NEW HORIZON COLLEGE OF ENGINEERING

Department of Mechanical Engineering

Academic Year 2025-26

7th and 8th 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

VII Semester													
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	22MEE71	Fundamentals of Heat Transfer	ME	3	0	0	0	3	3	50	50	**100**
2	PCCL	22MEL71	Fundamentals of Heat Transfer Lab	ME	0	0	1	0	1	2	50	50	**100**
3	PCC	22MEE72	Computer Integrated Manufacturing	ME	3	0	0	0	3	3	50	50	**100**
4	PCCL	22MEL72	Computer Integrated Manufacturing Lab	ME	0	0	1	0	1	2	50	50	**100**
5	PCC	22MEE73	Mechanical Vibrations	ME	3	0	0	0	3	3	50	50	**100**
6	PROJ	22MEE74	Project Phase - II	ME	0	0	10	0	10	20	100	100	**200**
7	OEC	23NHOP7XX	Industrial Open Elective Course-II	Offering Dept.	3	0	0	0	3	3	50	50	**100**
Total									**24**	**36**	**400**	**400**	**800**

PCC: Professional Core Course, PCCL: Professional Core Course laboratory, 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.

Industrial Open Elective Courses-II:

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.

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

Project Phase-II:

The objective of the Project work is

(i) To encourage independent learning and the innovative attitude of the students.

(ii) To develop interactive attitude, communication skills, organization, time management, and presentation skills.

(iii) To impart flexibility and adaptability.

(iv) To inspire team working.

(v) To expand intellectual capacity, credibility, judgment and intuition.

(vi) To adhere to punctuality, setting and meeting deadlines.

(vii) To install responsibilities to oneself and others.

(viii) To train students to present the topic of project work in a seminar without any fear, face the audience confidently, enhance communication skills, involve in group discussion to present and exchange ideas.

CIE procedure for Project Work:

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

(1) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work, shall be based on the evaluation of project work 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.

SEE procedure for Project Work: SEE for project work will be conducted by the two examiners appointed by the University. The SEE marks awarded for the project work shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the percentage ratio of 50:25:25.

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

VIII Semester													
S. No.	**Course and Course Code**		**Course Title**	**BoS**	**Credit Distribution**				**Overall Credits**	**Contact Hours**	**Marks**		
					L	**T**	**P**	**S**			**CIE**	**SEE**	**Total**
1	PEC	22MEE81X	Professional Elective Courses -III	ME	3	0	0	0	3	3	50	50	**100**
2	PEC	22MEE82X	Professional Elective Courses -IV	ME	3	0	0	0	3	3	50	50	**100**
3	INT	22MEE83	Internship	ME	0	0	10	0	10	20	100	100	**200**
4	NCMC	22IKK84	Indian Knowledge Systems	ME	0	0	0	0	0	1	50	-	**50**
Total									**16**	**27**	**250**	**200**	**450**

PEC: Professional Elective Course, L: Lecture, T: Tutorial, P: Practical S: SDA: Self Study for Skill Development, INT: Industry Internship / Research Internship / Rural Internship, CIE: Continuous Internal Evaluation, SEE: Semester End Evaluation.
NCMC: Online Assessment

Professional Elective Course-III			
22MEE811	Additive Manufacturing	22MEE814	Refrigeration and Air Conditioning
22MEE812	Industrial Robotics	22MEE815	Hydraulics and Pneumatics
22MEE813	Control Engineering		

Professional Elective Course-IV			
22MEE821	Energy Engineering	22MEE824	Industrial Internet of Things
22MEE822	Sustainable energy systems design	22MEE825	Advanced Semiconductor Materials and its applications
22MEE823	Advanced Nanotechnology		

Credit Definition:	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
1-hour Lecture (L) per week=1 Credit 2-hoursTutorial(T) per week=1 Credit 2-hours Practical / Drawing (P) per week=1 Credit 2-hous Self Study for Skill Development (SDA) per week = 1 Credit	

Elucidation:

At the beginning of IV years of the program i.e., after VI semester, VII semester classwork and VIII semester Research Internship /Industrial Internship / Rural Internship shall be permitted to be operated simultaneously by the University so that students have ample opportunity for an internship. In other words, a good percentage of the class shall attend VII semester classwork and a similar percentage of others shall attend to Research Internship or Industrial Internship or Rural Internship. Research/Industrial /Rural Internship shall be carried out at an Industry, NGO, MSME, Innovation center, Incubation centre, Start-up, centre of Excellence (CoE), Study Centre established in the parent institute and/or at reputed research organizations/institutes. The mandatory Research internship /Industry internship / Rural Internship is for 14 to 20 weeks. The internship shall be considered as a head of passing and shall be considered for the award of a degree. Those, who do not take up/complete the internship shall be declared to fail and shall have to complete it during the subsequent University examination after satisfying the internship requirements.

Internship (Research/Industrial /Rural): The internship shall be carried out at an Industry, NGO, MSME, Innovation center, Incubation center, Start-up, center of Excellence (CoE), Study Centre established in the parent institute and /or at reputed research organizations/institutes. The mandatory Internship (Research /Industry / Rural) is for 14 to 20 weeks. The internship shall be considered as a head of passing and shall be considered for the award of a degree. Those, who do not take up/complete the internship shall be declared to fail and shall have to complete it during the subsequent SEE examination after satisfying the internship requirements.

Research internship: A research internship is intended to offer the flavor of current research going on in the research field. It helps students get familiarized with the field and imparts the skill required for carrying out research.

Industry internship: Is an extended period of work experience undertaken by students to supplement their degree for professional development. It also helps them learn to overcome unexpected obstacles and successfully navigate organizations, perspectives, and cultures. Dealing with contingencies helps students recognize, appreciate, and adapt to organizational realities by tempering their knowledge with practical constraints.

Rural Internship: Rural development internship is an initiative of Unnat Bharat Abhiyan Cell, RGIT in association with AICTE to involve students of all departments studying in different academic years for exploring various opportunities in techno-social fields, to connect and work with Rural India for their upliftment.

The faculty coordinator or mentor has to monitor the student's internship progress and interact with them to guide for the successful completion of the internship. The students are permitted to carry out the internship anywhere in India or abroad. University shall not bear any expenses incurred in respect of the internship. With the consent of the internal guide and Principal of the Institution, students shall be allowed to carry out the internship at their hometown (within or outside the state or abroad), provided favorable facilities are available for the internship and the student remains regularly in contact with the internal guide.

VII Semester Syllabus

FUNDAMENTALS OF HEAT TRANSFER			
Course Code	**22MEE71**	**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:

22MEE71.1	Understand the fundamental concepts, governing laws, and boundary conditions of conduction, convection, and radiation heat transfer.
22MEE71.2	Apply the principles of one-dimensional steady and transient conduction, including lumped system analysis and Heisler's charts, to solve practical heat transfer problems
22MEE71.3	Analyze free and forced convection heat transfer using dimensional analysis and empirical correlations for different geometries and flow conditions.
22MEE71.4	Evaluate radiation heat transfer between surfaces using basic radiation laws and radiation shields, including gray and black body assumptions.
22MEE71.5	Design and assess heat exchangers using LMTD and Effectiveness-NTU methods by considering overall heat transfer coefficient, fouling, and temperature profiles
22MEE71.6	Develop innovative solutions for advanced thermal systems by exploring applications of micro, nano, and PCB type heat exchangers in modern engineering practice.

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
22MEE71.1	2	-	-	-	-	-	-	-	-	-	-	-	2	3
22MEE71.2	3	2	1	-	-	-	-	-	-	-	-	-	2	2
22MEE71.3	3	2	2	1	-	-	-	-	-	-	-	-	2	3
22MEE71.4	3	2	2	2	-	-	-	-	-	-	-	-	2	3
22MEE71.5	3	2	2	2	-	-	-	-	-	-	-	-	2	3
22MEE71.6	3	2	2	-	2	-	-	-	-	-	-	-	2	3

MODULE-1	INTRODUCTION TO HEAT TRANSFER CONCEPTS	22MEE71.1	8 Hours

Introduction to Concepts and Definitions: Modes of heat transfer; Basic laws governing conduction, convection, and radiation heat transfer; Boundary conditions of 1st, 2nd and 3rd kind (Numerical Problems). Derivation of general three-dimensional conduction equation in Cartesian coordinate and its special cases, discussion on 3-D conduction in cylindrical and spherical coordinate systems (No derivation). One dimensional conduction equation in rectangular, cylindrical and spherical coordinates for plane and composite walls (No Derivations only Numerical Problems). Thermal contact resistance (Numerical Problems).

Applications	Investigate the Practical Applications of Laws of Heat Transfer.
Text Book	Text Book 1: 1.1, 1.2, 1.3, 1.4,2.1,2.2,2.5,2.6 Text Book 2: 1.1, 1.2, 2.1,2.2,

MODULE-2	TRANSIENT CONDUCTION	22MEE71.2	8 Hours

Transient Conduction: Lumped system analysis, Use of Transient temperature charts (Heisler's charts) for transient conduction in slab, long cylinder and sphere; use of transient temperature charts for transient conduction in semi- infinite solids. Numerical Problems.

Case Study	Case study on Analysis of Transient Heat conduction in different Geometries.
Text Book	Text Book 1: 2.10,2.10.1,2.10.2,4.2,4.5Text Book 2: 1.1, 1.2, 1.3

MODULE-3	FREE CONVECTIONS AND FORCED CONVECTIONS	22MEE71.3	8 Hours

Free or Natural convection: Application of dimensional analysis for free convection, use of correlations of free convection in vertical, horizontal and inclined flat plates, vertical and horizontal cylinders and spheres, Numerical problems.
Forced Convections: Applications of dimensional analysis for forced convection, Use of various correlations for hydrodynamically and thermally developed, flows inside a duct, use of correlations for flow over a flat plate, over a cylinder and sphere. Numerical problems

Applications	Investigate the Application of dimensional analysis for free convection and forced convection.		
Text Book	Text Book 1: 6.6, 7.1, 7.2 , 7.3 ,8.1,8.5,8.8 Text Book 2: 2.1, 2.3, 2.4, 2.5, 2.6		
MODULE-4	**RADIATION HEAT TRANSFER**	**22MEE71.4**	**8 Hours**

Radiation Heat Transfer: Thermal radiation; definitions of various terms used in radiation heat transfer. Basic Laws: Stefan-Boltzmann law, Kirchoff's law, Planck's law and Wein's displacement law, Lambert's law. Radiation heat exchange between two parallel infinite black surfaces, between two parallel infinite gray surfaces; effect of radiation shield; intensity of radiation and solid angle; Numerical problems

Case Study	Case study on radiation heat transfer in Furnaces		
Text Book	Text Book 1: 11.1,11.2,11.3,11.4,11.5,11.6,11.7,11.8,11.9 Text Book 2: 5.1, 5.3, 5.5, 5.7		
MODULE-5	**HEAT EXCHANGERS**	**22MEE71.5 22MEE71.6**	**8 Hours**

Heat Exchangers: Classification of heat exchangers; Temperature profiles of Heat exchangers. Overall heat transfer coefficient, fouling and fouling factor; LMTD, Effectiveness-NTU methods of analysis of heat exchangers. Numerical problems. Introduction to the concepts of Micro, Nano and PCB type heat exchangers.

