGX0.3	Practice different Yogic methods such as Suryanamaskara, Pranayama and some of the Shat
22YOGX0.4	Use the teachings of Patanjali in daily life.

Mapping of Course Outcomes to Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
22YOGX0.1	-	-	-	-	-	3	-	-	-	-	-	1
22YOGX0.2	-	-	-	-	-	3	-	-	-	-	-	1
22YOGX0.3	-	-	-	-	-	3	-	-	-	-	-	1
22YOGX0.4	-	-	-	-	-	3	-	-	-	-	-	1

Semester / Course Code	CONTENT	COs	HOURS
3rd 22YOG30	**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 b of Suryanamaskar. 2. Suryanamaskar 12 count,2rounds **Different types of Asanas**: 1. Sitting: Padmasana, Vajrasana, Sukhasana 2. Standing: Vrikshana, Trikonasana, Ardhakati Chakrasana 3. Prone line: Bhujangasana, Shalabhasana 4. Supineline: Utthitadvipadasana, Ardhahalasana, Halasana	22YOG30.1, 22YOG30.2, 22YOG30.3, 22YOG30.4	Total 32 Hrs/ Semester 2 Hrs/week

4TH 22YOG40	**Suryanamaskara:** Suryanamaskar 12 count,4rounds **Brief introduction and importance of:** **Kapalabhati:** Revision of Kapalabhati -40strokes/min3rounds **Different types of Asanas**: 1. Sitting: Paschimottanasana, Ardha Ushtrasana, Vakrasana, Aakarna Dhanurasana 2. Standing: Parshva Chakrasana, Urdhva Hastothanasana, Hastapadasana 3. Prone line: Dhanurasana 4. Supine line: Karna Peedasana, Sarvangasana, Chakraasana **Patanjali's Ashtanga Yoga**: Asana, Pranayama **Pranayama:** Chandra Bhedana, Nadishodhana, Surya Bhedana	22YOG40.1, 22YOG40.2, 22YOG40.3, 22YOG40.4	Total 32 Hrs/ Semester 2 Hrs/week
5TH 22YOG50	**Kapalabhati:** Revision of Kapalabhati - 60strokes/min3rounds **Brief introduction and importance of:** **Different types of Asanas**: 1. Sitting: Yogamudra in Padmasana, Vibhakta Paschimottanasana, Yogamudra in Vajrasana 2. Standing: Parivritta Trikonasana, Utkatasana, Parshvakonasana 3. Prone line: Padangushtha Dhanurasana, Poorna Bhujangasana / Rajakapotasana 4. Supine line: Navasana/Noukasana, Pavanamuktasana, Sarvanga **Patanjali's Ashtanga Yoga**: Pratyahara, Dharana **Pranayama:** Ujjayi, Sheetali, Sheektari	22YOG50.1, 22YOG50.2, 22YOG50.3, 22YOG50.4	Total 32 Hrs/ Semester 2 Hrs/week
6TH 22YOG60	**Kapalabhati:** Revision of Kapalabhati – 80 strokes/min3rounds **Brief introduction and importance of:** **Different types of Asanas**: 1. Sitting: Bakasana, Hanumanasana, Ekapada Rajakapotasana 2. Standing: Parivritta Trikonasana, Utkatasana, Parshvakonasana 3. Supine line: Setubandhasana, Shavasanaa (Relaxation posture) 4. Balancing: Sheershasana **Patanjali's AshtangaYoga**: Dhyana (Meditation), Samadhi **Pranayama:** Bhastrika, Bhramari, Ujjai **Shat Kriyas:** Jalaneti and sutraneti, Sheetkarma Kapalabhati	22YOG60.1, 22YOG60.2, 22YOG60.3, 22YOG60.4	Total 32 Hrs/ Semester 2 Hrs/week

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:

1. Swami Kuvulyananda: Asma (Kavalyadhama, Lonavala)
2. Tiwari, O P: Asana Why and How
3.Ajitkumar: Yoga Pravesha (Kannada)
4.Swami Satyananda Saraswati: Asana Pranayama, Mudra, Bandha (Bihar School of yoga, Munger)
5.Swami Satyananda Saraswati: Surya Namaskar (Bihar School of yoga, Munger)
6.Nagendra H R: The art and science of Pranayama

7.Tiruka: Shatkriyegalu (Kannada) 8.Iyengar B K S: Yoga Pradipika (Kannada) 9.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**

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.