Case Study	Case study on Design of Heat Exchangers
Text Book	Text Book 1: 10.1,10.2,10.310.4,10.5, 9.1,9.2,9.3 Text Book 2: 8.1, 8.3, 8.4, 8.5, 8.6

CIE Assessment Pattern (50 Marks – Theory)

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) Heat & Mass transfer, R.K Rajaput, S Chand and Co Ltd, 5th Ed,2012. ISBN: 81-219-2617-3
2) Engineering Heat and Mass transfer, Mahesh M. Rathore, Lakshmi Publication Pvt Ltd 3rd Edition, 2016, ISBN: 978-81-318-0613-5

Reference Books:

1) Heat transfer, a practical approach, Yunus A- Cengel Tata McGraw Hill,5th Ed, ISBN: 9789339223199
2) Principles of heat transfer, Kreith Thomas Learning ,7th Ed, ISBN-13: 978-0495657704
3) Fundamentals of heat and mass transfer, Frank P. Incropera and David P. Dewitt, John Wiley and sons, 7th Ed, ISBN : 978-1-118-37924-0
4) Heat transfer-A basic approach, Ozisik, Tata McGraw Hill 2002.

Web links and Video Lectures (e-Resources):

- **https://onlinecourses.nptel.ac.in/noc20_ch21/preview**
- **https://www.youtube.com/watch?v=lvyCe0UaqJY**
- **https://www.udemy.com/course/fundamentals-of-heat-masstransfer-basic-to-advance-level/**
- **https://www.classcentral.com/course/swayam-heat-transfer-10061**

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 Conduction, convection and radiation heat transfer
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare heat transfer related Flowcharts and Handouts
  - Organizing Group wise discussions on issues
  - Seminars

FUNDAMENTALS OF HEAT TRANSFER LAB			
Course Code	**22MEL71**	**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:

22MEL71.1	Apply the concept of steady-state heat conduction using analytical and numerical methods to determine temperature distribution and heat flux in rods and composite walls.
22MEL71.2	Formulate one-dimensional conduction equations for systems such as fins and lumped bodies, and develop appropriate solutions for temperature distribution.
22MEL71.3	Analyze the concept of blackbody radiation to evaluate emissivity and radiative characteristics of surfaces.
22MEL71.4	Analyze free and forced convection heat transfer in ducts and vertical surfaces using dimensional analysis and empirical correlations.

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
22MEL71.1	3	2	1	-	1	-	-	-	-	-	-	-	3	2
22MEL71.2	2	2	2	-	-	-	-	-	-	-	-	-	3	2
22MEL71.3	3	2	2	-	-	-	-	-	-	-	-	-	3	2
22MEL71.4	3	2	2	-	-	-	-	-	-	-	-	-	3	2

Exp. No. / Pgm. No.	List of Experiments	Hours	COs
	Prerequisite Experiments / Demo		
	• Conduction, convection and radiation concepts and Laws • Engineering Thermodynamics concepts and Laws • Thermal analysis using FEM	2	NA
	PART-A		
1	Determination of Thermal Conductivity of a Metal Rod.	2	22MEL71.1
2	Determination of Overall Heat Transfer Coefficient of a Composite wall.	2	22MEL71.1
3	Thermal Analysis of Composite walls using FEM.	2	22MEL71.1
4	Experiment on Transient Heat Conduction.	2	22MEL71.2
5	Determination of Emissivity of a Surface	2	22MEL71.3
6	Determination of Heat Transfer Coefficient in a free Convection on a vertical/horizontal tube	2	22MEL71.4
	PART-B		
7	Determination of Heat Transfer Coefficient in a Forced Convention on a vertical/horizontal tube.	2	22MEL71.4
8	Determination of Heat transfer co-efficient, efficiency & Effectiveness on a Metallic fin by Free convection	2	22MEL71.4
9	Determination of Heat transfer co-efficient, efficiency & Effectiveness on a Metallic fin by forced convection	2	22MEL71.4
10	Determination of heat transfer coefficient in film wise condensation.	2	22MEL71.4

11	Determination of heat transfer coefficient in drop wise condensation.	2	22MEL71.4
12	Study of heat pipe and its demonstration	2	22MEL71.4

PART-C
Beyond Syllabus Virtual Lab Content

- https://sites.google.com/view/vlab-bnmitmech/home/heat-transfer-lab/determination-of-thermal-conductivity-of-a-metal-rod?authuser=0
- https://sites.google.com/view/vlab-bnmitmech/home/heat-transfer-lab/natural-convection?authuser=0
- https://vlab.amrita.edu/index.php?sub=1&brch=194&sim=791&cnt=1
- https://vlab.amrita.edu/index.php?sub=1&brch=194&sim=802&cnt=1

CIE Assessment Pattern (50 Marks – Lab)

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

SEE Assessment Pattern (50 Marks – Lab)

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

Suggested Learning Resources:

Reference Books:

1) Heat transfer, a practical approach, Yunus A- Cengel Tata McGraw Hill,5th Ed, ISBN: 9789339223199
2) Principles of heat transfer, Kreith Thomas Learning ,7th Ed, ISBN-13: 978-0495657704
3) Fundamentals of heat and mass transfer, Frank P. Incropera and David P. Dewitt, John Wiley and sons, 7th Ed, ISBN : 978-1-118-37924-0

COMPUTER INTEGRATED MANUFACTURING

Course Code	**22MEE72**	**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:

22MEE72.1	Understand the evolution, nature, and role of elements in Computer Integrated Manufacturing (CIM) systems
22MEE72.2	Apply the concepts of automated production lines and flow line configurations to select suitable part transfer methods, transport mechanisms, and control functions
22MEE72.3	Analyze the design and functioning of automated material handling systems, including parts feeding, delivery devices, AGVs, AS/RS, and smart conveying systems.
22MEE72.4	Apply computer-aided process planning, material requirement planning (MRP), and capacity planning techniques to improve production scheduling and resource utilization.
22MEE72.5	Evaluate the effectiveness of advanced manufacturing approaches such as Just-in-Time (JIT), Manufacturing Resource Planning (MRP-II).
22MEE72.6	Analyze automated inspection systems, including CMMs, machine vision, barcode/RFID 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
22MEE72.1	2	1	-	-	2	-	-	-	-	-	-	-	2	2
22MEE72.2	3	2	1	-	2	-	-	-	-	-	-	-	2	2
22MEE72.3	3	2	2	-	2	-	-	-	-	-	-	-	2	2
22MEE72.4	3	2	2	-	2	-	-	-	-	-	-	-	2	2
22MEE72.5	2	2	-	-	2	-	-	-	-	-	-	-	2	2
22MEE72.6	2	2	-	-	2	-	-	-	-	-	-	-	2	2

MODULE-1	**INTRODUCTION TO COMPUTER INTEGRATED MANUFACTURING AND AUTOMATION**	**22MEE72.1**	**8 Hours**

CIM, Computerized Elements of a CIM System, Evolution of Computer Integrated Manufacturing, Nature and Role of Elements of CIM system.
Automation, Types, Levels, Principles, Strategies, Advantages, Disadvantages, Information Processing Cycle, Production concepts, Smart Manufacturing.

Applications	Applications and implementation of automation in various industries.
Text Book	Text Book 1: 1.1, 1.2, 1.3, 1.4 Text Book 2: 1.1, 1.2 , 1.3

MODULE-2	**HIGH VOLUME PRODUCTION SYSTEMS**	**22MEE72.2**	**8 Hours**

Automated Production Lines, Automated Flow Line Symbols, Objectives, Configurations, Work Part Transport Methods, Work Part Transfer Mechanisms, Pallets, Buffer Storages, Control Functions.

Self-study	Usage of pallets and work part holding devices in the production line.
Text Book	Text Book 2: 2.1, 2.2, 2.3, 2.4

MODULE-3	**AUTOMATED ASSEMBLY SYSTEMS AND MATERIAL HANDLING**	**22MEE72.3**	**8 Hours**

Design, Types, Parts Feeding Devices, Parts Delivery System, Material Handling, Automated Guided Vehicles, Types, Vehicle Guidance Technology, Routing, System Management, Safety, Automated Storage and Retrieval System, Smart Conveying.

Case Study	Need for automated assembly and storage in various manufacturing industries.
Text Book	Text Book 1: 17.1 Text Book 2: 3.1, 3.2, 3.3, 3.4

MODULE-4	**COMPUTERIZED MANUFACTURING SYSTEMS**	**22MEE72.4 22MEE72.5**	**8 Hours**

Computer Aided Process Planning, Master Production Schedule, Material Requirement Planning, Fundamental Concepts, Capacity Planning, Outputs, Benefits, Manufacturing Resource Planning, Just-In-Time Production, Manufacturing Execution Systems.

Self-study	Software's used for Process Planning.
Text Book	Text Book 1: 24.1, 24.2 Text Book 2: 6.1, 6.2, 6.3, 6.4

MODULE-5	**AUTOMATED INSPECTION AND DATA CAPTURE**	**22MEE72.6**	**8 Hours**

Contact and Non-Contact Inspection, Co-ordinate Measuring Machine, Construction, Types, Operation, Machine Vision, Automatic Identification, Bar Code Technology, Radio Frequency Identification, Automated Optical Inspection.

Case Study	Current inspection and data capture techniques used in the industry.
Text Book	Text Book 1:22.1, 22.2

CIE Assessment Pattern (50 Marks – Theory)

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) Mikell P. Groover,"Automation, Production Systems and Computer Integrated Manufacturing", PHI Learning Pvt. Ltd., 4th Edition, 2016, ISBN- 978-9332572492.
2) A.C. Niranjan,"Computer Integrated Manufacturing", Pooja Publications, 4th Edition, 2016.

Reference Books:

1) Bharat Vinjamuri ,"Computer Integrated Manufacturing" star publishers 3rd edition 2016.

Web links and Video Lectures (e-Resources):

- **https://www.techopedia.com/definition/30965/computer-integrated-manufacturing-cim**

- **https://archive.nptel.ac.in/noc/courses/noc21/SEM1/noc21-me65/**
- **https://www.slideshare.net/hareeshang/high-volume-production-systems-class-presentation**
- **https://www.systema.com/digital-transformation/automated-material-handling-systems**
- **https://en.wikipedia.org/wiki/Computer-aided_process_planning**

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

- Visit to any design department of manufacturing/automotive industry.
- Demonstration of lathe/milling/drilling/CNC operations.
- Video demonstration of latest trends in computer integrated manufacturing.
- 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.

COMPUTER INTEGRATED MANUFACTURING LAB

Course Code	**22MEL72**	**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:

22MEL72.1	Understand the fundamental concepts and structure of CNC part programming, including G-code and M-code commands.
22MEL72.2	Apply CNC programming techniques to develop part programs for basic CNC milling operations
22MEL72.3	Apply CNC programming knowledge to generate part programs for CNC turning operations.
22MEL72.4	Analyze the working principles, components, and operational flow of industrial CNC machines for effective troubleshooting and optimization

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
22MEL72.1	2	-	-	-	2	-	-	-	-	-	-	2	3	2
22MEL72.2	3	2	2	-	2	-	-	-	-	-	-	2	3	2
22MEL72.3	3	2	2	-	2	-	-	-	-	-	-	2	3	2
22MEL72.4	3	2	2	2	2	-	-	-	-	-	-	2	3	2

Exp. No.	List of Experiments	Hours	COs
	Prerequisite Experiments / Demo		
	• Introduction to programming, G codes and M codes. • Understanding of CNC programming. • Simulation of simple programs.	2	NA
	PART-A		
1	Create a part program for the given rectangular MILLING profile using Absolute programming method.	2	22MEL72.1 22MEL72.2 22MEL72.4
2	Create a part program for the given Semi-Circular MILLING profile using Absolute programming method.	2	22MEL72.1 22MEL72.2 22MEL73.4
3	Create a part program for the given irregular MILLING profile using Absolute programming method.	2	22MEL72.1 22MEL72.2 22MEL73.4
4	Create a part program for the given rectangular MILLING profile using Incremental programming method.	2	22MEL72.1 22MEL72.2 22MEL73.4
5	Create a part program for the given Semi-Circular MILLING profile using Incremental programming method.	2	22MEL72.1 22MEL72.2 22MEL73.4
6	Create a part program for the given irregular MILLING profile using Incremental programming method.	2	22MEL72.1 22MEL72.2 22MEL73.4
	PART-B		

7	Create a part program for the given TURNING profile having Box Turning Operation.	2	22MEL72.1 22MEL72.3 22MEL73.4
8	Create a part program for the given TURNING profile having Semi-Circular Turning Operation.	2	22MEL72.1 22MEL72.3 22MEL73.4
9	Create a part program for the given TURNING profile having Taper Turning Operation.	2	22MEL72.1 22MEL72.3 22MEL73.4
10	Create a part program for the given TURNING profile having Thread Cutting Operation.	2	22MEL72.1 22MEL72.3 22MEL73.4
11	Create a part program for the given TURNING profile having a Combination of Operations.	2	22MEL72.1 22MEL72.3 22MEL73.4
12	Create a part program for the given profile having Peck Drilling operations.	2	22MEL72.1 22MEL72.3 22MEL73.4

PART-C

Beyond Syllabus Virtual Lab Content

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

- **http://vlabs.iitkgp.ernet.in/vlabs/rtvlab1/vmc.html**
- **https://www.teksure.in/virtual_CNC_lathe_simulator.php**

CIE Assessment Pattern (50 Marks – Lab)

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

SEE Assessment Pattern (50 Marks – Lab)

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

Suggested Learning Resources:

Reference Books:

1) Mikell P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", PHI Learning Pvt. Ltd., 4th Edition, 2016, ISBN- 978-9332572492.

2) A.C. Niranjan,"Computer Integrated Manufacturing", Pooja Publications, 4th Edition, 2016.

MECHANICAL VIBRATIONS			
Course Code	**22MEE73**	**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:

22MEE73.1	Apply the fundamental knowledge of physics and mechanics in understanding the theory behind free & forced vibrations, frequencies, damping, degrees of freedom and vibrations measuring instruments.
22MEE73.2	Analyze appropriate methods to determine the natural frequencies and responses of free, forced, damped, undamped, multiple degree-of-freedom, and continuous systems
22MEE73.3	Analyze the solutions through detailed process, investigations & vibrations of machines and shafts under distinctive loading conditions and evaluation of vibration of vibration measuring instruments.
22MEE73.4	Apply adequate theory, formula, and analysis techniques to provide vibration solution for mechanical machine elements of specific functions.
22MEE73.5	Develop feasible engineering components with thorough vibrations investigation & analysis so as to benefit the industry and environment.
22MEE73.6	Analyze new products with the fundamental knowledge on vibrations by latest technological advancement in design of vibrating machine parts and components.

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
22MEE73.1	3	2	-	-	-	-	-	-	-	-	-	-	2	2
22MEE73.2	3	3	2	-	-	-	-	-	-	-	-	-	2	2
22MEE73.3	3	2	2	-	2	-	-	-	-	-	-	-	2	2
22MEE73.4	2	2	-	-	2	-	-	-	-	-	-	-	2	2
22MEE73.5	3	3	2	2	-	-	-	-	-	-	-	-	2	2
22MEE73.6	3	2	2	-	2	-	-	-	-	-	-	-	2	2

MODULE-1	**INTRODUCTION TO VIBRATIONS**	**22MEE73.1 22MEE73.2**	**8 Hours**

Basic concepts and definitions. Simple harmonic motions, addition by analytical and graphical methods. Types of vibrations, elements of vibrating system. Super position of waves, Beats. Representation of wave forms using Fourier series and work done by a wave (derivations and problems)

Applications	Apply harmonic analysis methods to diverse engineering challenges such as IC Engines, Wind Turbines, and Industrial Plants.
Text Book	Text Book 1: 1.2, 1.3, 1.4, 1.13, 1.15, 1.16

MODULE-2	**UNDAMPED AND DAMPED FREE VIBRATIONS**	**22MEE73.1 22MEE73.2**	**08 Hours**

Undamped free Vibrations: Differential equation for undamped spring mass system using Newton's, Energy and Rayleigh's methods. Natural frequency of simple and compound pendulum, and spring mass system considering the mass of the spring.

Damped free Vibrations: Types of damping systems, Differential equation for damped spring mass system with solution for under damped, critically damped and over damped systems. Log decrement. Problems on damped systems.

Case Study	Study the vibrations produced by an internal combustion engine, focusing on sources of vibrations, their frequencies, and methods for mitigation.		
Text Book	Text Book 1: 2.2, 2.3, 2.4 to 2.15		
MODULE-3	**FORCED VIBRATIONS AND MEASURING INSTRUMENTS**	**22MEE73.3 22MEE73.4**	**08 Hours**
Forced Vibrations: Excitation sources, equation of motion for a forced spring mass damper system, rotating and reciprocating unbalanced system response. Absolute and relative motion. Vibrations isolations and transmissibility. Problems on forced vibrations. Measuring instruments: Vibrometer and accelerometer. Whirling of shafts with and without air damping. Critical speed of a shaft. Problems on a vibrometer and accelerometer. Problems on critical speed of shaft.			
Applications	Investigate the vibrations in turbines, compressors, and other rotating machinery in power plants, for Rotor dynamics, imbalance, misalignment, and vibration monitoring.		
Text Book	Text Book 2: 3.1, 3.3, 3.5, 3.7, 3.10		
MODULE-4	**MULTI DEGREE FREEDOM SYSTEMS**	**22MEE73.3 22MEE73.4**	**08 Hours**
Introduction, influence coefficients, Maxwell's reciprocal theorm, Determination of natural frequency using Rayleigh's method, Dunkerley's method, Holzer's method, Stodola method andMatrix iteration method.(spring mass systems and torsional systems)			
Self-study	Analyze the MDOF vibrations in a vehicle's suspension system, rotating machinery such as turbines and compressors, focusing on rotor-stator interactions.		
Text Book	Text Book 1: 6.1, 6.3, 6.5, 6.7, Text Book 2: 10.1, 10.3, 10.5, 10.7		
MODULE-5	**CONTINUOUS SYSTEMS AND SIGNAL CONDITION WITH MONITORING TECHNIQUES**	**22MEE73.5 22MEE73.6**	**8 Hours**
Continuous system: Introduction to continuous systems, vibrations of a string, longitudinal vibrations of rods, torsional vibrations of rods, Euler's equation of beams. Problems.Dynamic testing of machines and structures, experimental modal analysis, machine condition monitoring techniques and diagnosis. AI-based condition monitoring on mechanical systems using multibody dynamics models, Development of artificial intelligence tools and neural networks with direct application to vibration measurements,			
Case Study	Investigate vibrations in industrial machinery such as pumps, fans, and motors, for Condition monitoring, predictive maintenance, and fault diagnosis.		
Text Book	Text Book 2: 12.1 to 12.10		

CIE Assessment Pattern (50 Marks – Theory) –

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) Mechanical vibrations by V. P Singh, DhanpatRai& Co (P) Ltd, 5th edition 2015. ISBN-978-81-7700- 031-3

2) Mechanical vibrations by S. S. Rao, Peason Prentice Hall, 6th edition 2016,ISBN-10-0134361307.

Reference Books:

1) Mechanical vibrations, S. Graham Kelly, Schaum outline series, McGraw-Hill Education, 2016,ISBN- 10: 007034041

2) Mechanical vibrations by Srinath.M.K, Sanguine Technical Publishers Bangalore, 2015. ISBN-978 9383506 48-4

Web links and Video Lectures (e-Resources):

- **https://ocw.mit.edu/courses/2-003sc-engineering-dynamics-fall-2011/pages/mechanical-vibration/**
- **https://www.coursera.org/learn/introduction-basic-vibrations**
- **https://www.youtube.com/playlist?list=PLAC668A0566953FB5**
- **https://www.isu.edu/media/libraries/college-of-science-and-engineering/mechanical-engineering-v2/robotics-research-lab/Mechanical-Vibration.pdf**

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

- Allow students to build and analyze a spring-mass-damper system, recording the oscillations and comparing with theoretical predictions.
- Have students create simulations of vibrational systems and analyze the effects of varying parameters.
- Analyze the vibrational characteristics of a vehicle's suspension system and propose improvements.
- Use a simple pendulum setup or a vibrating table to demonstrate resonance and natural frequencies.
- Visit a plant where machinery vibration monitoring is essential for maintenance.

PROJECT PHASE -II

Course Code	**22MEE74**	**CIE Marks**	**100**
L:T:P:S	**0:0:10:0**	**SEE Marks**	**100**
Hrs / Week	**20**	**Total Marks**	**200**
Credits	**10**	**Exam Hours**	**03**

Course outcomes:

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

22MEE74.1	Apply the Domain knowledge, technical skill set and mechanical engineering principles for solving industry/research problems
22MEE74.2	Conduct detailed review of industrial and societal needs to reach sustainable conclusions.
22MEE74.3	Design a new innovation method based on the real-world requirements.
22MEE74.4	Evaluate the identified methodologies and select based on specific criteria.
22MEE74.5	Manage project schedules, resources and work assignments to ensure timely completion
22MEE74.6	Demonstrate the work with detailed project/technical report.

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
22MEE74.1	3	2	2	-	2	2	-	-	2	1	2	2	2	2
22MEE74.2	3	3	3	2	2	2	1	1	2	1	3	2	2	2
22MEE74.3	3	3	3	2	3	2	1	2	3	1	2	2	2	2
22MEE74.4	3	3	3	2	2	2	1	1	2	1	2	3	2	2
22MEE74.5	3	3	3	2	3	2	1	1	3	1	3	2	2	2
22MEE74.6	3	3	3	2	2	2	1	1	2	1	2	2	2	2

Project is an experimental learning course which will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications. The student shall be capable of recognizing a problem with appropriate consideration about societal needs in multiple areas and solve it using latest tools and technologies. Based on the ability/abilities of the student(s) and recommendations of the guide, multidisciplinary project can be assigned to a group having not more than 4 students. The project work will be reviewed by a panel of experts throughout the semester. The CIE marks awarded for the project work shall be based on the work accomplishment, project presentation skill, and question and answer session. The plagiarized projects will automatically result an F grade and the student will be liable for further disciplinary action. At the completion of a project the student will submit a project report, which will be evaluated by duly appointed examiner(s).