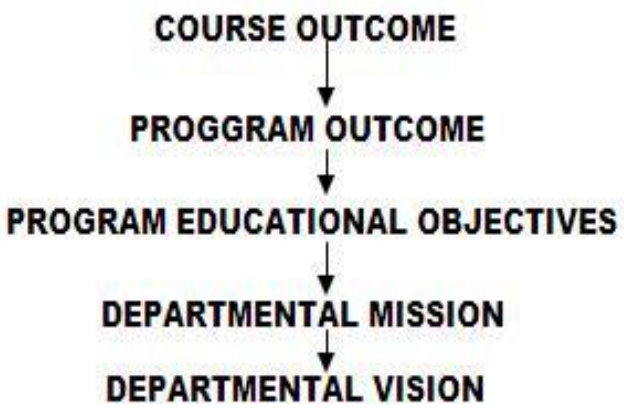
There are three educational Outcomes as defined by the National Board of Accreditation:

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 the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

Conduct investigations of complex problems: The problems that cannot be solved by straightforward application of knowledge, theories and techniques applicable to the engineering discipline that may not have a unique solution. For example, a design problem can be solved in many ways and lead to multiple possible solutions that require consideration of appropriate constraints/requirements not explicitly given in the problem statement (like: cost, power requirement, durability, product life, etc.) which need to be defined (modeled) within appropriate mathematical framework that often require use of modern computational concepts and tools.

Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

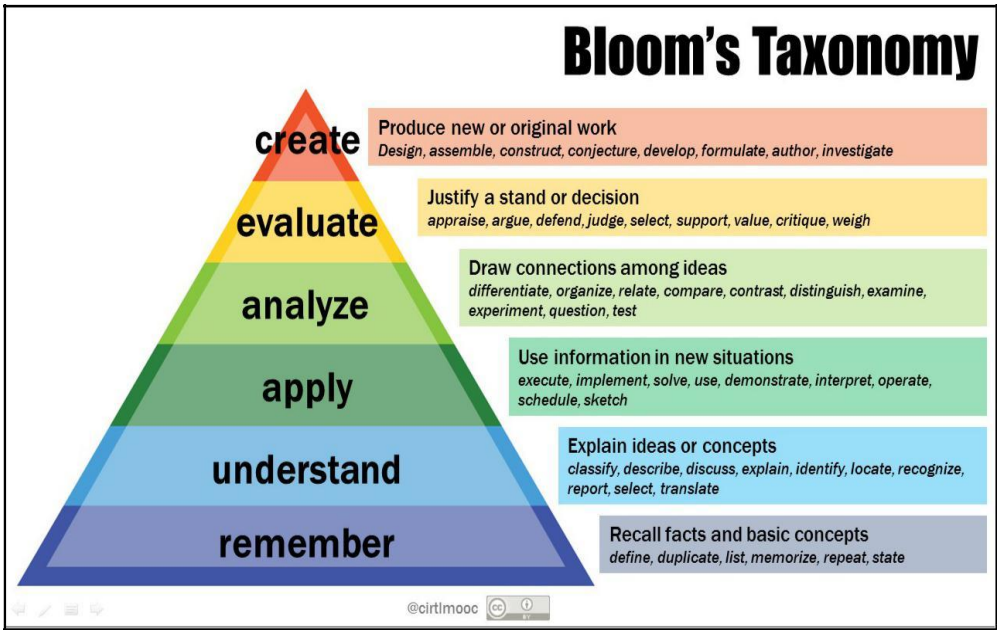
Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

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

Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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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