CONTENTS	COs
Perform a literature search to review current knowledge and developments in the chosen technical area. Review and finalization of the Approach to the Problem relating to the chosen topic/title. Preparation of work schedule with a team.	22MEE74.1, 22MEE74.2
Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as required for the chosen field.	22MEE74.2, 22MEE74.3
Development of product/process, testing, results, conclusions and future directions.	22MEE74.4
Present the work in a forum involving poster presentations and demonstrations of operational hardware and software.	22MEE74.5
Preparation of a project report in the standard format for being evaluated by the guide and the department with plagiarism certificate and present it as a team to the evaluators.	22MEE74.5, 22MEE74.6

CIE Assessment Pattern (100 Marks)

RBT Levels		Marks Distribution	
		Review 1 (50 Marks)	Review 2 (50 Marks)
L1	Remember	-	-
L2	Understand	10	10
L3	Apply	10	10
L4	Analyze	10	10
L5	Evaluate	10	10
L6	Create	10	10

SEE Assessment Pattern (100Marks)

RBT Levels		Exam Marks Distribution (100)
L1	Remember	-
L2	Understand	20
L3	Apply	20
L4	Analyze	20
L5	Evaluate	20
L6	Create	20

VIII Semester Syllabus

ADDITIVE MANUFACTURING

Course Code	**22MEE811**	**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:

22MEE811.1	Understand the fundamental principles, classifications, and industrial relevance of various additive manufacturing (AM) processes.
22MEE811.2	Apply the working knowledge of mechanisms, materials, and design considerations of vat photopolymerization processes such as SLA and DLP.
22MEE811.3	Analyze powder-bed fusion technologies (SLS, SLM, EBM) with respect to process parameters, material behavior, and defect mechanisms.
22MEE811.4	Evaluate extrusion and deposition-based AM techniques including FDM and DED for their applicability in functional part fabrication and repair.
22MEE811.5	Describe the operation and characteristics of sheet lamination, binder jetting, and material jetting processes used in industrial AM.
22MEE811.6	Apply knowledge of process-material interaction, design for AM, and post-processing techniques to select suitable AM methods for given applications.

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
22MEE811.1	3	-	2	-	1	1	2	-	-	-	-	-	3	3
22MEE811.2	3	-	2	-	1	1	2	-	-	-	-	-	3	3
22MEE811.3	3	-	2	-	1	1	2	-	-	-	-	-	3	3
22MEE811.4	3	-	2	-	1	1	2	-	-	-	-	-	3	3
22MEE811.5	3	-	2	-	1	1	2	-	-	-	-	-	3	3
22MEE811.6	3	-	2	-	1	1	2	-	-	-	-	-	3	3

MODULE-1	**INTRODUCTION TO ADDITIVE MANUFACTURING**	**21MEE811.1**	**8 Hours**

Definition and evolution of Additive Manufacturing, Differences between AM, Subtractive, and Formative processes, Classification of AM processes, General workflow of Additive Manufacturing, Design, Slicing, Printing, and Post-processing, Industrial Application.

Self-study	GE Aviation's 3D printed LEAP fuel nozzle revolutionizing jet engine efficiency through AM.
Text Book	Text Book 1: 1.1 to 1.12.

MODULE-2	**VAT PHOTO-POLYMERIZATION ADDITIVE MANUFACTURING PROCESSES**	**21MEE811.2**	**8 Hours**

Stereolithography (SLA), Digital Light Processing (DLP) Principles, photopolymer resins, layer curing, Materials used: Photopolymers, properties, and constraints, Curing mechanisms, resolution, and surface finish, Support structure design and removal.

Case Study	Formlabs' use of SLA to produce custom dental aligners with high-resolution photopolymer resins.
Text Book	Text Book 1: 2.2, 2.3, 2.4 to 2.15

MODULE-3	**POWDER-BASED FUSION ADDITIVE MANUFACTURING PROCESSES**	**21MEE811.3 21MEE811.4**	**8 Hours**

Selective Laser Sintering (SLS), Selective Laser Melting (SLM) and Electron Beam Melting (EBM), Working principle, sintering theory, Powder characteristics and recycling, Thermal stresses, shrinkage, and defect formation, Inert atmosphere and material compatibility.

Self-study / Case Study /	Siemens' adoption of SLM for printing gas turbine blades with optimized thermal resistance.

Text Book	Text Book 2: 3.1, 3.3, 3.5, 3.7, 3.10		
MODULE-4	**EXTRUSION AND DEPOSITION-BASED ADDITIVE MANUFACTURING PROCESSES**	**21MEE811.5**	**8 Hours**
Fused Deposition Modeling (FDM), Feedstock preparation, nozzle mechanics, Process parameters: temperature, speed, cooling, Direct Energy Deposition (DED) Laser/arc-based deposition, coaxial feeders, Applications in repair and cladding, Role of path planning and tool path optimization.			
Self-study	Stratasys' FDM use in fabricating functional prototypes for consumer electronics housings.		
Text Book	Text Book 1: 2.1 to 2.7. Text Book 2: 10.1, 10.3, 10.5, 10.7		
MODULE-5	**SHEET, JETTING, AND BINDER-BASED ADDITIVE MANUFACTURING PROCESSES**	**21MEE811.6**	**8 Hours**
Working Principles Applications of Binder Jetting (BJ), Binder chemistry, infiltration, Material Jetting (MJ) and Drop-on-Demand Printing, Laminated Object Manufacturing (LOM), Sheet bonding, cutting, and stacking			
Case Study / Applications	HP's Multi Jet Fusion technology in mass-producing custom shoe midsoles for FitStation.		
Text Book	Text Book 1: 10.1 to 10.8 Text Book 2: 10.1, 10.3, 10.5, 10.7		

CIE Assessment Pattern (50 Marks – Theory)

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

TEXT BOOKS:

1. Ian Gibson, David W. Rosen, Brent Stucker, "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", Springer (2nd Ed., 2015).
2. Kun Zhou, "Additive Manufacturing: Materials, Processes, Quantifications and Applications", CRC Press (2020)
3. Andreas Gebhardt, Jan-Steffen Hötter, "Introduction to Additive Manufacturing: Technologies and Applications" Hanser Publications (2021)

REFERENCE BOOKS:

1. M. F. Zaeh, "Fundamentals of Additive Manufacturing for the Practitioner", Wiley-VCH (2019).
2. Chee Kai Chua, Kah Fai Leong, "3D Printing and Additive Manufacturing: Principles and Applications", World Scientific Publishing (5th Edition, 2017).

Web links and Video Lectures (e-Resources):

- https://www.sciencedirect.com/journal/additive-manufacturing
- https://www.additivemanufacturing.media
- **https://www.3dprinting.com**
- **https://www.sme.org**
- https://all3dp.com/
- https://nptel.ac.in/courses/112/104/112104265
- https://ocw.mit.edu/courses/mechanical-engineering/2-008-design-and-manufacturing-ii-spring-2004/video-lectures/
- https://www.coursera.org/specializations/3d-printing
- https://www.youtube.com/playlist?list=PLyQSN7X0ro2314mKyUiR1Wyd7n6WgG_9t
- https://www.edx.org/course/additive-manufacturing

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

- Demonstration by taking students to additive manufacturing Lab
- 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

INDUSTRIAL ROBOTICS

Course Code	**22MEE812**	**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:

22MEE812.1	Apply the concepts of robotics to analyze their significance, social impact, and future prospects in engineering applications
22MEE812.2	Apply suitable drives and sensors for the effective operation of robotic systems
22MEE812.3	Evaluate the effectiveness of path planning and kinematic approaches in achieving precise and efficient robotic motion
22MEE812.4	Apply forward and inverse kinematics methods to analyze robotic manipulators with different degrees of freedom."
22MEE812.5	Analyze forward and inverse kinematics of robotic manipulators with different degrees of freedom to determine their motion characteristics.
22MEE812.6	Apply robotics concept to automate the monotonous and hazardous tasks and categorize various types of robots based on the design and applications in real world scenarios.

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
22MEE812.1	3	2	-	-	1	-	-	-	-	-	-	-	3	3
22MEE812.2	3	2	-	-	2	-	-	-	-	-	-	-	3	3
22MEE812.3	3	2	2	-	2	-	-	-	-	-	-	-	3	3
22MEE812.4	3	2	-	-	2	-	-	-	-	-	-	-	3	3
22MEE812.5	3	2	2	-	3	-	-	-	-	-	-	-	3	3
22MEE812.6	3	2	-	-	2	-	-	-	-	-	-	-	3	3

MODULE-1	**INTRODUCTION TO ROBOTICS**	**22MEE812.1**	**8 Hours**

Introduction to Robotics and Automation, laws of robot, brief history of robotics, basic components of robot, robot specifications, classification of robots, robot centered work cell, work cell design, safety measures in robotics, social impact, Robotics market and the future prospects.

Self-study	Understand the Introduction to Robotics and Automation with respect to human system and social impact.
Text Book	Text Book 1: 1.1 to 1.12.

MODULE-2	**Control systems and components**	**22MEE812.2**	**8 Hours**

Basic control systems and components: Basic control systems concepts and models, Controllers, control system analysis, simple numerical problem.

Robot sensors: Position & Velocity Sensors, types of sensor Actuators: Pneumatic & Hydraulic Actuators, Electric Motors, Stepper Motors & AC Servomotors

Case Study	Case study on Controllers and Robot sensors
Text Book	Text Book 1: 2.2, 2.3, 2.4 to 2.15

MODULE-3	**PATH PLANNING**	**22MEE812.3, 22MEE812.4**	**8 Hours**

1 DoF, 2 DoF, multiple degrees of freedom robot hand, Robot control types: limited sequence control, point-to-point control, playback with continuous path control, and intelligent control.

Path Planning: Definition-Joint space technique, Use of P-degree polynomial-Cubic, polynomial- Cartesian space technique, parametric descriptions, straight line and circular paths, position and orientation planning.

Case Study	Investigate the path planning and cubic polynomial.

Text Book	Text Book 2: 3.1, 3.3, 3.5, 3.7, 3.10		
MODULE-4	**FORWORDN KINEMATICS**	**22MEE812.5**	**8 Hours**
Forward Kinematics; Inverse Kinematics and Differences. Forward Kinematics and Reverse Kinematics of Manipulators with Two Degrees of Freedom (In 2 Dimensional); Deviations and Problems. Teach Pendant Programming; Lead through programming; Robot programming Languages; VAL Programming. Motion Commands; Sensor Commands; End effecter commands; and Simple programs. G codes and M Codes.			
Self-study	Know the kinematics robotics techniques and simple program.		
Text Book	Text Book 1: 2.1 to 2.7. Text Book 2: 10.1, 10.3, 10.5, 10.7		
MODULE-5	**APPLICATIONS OF ROBOT**	**22MEE812.6**	**8 Hours**
Application of Robot: aerial robots helicopters, Multi rotor UAV, Flapping wing/Bio inspired UAV, wheeled mobile robots, swarm robots, Legged robots, medical/healthcare robots , Rehabilitation robot, hospital robot, space robots, service robots, Underwater and floating robots, Military Robots, unmanned vehicles: ground, robotic for computer integrated manufacturing, Industrial robots, Humanoids, Autonomous robots			
Applications	Applications and case studies aerial robots helicopters, Multi rotor UAV, Flapping wing/Bio inspired UAV, satellites applications.		
Text Book	Text Book 1: 10.1 to 10.8 Text Book 2: 10.1, 10.3, 10.5, 10.7		

CIE Assessment Pattern (50 Marks – Theory)

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

TEXT BOOKS:

1. S.R. Deb, Robotics Technology and flexible automation, Tata McGraw-Hill Education, 2009.ISBN 978-0070707085.
2. Mikell P. Groover et. al., "Industrial Robots - Technology, Programming and Applications", McGraw Hill, Special Edition, (2012). ISBN 978-0070249898
3. Ganesh S Hegde, “A textbook on Industrial Robotics”, University science press, 3rd edition, 2017.

REFERENCE BOOKS:

1. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India Pvt. Ltd., 2006.
2. Fu K S, Gonzalez R C, Lee C.S.G, "Robotics: Control, Sensing, Vision and Intelligence", McGraw Hill.

Web links and Video Lectures (e-Resources):

- https://roboticscasual.com/ros-tutorial-pick-and-place-task-with-the-moveit-c-interface/
- https://roboticscasual.com/ros-tutorial-simulate-ur5-robot-in-gazebo-urdf-explained/
- https://roboticscasual.com/the-best-degrees-to-work-in-robotics/
- https://roboticscasual.com/robotics-tutorials/
- https://www.ieee-ras.org/educational-resources-outreach/educational-material-in-robotics-and
- automation https://www.academia.edu/20361073/Web_Based_Control_and_Robotics_Education_pdf
- https://github.com/Developer-Y/cs-video-courses https://www.isa.org/

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

- Video demonstration of latest trends in Industrial Robotics
- 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

CONTROL ENGINEERING

Course Code	**22MEE813**	**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:

22MEE813.1	Apply control system concepts to mechanical models and identify key control parameters for safe and reliable operation.
22MEE813.2	Analyze and categorize transient and steady-state responses of mechanical control systems to interpret practical engineering problems.
22MEE813.3	Apply system reduction techniques and evaluate transfer functions with appropriate representations and documentation
22MEE813.4	Determine stability conditions of control systems using graphical methods, and evaluate results to recommend necessary improvements
22MEE813.5	Develop control systems with suitable compensators to optimize system response and ensure functional efficiency.
22MEE813.6	Formulate the problems using MAT Lab programming.

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
22MEE813.1	3	2	1	-	-	-	-	-	-	-	-	-	3	3
22MEE813.2	3	2	1	-	2	-	-	-	-	-	-	-	3	3
22MEE813.3	3	2	1	-	2	-	-	-	-	-	-	-	3	3
22MEE813.4	3	1	1	-	2	-	-	-	-	-	-	-	3	3
22MEE813.5	3	2	1	2	2	-	-	-	-	-	-	-	3	3
22MEE813.6	3	2	1	-	2	-	-	-	-	-	-	-	3	3

MODULE-1	**Introduction to Control Engineering**	**22MEE813.1**	**8 Hours**

Concept of automatic controls, Open loop and closed loop systems, Concepts of feedback, requirements of an ideal control system, Types of controllers- Proportional, Proportional Integral, and Proportional Integral Differential controllers

Mathematical Models: Transfer function models, models of mechanical systems, models of electrical circuits, DC and AC motors in control systems, models of thermal systems, models of hydraulic systems, pneumatic system.

Self-study	Cruise Control System in Automobiles: Open-loop: Accelerator pedal manually pressed; Closed-loop: Speed is automatically maintained by feedback.
Text Book	Text Book 1: 1.1 to 1.12.

MODULE-2	**Transient and Steady State Response Analysis:**	**22MEE813.2**	**8 Hours**

Introduction, firstorder and second order system response to step, ramp and impulse inputs, concepts of time constant and its importance inspeed of response. System stability: Routh's-Hurwitz Criterion.

Case Study	Introduction, First-Order and Second-Order System Response, and Routh-Hurwitz Criterion for Cruise Control System in Automobiles
Text Book	Text Book 1: 2.2, 2.3, 2.4 to 2.15

MODULE-3	**Block Diagrams and Signal Flow Graphs:**	**22MEE813.3, 22MEE813.4**	**8 Hours**

Transfer Functions definition, function, block representation of systems elements, reduction of block diagrams, Signal flow graphs: Mason's gainformula. MAT lab simple program for representation of block diagrams

Self-study / Case Study /	Modeling and Analysis of a DC Motor Speed Control System Using Transfer Functions and Signal Flow Graphs

Text Book	Text Book 2: 3.1, 3.3, 3.5, 3.7, 3.10		
MODULE-4	**Frequency Response Analysis:**	**22MEE813.5**	**8 Hours**
Polar plots, Nyquist stability criterion, Stability analysis, Relative stability concepts, Gain margin and phase margin, M&N circles. Frequency Response Analysis Using Bode Plots: Bode attenuation diagrams, Stability analysis using Bode plots(Graphical method and also MAT Lab programming), Simplified Bode Diagrams			
Self-study	Frequency Domain Stability Analysis of an Aircraft Autopilot System Using Bode and Nyquist Techniques.		
Text Book	Text Book 1: 2.1 to 2.7. Text Book 2: 10.1, 10.3, 10.5, 10.7		
MODULE-5	**Root Locus Plots:**	**22MEE813.6**	**8 Hours**
Definition of root loci, General rules for constructing root loci, Analysis using root locus plots using graphical representation, relative stability. System Compensation: types of compensation system, design of lead and lag compensator, designing proportional controller for desired angle.			
Case Study / Applications	Root Locus-Based Compensator Design for Stabilizing a DC Motor Speed Control System.		
Text Book	Text Book 1: 10.1 to 10.8 Text Book 2: 10.1, 10.3, 10.5, 10.7		

CIE Assessment Pattern (50 Marks – Theory)

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

TEXT BOOKS:

1) Control Engineering, V.U.Bakshi & U.A.Bakshi, Technical Publications, 2014 edition,ISBN-13: 978-9350996577
2) Control System Engineering, I J Nagrath& M Gopal, New Age International Pvt Ltd; Sixth edition (1 January 2017), ISBN – 13: 978-9386070111
3) Modern Control Engineering, Katsuhiko Ogata, Pearson Publication, 5th Ed. ISBN-13: 978-0136156734

REFERENCE BOOKS:

1) ControlEngineering, D. Ganesh Rao,Pearson Education, 2010 edition, ISBN-13: 978-8131732335
2) MATLAB: Easy Way of Learning, S. Swapna Kumar&S. V. B. Lenina, Prentice-Hall of India Pvt.Ltd, 2016 edition, ISBN-13: 978-8120351653
3) MATLAB: An Introduction with Applications, Amos Gilat, Wiley; Fourth edition (9August 2012), ISBN-13: 978-8126537204
4) MATLAB and Simulink for Engineers, Agam Kumar Tyagi, Oxford; Pap/Cdr edition(24 November 2011), ISBN-13: 978-0198072447

Web links and Video Lectures (e-Resources):

- https://www-control.eng.cam.ac.uk/gv/p6/Handout5.pdf?utm
- https://www.cds.caltech.edu/~murray/courses/cds101/fa02/caltech/astrom-ch5.pdf?utm
- https://ocw.mit.edu/courses/2-04a-systems-and-controls-spring-2013/e1a7408acfaa5b79f0b3147e84d93bdd_MIT2_04AS13_Lecture10.pdf?utm
- https://www.vssut.ac.in/lecture_notes/lecture1423904331.pdf?utm
- https://www.youtube.com/watch?v=fVO7LOhfn0w
- https://www.youtube.com/watch?v=RMwSnHRMjOY
- https://www.youtube.com/watch?v=WBCZBOB3LCA
- https://www.youtube.com/watch?v=CzzsR5FT-8U

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

- Video demonstration of latest trends in Control systems and Engineering
- 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

REFRIGERATION AND AIR CONDITIONING			
Course Code	**22MEE814**	**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:

22MEE814.1	Understand Basics of Refrigeration and AC (HVAC & R) thermodynamic cycles
22MEE814.2	Explain working of VCRS (various configurations) & VARS as used in industry
22MEE814.3	Apply the selection criteria of refrigerants for eco-friendly operations in refrigeration systems
22MEE814.4	Analyze various indoor and outdoor HVAC design conditions based on human comfort condition requirements and an overview of Data Centre cooling
22MEE814.5	Analyze the concepts and working of various types of industrial and commercial air-conditioning and refrigeration systems, and examine their relevance to basic cooling load calculations
22MEE814.6	Classify various types ducting design of industrial ACs and Refrigeration systems based on applications

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
22MEE814.1	2	2	-	-	-	-	-	-	-	-	-	-	2	3
22MEE814.2	2	1	-	-	-	-	-	-	-	-	-	-	2	3
22MEE814.3	2	-	-	-	-	-	-	-	-	-	-	-	2	3
22MEE814.4	2	3	2	-	-	-	-	-	-	-	-	-	2	3
22MEE814.5	2	2	-	-	-	-	-	-	-	-	-	-	2	3
22MEE814.6	2	1	3	-	-	-	-	-	-	-	-	-	2	3

MODULE-1	**INTRODUCTION TO REFRIGERATION AND AIR CONDITIONING**	**22MEE814.1**	**8 Hours**

Introduction about Refrigeration – Definitions of various terms. Methods of refrigeration. Air refrigeration system. Bell – Coleman cycle. Introduction about Air craft Air-Conditioning. Simple numerical on the same.

Text Book	Text Book 1: 2.1, 2.2

MODULE-2	**VCRS & VARS SYSTEMS**	**22MEE814.2**	**8 Hours**

Analysis of Vapour compression cycle, Modifications to basic cycle. Multi pressure systems. Multi evaporator system and Cascade systems. Vapour Absorption Refrigeration System. Applications of VCRS & VARS. Simple numerical on VCRS & VARS.

Text Book	Text Book 1: 3.1, 3.2, 3.8

MODULE-3	**REFRIGERANTS**	**22MEE814.3**	**8 Hours**

Pollution by refrigerants. Various Refrigerants selection and properties - overview. Use of solar energy, low grade energy to run the refrigeration system. Methods of refrigeration in Dry ice manufacturing, Ejector refrigeration system, Evaporative Coolers. Desiccant cooling system – overview (No Numerical)

Text Book	Text Book 1:4.1, 4.2

MODULE-4	**PSYCHROMETRY**	**22MEE814.4**	**8 Hours**

Psychrometry – Definitions for properties. Introduction to AC cooling load calculations. Comfort conditions. Data Center Cooling. Effective temperature and humidity (ADP) concept. Idea of cooling load calculation Freeware's. Simple numerical (with & without using psychrometric chart) .

Text Book	Text Book 1:6.1, 6.4		
MODULE-5	**APPLICATIONS OF AIR CONDITIONING & REFRIGERATION SYSTEMS**	**22MEE814.5 22MEE814.6**	**8 Hours**

Air-conditioning systems – discussion about the central plant with direct evaporator and chiller applications, Ice plant, refrigerators. Duct sizing methods. Simple numerical. Idea of Duct Sizing Freeware's. Food preservation, IQF technique and freeze drying etc. Cold storage and thermal insulation. Simple numerical.

Text Book	Text Book -1: 8.1, 8.2

CIE Assessment Pattern (50 Marks – Theory) –

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) C.P. Arora, Refrigeration and Air Conditioning, Publisher - TMH, 4th Edition, 2021, ISBN-10 9390385849, ISBN-13 978-9390385843

2) R.C. Arora, Refrigeration and Air Conditioning, Publisher – 2010 PHI, ISBN-10 9788120339156, ISBN-13 978-8120339156

Reference Books:

1) ASHRAE Handbook - Fundamentals, Publisher – ASHRAE, ISBN-10 1947192892, ISBN-13 978-1947192898

2) ASHRAE Handbook – Refrigeration, Publisher – ASHRAE, ISBN-10 1931862869, ISBN-13 978-1931862868

Web links and Video Lectures (e-Resources):

- Refrigeration and Air-conditioning - Course (nptel.ac.in)
- NPTEL :: Mechanical Engineering - Refrigeration and Air Conditioning

HYDRAULICS AND PNEUMATICS

Course Code	**22MEE815**	**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:

22MEE815.1	Understand the working of hydraulic systems and pumps.
22MEE815.2	Evaluate the need of valves for hydraulic systems.
22MEE815.3	Investigate the need and functioning of hydraulic circuits.
22MEE815.4	Apply the role of pneumatic systems in the industry.
22MEE815.5	Analyze the working of multi-cylinder applications.
22MEE815.6	Evaluate the working of electro-pneumatic control 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
22MEE815.1	3	3	2	2	-	-	-	-	-	-	-	-	2	2
22MEE815.2	3	2	2	2	-	-	-	-	-	-	-	-	2	2
22MEE815.3	3	3	2	2	-	-	-	-	-	-	-	-	2	2
22MEE815.4	3	3	2	2	-	-	-	-	-	-	-	-	2	2
22MEE815.5	3	2	2	2	-	-	-	-	-	-	-	-	2	2
22MEE815.6	3	2	2	2	-	-	-	-	-	-	-	-	2	2

MODULE-1	**INTRODUCTION TO HYDRAULIC POWER**	**22MEE815.1**	**8 Hours**

Definition of Hydraulic System, Pascal's Law, Advantages, Limitations, Applications, Pumps, Classification, Positive Displacement Pumps, Selection of Pumps, Hydraulic Actuators, Smart Hydraulic Systems -smart sensors and data analytics

Applications	Real time applications of Pascal's Law.
Text Book	Text Book 1: 1.1,1.3,1.4,3.3,3.4,3.7,5.2,5.3

MODULE-2	**CONTROL COMPONENTS IN HYDRAULIC SYSTEMS.**	**22MEE815.2**	**8 Hours**

Directional Control Valves, Symbolic Representation, Pressure Control Valves, Flow Control Valves, Hydraulic Oils, Types, Desirable Properties, Electro-Hydraulic Control Components- servo valve

Self-study	Types of valves used in various industries.
Text Book	Text Book 1: 8.2,8.3,8.4,

MODULE-3	**HYDRAULIC CIRCUIT DESIGN AND ANALYSIS**	**22MEE815.3**	**8 Hours**

Control of Single and Double – acting Hydraulic cylinder, Regenerative Circuit, Pump Unloading Circuit, Double Pump Hydraulic system, Counter Balance Valve application, Hydraulic Cylinder Sequencing Circuits. Locked Cylinder using Pilot Check Valve, Cylinder Synchronizing Circuits, Speed Control of Hydraulic Cylinder, Speed Control of Hydraulic Motors, Accumulators and Accumulator Circuits, a smart hydraulic circuit

Case Study	Real time applications of hydraulic systems in industry.
Text Book	Text Book 1: 9.2,9.3,9.4,9.5,9.6,9.7,9.8,9.10,9.11,9.13,9.14

MODULE-4	**PNEUMATIC CONTROL SYSTEM**	**22MEE815.4**	**8 Hours**

Choice of working medium, characteristics of compressed air, preparation of compressed air- Driers, Filters, Regulators, Lubricators, Distribution of compressed air- Piping layout. Pneumatic Actuators: Linear cylinders – Types, conventional type of cylinder working, end position cushioning, seals. Rod – less cylinders – types, working advantages, Rotary cylinder-types, construction.

Directional Control Valves: Design and constructional aspects, poppet valves, slide valves spool valve, suspended seat type slide valve.
Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders. Flow control valves and speed control of cylinders supply air throttling and exhaust air throttling use of quick exhaust valve, Pneumatics in Industry 4.0

Self-study	Comparing efficiency of pneumatic and hydraulic systems.		
Text Book	Text Book 1: 13.2,13.4		
MODULE-5	**MULTI-CYLINDER APPLICATIONS IN PNEUMATICS**	**22MEE815.5 22MEE815.6**	**8 Hours**

Multi-cylinder Applications: Coordinated and sequential motion control. Motion and control diagrams – Signal elimination methods. Cascading method – principle. Practical application examples (up to two cylinders) using cascading method using reversing valves.
Electro-Pneumatic control: Principles-signal input and output pilot assisted solenoid control of directional control valves, use of relay and contactors. Control circuitry for simple single cylinder applications, PLC control of hydraulic and pneumatic systems

Case Study	Control and monitoring of electro-pneumatic systems.
Text Book	Text Book 1: 15.6,15.7

CIE Assessment Pattern (50 Marks – Theory)

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) "Fluid Power with Applications" Anthony Esposito, Seventh edition, Pearson New International Edition, 7th edition 2013, ISBN-13: 9781292023878

2) Hydraulics and Pneumatics, A Technician's and Engineer's Guide, Andrew Parr, 3rd Edition 2011,Butterworth-Heinemann 2011 publication, ISBN:9780080966748

Reference Books:

1) Oil Hydraulic systems', Principles and Maintenance S. R. Majumdar, Tata McGraw Hill Publishing Company Ltd. – 2001, ISBN-13: 978-0074637487
2) Principles of Hydraulic Systems Design, Peter Chapple, 2nd Edition ((Dec 31 2014),Momentum Press publishing, ISBN: 9781606504529
3) Fluid Power: Hydraulics and Pneumatics, James R Daines2nd Edition (Aug 30, 2012),Goodheartwillcox Publication, ISBN: 9781605259369
4) Pneumatic Systems', S. R. Majumdar, McGraw-Hill Professional; 2004 Publication, ISBN 13: 9780074602317
5) Hydraulics and Pneumatics, 1/e Jagadeesha T, I K International publishers (2015), ISBN- 13: 97893845889

Web links and Video Lectures (e-Resources):

- https://elearn.nptel.ac.in/shop/nptel/oil-hydraulics-and-pneumatics/?v=c86ee0d9d7ed
- https://uk.rs-online.com/web/content/discovery/ideas-and-advice/pneumatics-hydraulics-overview
- https://www.udemy.com/course/introduction-of-hydraulics-and-pneumatics/

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

- Video demonstration of latest trends in hydraulics and pneumatics
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare flowcharts
  - Organizing Group wise discussions on issues in maintenance of hydraulic and pneumatic systems
  - Seminars

ENERGY ENGINEEERING			
Course Code	**22MEE821**	**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:

22MEE821.1	Understand the basic working principles of non-conventional power plants like Nuclear, Solar, Geo-thermal, Tidal and Ocean Thermal Energy power plant.
22MEE821.2	Evaluate cycle efficiency and performance of Various Power Plants.
22MEE821.3	Distinguish the various types of fuels used in power plants and estimate their Heating values.
22MEE821.4	Analyze the applications of Bio Mass and Hydrogen energy.
22MEE821.5	Investigate the ways to increase the thermal efficiency of power plant by the use of accessories.
22MEE821.6	Apply the working principles and identify the basic components of diesel and hydroelectric power plants, along with relevant economic considerations

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
22MEE821.1	3	-	-	-	-	3	-	-	-	-	-	-	3	2
22MEE821.2	3	3	-	-	-	-	-	-	-	-	-	-	3	2
22MEE821.3	3	3	-	-	-	-	-	-	-	-	-	-	3	2
22MEE821.4	3	-	-	-	-	3	-	-	-	-	-	-	3	2
22MEE821.5	3	3	-	-	-	-	-	-	-	-	-	-	3	2
22MEE821.6	3	3	-	-	-	-	-	-	-	-	-	-	3	2

MODULE-1	**STEAM POWER PLANT**	**22MEE821.2 22MEE821.5**	**8 Hours**

Layout of steam power plant, Different Types of Fuels used for steam generation, Equipment for burning coal in lump form, strokers, different types, Advantages and Disadvantages of using pulverized fuel, Equipment for preparation and burning of pulverized coal, unit system and bin system. Pulverized fuel furnaces, cyclone furnace.

A Brief Account of Benson, Velox, Schmidt Steam Generators, Chimneys: Natural, forced, induced and balanced draft. Cooling towers and Ponds. Accessories for the Steam generators such as Super heaters, De-super heater, control of super heaters, Economizers, Air pre heaters and re-heaters.

Case Study	Case Studies on Performance different Boilers
Text Book	Text Book 1: 1.1, 1.2, 1.3

MODULE-2	**DIESEL ENGINE POWER PLANT AND HYDRO-ELECTRIC PLANTS**	**22MEE821.3 22MEE821.6**	**8 Hours**

Applications of Diesel Engines in Power field. Method of starting Diesel engines. Auxiliaries like cooling and lubrication system, intake and exhaust system, Layout of diesel power plant.

Hydro-Electric Plants: Hydrographs, flow duration and mass curves, unit hydrograph and numerical. Storage and pondage, pumped storage plants, low, medium and high head plants, Penstock, water hammer, surge tanks, gates and valves. General layout of hydel power plants.

Applications	Investigate the applications of Diesel power plant
Text Book	Text Book 2: 3.1, 3.2, 3.3, 3.5

MODULE-3	**SOLAR ENERGY**	**22MEE821.1**	**8 Hours**

Solar extra terrestrial radiation and radiation at the earth surface, radiation-measuring instruments, working principles of solar flat plate collectors, solar pond and photovoltaic conversion (Numerical Examples).
Wind Energy: Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, wind machines; Types of wind machines and their characteristics, horizontal and vertical axis wind mills.

Applications	Analyze the Applications of Solar Energy
Text Book	Text Book 1: 4.1, 4.2, 4.3, 4.4

MODULE-4	**NUCLEAR POWER PLANT**	**22MEE821.1**	**8 Hours**

Principles of release of nuclear energy; Fusion and fission reactions. Nuclear fuels used in the reactors. Elements of the nuclear reactor; moderator, control rod, fuel rods, coolants. Brief description of reactors of the following types- Pressurized water reactor, Boiling water reactor, Sodium graphite reactor and gas cooled reactor, Radiation hazards, Shieldings, Radio-active waste disposal.
Hydrogen Energy: Properties of Hydrogen with respected to its utilization as a renewable form of energy, sources of hydrogen, production of hydrogen, electrolysis of water, thermal decomposition of water, thermo chemical production, bio- chemical production.

Case Study	Case study on Nuclear power and its waste disposal
Text Book	Text Book 2: 5.1, 5.2, 5.3

MODULE-5	**GEOTHERMAL ENERGY CONVERSION**	**22MEE821.1 22MEE821.4**	**8 Hours**

Principle of working, types of geothermal station with schematic diagram, problems associated with geothermal conversion, scope of geothermal energy.
Tidal Power: fundamental characteristics of tidal power, harnessing tidal energy, limitations.
Ocean Thermal Energy Conversion: Principle of working, Rankine cycle, problems associated with OTEC.
Energy from Bio Mass: Photosynthesis, photosynthetic oxygen production, energy plantation, bio gas production from organic wastes by anaerobic fermentation, description of bio-gas plants, problems involved with bio-gas production.

Applications	Investigate the applications of OTEC, Biomass
Text Book	Text Book 3: 8.1, 8.2, 8.3, 8.4, Text Book 4: 10.1, 10.2, 10.3, 10.4

CIE Assessment Pattern (50 Marks – Theory)

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) Non-Conventional Energy Sources by G.D Rai K, Khanna Publishers, 5th Ed, ISBN: 97881- 7409-073-8
2) Solar energy, by Subhas P Sukhatme– Tata McGraw Hill, 3rd Ed, ISBN: 9780070260641
3) Power Plant Engineering, P. K. Nag Tata McGraw Hill ,4th Ed, ISBN: 9789339204044
4) Power Plant Engineering, Domakundawar, Dhanpath Rai sons.

Reference Books:

1) Power Plant Engineering, R. K. Rajput, Laxmi publication, 5th Ed, ISBN: 9788131802557
2) Principles of Energy conversion, A. W. Culp Jr., McGraw Hill, 2nd Ed, ISBN-13: 978- 0070435599
3) Renewable Energy Sources and Conversion Technology by N.K.Bansal, Manfred Kleeman & Mechael Meliss, Tata McGraw Hill, 2001.

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

SUSTAINABLE ENERGY SYSTEMS DESIGN			
Course Code	**22MEE822**	**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:

22MEE822.1	Apply the principles of sustainability to understand global energy scenarios.
22MEE822.2	Analyze the working principles, technologies, and applications of solar, biomass, and tidal energy systems.
22MEE822.3	Evaluate wind, geothermal, and hydropower energy systems with a focus on resource availability, system components, and practical applications.
22MEE822.4	Apply simulation tools and emerging technologies such as AI and IoT in renewable energy systems for monitoring, prediction, and maintenance.
22MEE822.5	Design sustainable energy systems by performing load estimation, component sizing, and optimizing system configuration.
22MEE822.6	Apply techno-economic analysis methods to understand the environmental impacts of sustainable energy projects.

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
22MEE822.1	3	2	1	-	-	-	-	-	-	-	-	-	2	3
22MEE822.2	3	2	2	-	-	-	-	-	-	-	-	-	2	3
22MEE822.3	3	3	2	1	-	-	-	-	-	-	-	-	2	3
22MEE822.4	3	2	1	-	-	-	-	-	-	-	-	-	2	3
22MEE822.5	3	2	2	2	-	-	-	-	-	-	-	-	2	3
22MEE822.6	3	2	1	-	-	-	-	-	-	-	-	-	2	3

MODULE-1	**INTRODUCTION TO SUSTAINABLE ENERGY SYSTEMS**	**22MEE822.1**	**8 Hours**

Basics of Sustainability - Definition and principles of sustainability and Global energy scenario and environmental impact.
Renewable vs. Non-renewable Energy Sources - Types, availability, and comparative analysis.
Sustainable Energy Metrics - Energy return on investment (EROI), life-cycle analysis.
Policy and Regulations - Global agreements (e.g., Paris Agreement), SDGs and National energy policies and incentives.

Self-study	Study on National energy policies and incentives on RE power generation.
Text Book	Text Book 2: 1.1-1.33

MODULE-2	**SOLAR ENERGY, BIOMASS ENERGY AND TIDAL ENERGY**	**22MEE822.2**	**8 Hours**

Introduction – extra terrestrial solar radiation - radiation at ground level – collectors - solar cells , applications of solar energy
Introduction - Biomass Conversion - Biogas Production - Ethanol Production - Pyrolysis and Gasification-Direct Combustion.
Origin of tides - power generation schemes.

Case Study	Study on AI-driven solar microgrids
Text Book	Text Book 2: 2.37 - 2.56, 3.57 - 3.95, 5.113 – 5.171, 7.241 – 7.329

MODULE-3	**WIND, GEO THERMAL AND HYDRO ENERGY SOURCES AND APPLICATIONS**	**22MEE822.3**	**8 Hours**

Wind Energy – Introduction, basic theory - types of wind turbines applications.

Geothermal Energy - Introduction-geothermal resource types - resource base applications for heating and electricity generation.
Hydropower – introduction - basic concepts site selection - types of turbines - small scale hydropower.

Applications	Applications of Wind power and Hydropower generation.		
Text Book	Text Book 2: 6.175 - 6.238, 8.333 - 8.372		
MODULE-4	**DESIGN TOOLS, SIMULATION & EMERGING TECHNOLOGIES**	**22MEE822.4**	**8 Hours**

AI in Energy Systems - Predictive analytics for energy demand, AI for fault detection and maintenance in RE systems and ML algorithms for solar/wind output prediction.
IoT in Energy Monitoring - Smart sensors, real-time data collection, cloud platforms.

Self-study	Survey on Net-zero buildings and campuses.		
Text Book	Text Book 5: 3.45 to 3.78, 6.145 to 6.180 and 8.210 to 8.245		
MODULE-5	**SUSTAINABLE DESIGN AND PROJECT IMPLEMENTATION**	**22MEE822.5 22MEE822.6**	**8 Hours**

System Design Principles - Load estimation, Component sizing, and Optimization.
Techno-Economic Feasibility - Cost-benefit analysis.
Environmental Impact Assessment (EIA) - Carbon footprint calculation.

Case Studies	Study on Smart city renewable integration.
Text Book	Text Book 3: 4.85 to 4.130 and 7.215-7.260, Text Book 4: 2.20 -3.80

CIE Assessment Pattern (50 Marks – Theory)

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) T.N.Veziroglu, Alternative Energy Sources,Vol 5 and 6,McGraw- Hil (1978).
2) Non-Conventional Energy Sources G.D Rai Khanna Publishers 2003
3) The Art of Systems Architecting (3rd Ed., 2015) by Mark W. Maier & Eberhardt Rechtin
4) Benefit–Cost Analysis: Financial and Economic Appraisal Using Spreadsheets (Cambridge Univ. Press, 2011) by Harry Campbell & Richard Brown.
5) Artificial Intelligence and Machine Learning for Renewable Energy Systems by Soteris A. Kalogirou Published by Academic Press, 2021, ISBN: 9780128205110

Reference Books:

1) A. Duffie and W.A. Beckmann, Solar Engineering of Thermal Processes-John Wiley (1980).
2) F.Kreith and J.F. Kreider, Principles of Solar Engineering, McGraw-Hill (1978).
3) System Analysis and Design Methods (4th Ed., 2012) by Jeffrey L. Whitten et al.

Web links and Video Lectures (e-Resources):

- http ://www.solstice.crest.org
- http ://www.res-.ltd-com
- www.mnes.mic.in
- www.ireada.org
- http://sundancepower.com

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

- Visit to any type of power PLANT
- Demonstration of power Generation – Various Renewable type
- Video demonstration of latest trends in power plant
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare Flowcharts and Handouts
  - Seminars

ADVANCED NANOTECHNOLOGY

Course Code	**22MEE823**	**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:

22MEE823.1	Apply appropriate synthesis techniques to develop advanced nanoparticles with desired properties.
22MEE823.2	Analyze the working principles and functionalities of instruments used for the characterization of nanoparticles.
22MEE823.3	Classify and differentiate nanomaterials based on their functional properties and structural configurations.
22MEE823.4	Apply nanotechnology principles in the design and fabrication of nanoscale devices and systems
22MEE823.5	Evaluate the suitability and performance of nanomaterials in various device-level applications.
22MEE823.6	Analyze and assess the integration of nanotechnology across emerging domains such as electronics, energy, healthcare, and environmental engineering.

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
22MEE823.1	3	2	-	-	2	-	-	-	-	-	-	2	2	2
22MEE823.2	3	2	2	-	2	-	-	-	-	-	-	2	2	2
22MEE823.3	3	2	-	-	2	-	-	-	-	-	-	2	2	2
22MEE823.4	3	2	-	2	2	-	-	-	-	-	-	2	2	2
22MEE823.5	3	2	2	-	2	-	-	-	-	-	-	2	2	2
22MEE823.6	3	2	2	-	2	-	-	-	-	-	-	2	2	2

MODULE-1	**ADVANCED SYNTHESIS TECHNIQUES FOR NANOMATERIAL**	**22MEE823.1**	**8 Hours**

Introduction: Advanced methods for synthesizing of nanomaterials - top-down and bottom-up approaches. Synthesis techniques: Chemical Vapor Deposition (CVD), Atomic Layer Deposition (ALD), Molecular Beam Epitaxy (MBE), sol-gel processing, and hydrothermal methods. particle size, shape, morphology, and surface characteristics for specific applications. Green synthesis routes and microwave-assisted processes for sustainable nanomaterial production.

Self-study	Self-study of different Nano material synthesis techniques.
Text Book	Text Book 1: 2.1

MODULE-2	**ADVANCED CHARATERIZATION OF NANOSTRUCTURES**	**22MEE823.2**	**8 Hours**

Introduction: Advanced characterization techniques to analyze the structure, morphology, and properties of nanomaterials. Electron microscopy methods: High-Resolution Transmission Electron Microscopy (HRTEM), Field Emission Scanning Electron Microscopy (FESEM), and Scanning Tunneling Microscopy (STM). Spectroscopic techniques - Raman spectroscopy, X-ray Photoelectron Spectroscopy (XPS), and Fourier Transform Infrared Spectroscopy (FTIR) for chemical and surface analysis. Crystallographic and phase analysis using X-ray Diffraction (XRD) and Selected Area Electron Diffraction (SAED).

Case Study	Case study in use of different nanomaterial characterization Techniques for different applications.
Text Book	Text Book 1: 3.4,3.7,3.8,5.1,5.2,5.3,5.4

MODULE-3	FUNCTIONAL NANOMATERIALS AND THEIR PROPERTIES	22MEE823.3	8 Hours
Introduction, classification of functional nanomaterials - quantum dots, carbon nanotubes, graphene, MXenes, and two-dimensional materials. Discussion of electrical, optical, magnetic, thermal, and catalytic properties arising from nanoscale effects. Design and synthesis of hybrid nanostructures, core-shell systems, and smart responsive materials. Applications in energy, electronics, sensors, and biotechnology. Environmental and health impacts, toxicity and biocompatibility of nanomaterials.			
Case Study	Case study on the functions of nanomaterials.		
Text Book	Text Book 1: 6.1,6.2,6.3,6.4,6.5,6.6,7.1,7.2,7.3,11.1,11.3,11.4,11.5,11.6		
MODULE-4	**NANO DEVICES AND NANO FABRICATION**	**22MEE823.4**	**8 Hours**
Principles and Techniques; Design and fabrication of nanoscale devices. Advanced lithography methods: electron beam lithography, nanoimprint lithography, and dip-pen nanolithography. Development of MEMS/NEMS, nanoelectronics, and lab-on-chip systems, emphasis on material selection and device integration. Nano biosensors, nano-optoelectronic devices, and CMOS-compatible nanofabrication processes. Challenges in miniaturization, reliability, and large-scale manufacturing of nano devices.			
Case Study	Case studies on the fabrication of nano materials.		
Text Book	Text Book 1: 8.1,8.2,8.4,8.7,9.1, 15.1,15.2,15.3,15.5,15.7,15.8		
MODULE-5	**APPLICATIONS AND EMERGING TRENDS**	**22MEE823.5 22MEE823.6**	**8 Hours**
Nanotech Applications and Recent Breakthroughs: Introduction, Significant Impact of Nanotechnology and Nanomaterial, Medicine and Healthcare Applications, Biological and Biochemical Applications (Nano biotechnology), Electronic Applications (Nano electronics), Computing Applications (Nano computers), Chemical Applications (Nano chemistry), Optical Applications (Nano photonics), targeted drug delivery, cancer therapy, biosensing, and tissue engineering, Agriculture and Food Applications, Recent Major Breakthroughs in Nanotechnology. Emerging trends: quantum nanotechnology, nano-robotics, AI-assisted nanomaterial design, and ethical considerations in nanotech deployment.			
Applications	Visiting the facility which uses applications of Nanotechnology		
Text Book	Text Book 1: 14.1,14.2,18.1,18.2,18.3,18.4,20.1,20.2,20.3,20.4		

CIE Assessment Pattern (50 Marks – Theory)

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1. Nanotechnology: Principles and Practices, Sulabha K. Kulkarni, Capital publishing company, New Delhi, 2011
2. Introduction to Nanotechnology" – Charles P. Poole Jr. and Frank J. Owens, Wiley-Interscience; 1st edition, 2003
3. Nanocrystals: Synthesis, Properties and Applications – C.N.R. Rao, P. John Thomas and G. U. Kulkarni, Springer Series in Materials Science, 2007
4. Nano Essentials- T. Pradeep/TMH, 2007, Peter J. F. Harris, Carbon nanotube science: synthesis, properties, and applications, Cambridge University Press, 2011

Reference Books:

1. Introduction to Nanoscience and Nanotechnology, Gabor L. Hornyak et al., CRC Pr I Llc; Illustrated edition, 2008
2. Nanotechnology, M. Ratner and D. Ratner, Prentice Hall, 2003
3. Nanotechnology, M. Wildon, K. Kannagara, G. Smith, M. Simmons and B. Raguse, CRC Press, 2002

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=PNElByWIGNc https://www.youtube.com/watch?v=qUEbxTkPIWI
https://www.youtube.com/watch?v=lFYs3XDu4fQ
https://www.youtube.com/watch?v=Lpju0DTY8_g
https://www.youtube.com/watch?v=G6MIQlIIozg
https://www.youtube.com/watch?v=-gdILnzYZEg

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

- Visit to any Nano Technology implemented manufacturing/assembly industry
- Demonstration of Nano material synthesis operations
- Demonstration of working of Nano material synthesis machines
- Demonstration of Nano material synthesis applied to a typical case study
- Video demonstration of latest trends in nanotechnology
- Contents related activities (Activity-based discussions)
- For active participation of students, instruct the students to prepare Flowcharts and Handout
- Organizing Group wise discussions on issues
- Seminars

INDUSTRIAL INTERNET OF THINGS			
Course Code	**22MEE824**	**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:

22MEE824.1	Understand the theoretical foundation of IIoT systems. Identify issues IIoT aims to solve in manufacturing and process industries.
22MEE824.2	Apply knowledge of component specifications to design simple IIoT edge solutions considering real-world constraints
22MEE824.3	Apply the concept of microcontrollers and embedded tools for system interfacing and performance of different network technologies.
22MEE824.4	Explore emerging network standards like TSN, 5G. Design basic IIoT data processing and visualization pipelines.
22MEE824.5	Evaluate cloud platforms and dashboards for real-time insights. Integrate IIoT systems with cost-effective, scalable cloud solutions
22MEE824.6	Analyze IIoT's impact on sustainable manufacturing. Address privacy, data ownership, and security challenges.

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
22MEE824.1	2	2	-	-	-	-	-	-	-	-	-	-	2	3
22MEE824.2	3	2	1	-	2	-	-	-	-	-	-	-	2	3
22MEE824.3	3	2	1	-	2	-	-	-	-	-	-	-	2	3
22MEE824.4	2	2	-	-	3	-	-	-	-	-	-	-	2	3
22MEE824.5	3	2	2	-	3	-	-	-	-	-	-	-	2	3
22MEE824.6	3	2	2	-	2	-	-	-	-	-	-	-	2	3

MODULE-1	**FUNDAMENTALS OF IIOT**	**22MEE824.1**	**8 Hours**

Evolution from traditional automation to IIoT. Core principles of IIoT and Industry 4.0. Architecture: Perception layer, Network layer, Data processing layer, Application layer. Enabling technologies: Cloud computing, Edge computing, Big data, Artificial Intelligence Benefits: Predictive maintenance, real-time monitoring, operational efficiency. Challenges: Legacy systems, data interoperability, scalability.

Self-study	Case study on the impact of Industry 4.0 on a specific type of Industry.
Text Book	Text Book 2: 1.1-1.33

MODULE-2	**SENSORS, ACTUATORS, AND EDGE DEVICES**	**22MEE824.2**	**8 Hours**

Types of sensors: temperature, pressure, proximity, flow, vibration, etc. Actuators: electrical, pneumatic, hydraulic Microcontrollers and SBCs: Arduino, Raspberry Pi, ESP32, STM32 Edge devices and fog computing: role in latency reduction and local processing Analog vs digital sensors, calibration, noise reduction, and real-time data acquisition Embedded programming basics and interfacing with industrial equipment.

Case Study	Study on AI-driven solar microgrids
Text Book	Text Book 2: 2.37 - 2.56, 3.57 - 3.95, 5.113 – 5.171, 7.241 – 7.329

MODULE-3	**COMMUNICATION PROTOCOLS AND NETWORKING**	**22MEE824.3, 22MEE824.4**	**8 Hours**

Overview of IIoT network requirements: reliability, real-time capability, fault tolerance. IIoT communication protocols: MQTT, CoAP, OPC UA, Modbus, etc. Wireless technologies: ZigBee, LoRaWAN, NB-IoT, BLE, 5G in industrial use. Industrial Ethernet, fieldbuses (PROFIBUS, CANbus), SCADA communication.
Network architecture, topology planning, routing and addressing. Network security concerns (encryption, authentication, VPNs).

Hands on	Modelling a IOT based industrial gas monitoring system.

Text Book	Text Book 2: 6.175 - 6.238, 8.333 - 8.372		
MODULE-4	**DATA ANALYTICS AND CLOUD INTEGRATION**	**22MEE824.5**	**8 Hours**
Data lifecycle in IIoT: acquisition, preprocessing, analytics, action Basics of data analytics: filtering, anomaly detection, trend analysis Machine Learning use cases in IIoT: predictive maintenance, quality control IIoT cloud platforms: AWS IoT Core, Azure IoT Hub, IBM Watson IoT, Google Cloud IoT Use of APIs and SDKs for cloud integration Dashboard development using tools like Grafana, Power BI, or Node-RED.			
Hands on	Create manufactory orders using Odoo Manufacturing.		
Text Book	Text Book 5: 3.45 to 3.78, 6.145 to 6.180 and 8.210 to 8.245		
MODULE-5	**APPLICATIONS, SECURITY, AND CASE STUDIES**	**22MEE824.6**	**8 Hours**
Real-world IIoT applications: Smart manufacturing, energy management, fleet tracking, oil & gas, predictive maintenance. IIoT security: device authentication, secure boot, encryption, physical security. ROI and implementation challenges in brownfield vs greenfield industries. Case studies: GE Predix, Siemens indSphere, Bosch IoT Suite.			
Hands on	Create a temperature monitoring dashboard using IoT cloud with Node MCU		
Text Book	Text Book 3: 4.85 to 4.130 and 7.215-7.260, Text Book 4: 2.20 -3.80		

CIE Assessment Pattern (50 Marks – Theory)

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1) T.N.Veziroglu, Industrial Internet of Things (IIoT) ,Vol 5 and 6,McGraw- Hil (1978).
2) Introduction to IoT by Prof. Sudip Misra Khanna Publishers 2003
3) Applications of IIoT (3rd Ed., 2015) by Mark W. Maier & Eberhardt Rechtin
4) Future Developments in IoT (Cambridge Univ. Press, 2011) by Harry Campbell & Richard Brown.
5) Artificial Intelligence and Machine Learning for Renewable Energy Systems by Soteris A. Kalogirou Published by Academic Press, 2021, ISBN: 9780128205110

Reference Books:

1) A. Duffie and W.A. Beckmann, Industrial Internet of Things (IIoT) -John Wiley (1980).
2) F.Kreith and J.F. Kreider, Principles IIoT, McGraw-Hill (1978).
3) System Analysis and Design Methods (4th Ed., 2012) by Jeffrey L. Whitten et al.

Web links and Video Lectures (e-Resources):

- http ://www.solstice.crest.org
- http ://www.res-.ltd-com
- www.mnes.mic.in
- www.ireada.org
- http://sundancepower.com

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

- Visit to any type of power PLANT
- Demonstration of power Generation – Various Renewable type
- Video demonstration of latest trends in power plant
- Contents related activities (Activity-based discussions)
  - For active participation of students, instruct the students to prepare Flowcharts and Handouts
  - Seminars

ADVANCED SEMICONDUCTOR MATERIALS AND ITS APPLICATIONS

Course Code	**22MEE825**	**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:

22MEE825.1	Recollect the basic concepts of semiconductor, its materials and classification.
22MEE825.2	Define the basic properties and characteristics of semiconductor materials by analysing their properties through a set of characterisation techniques
22MEE825.3	Understand the latest developments and advancements in semiconductor technology.
22MEE825.4	Study the applications of various semiconductor devices
22MEE825.5	Demonstrate the basic aspects of advanced engineering of semiconductor materials and their applications, such as lasers and LEDs, solar cells and photocatalysts
22MEE825.6	Discuss the basic principles of semiconductors technology, including conventional and cutting-edge fabrication techniques

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
22MEE825.1	3	-	-	-	-	-	-	-	-	-	-	1	3	3
22MEE825.2	3	2	-	2	2	-	-	-	-	-	-	1	3	3
22MEE825.3	3	-	-	-	2	-	1	-	-	-	-	2	3	3
22MEE825.4	3	2	2	1	2	1	1	-	-	-	-	2	3	3
22MEE825.5	3	2	2	2	3	1	2	-	1	-	-	2	3	3
22MEE825.6	3	2	-	2	3	-	1	-	1	-	-	3	3	3

MODULE-1	**INTRODUCTION TO SEMICONDUCTORS & IT'S MATERIALS**	**22MEE825.1, 22MEE825.2**	**8 Hours**

Classification of Semiconductors- Organic, inorganic and organic polymers, Intrinsic, Extrinsic, p type ,n type etc p-n junction under forward and reverse bias. Different semiconductor materials

Self-study	Investigate the Challenges of organic semiconductors
Text Book	Text Book 1: 2.5, 2.8, 2.10

MODULE-2	**MOSFETS**	**22MEE825.3**	**8 Hours**

MOSFET: Basic Device Characteristics, Non uniform Doping and Buried Channel Device, Device Scaling and Short-Channel Effects, MOSFET Structures, Circuit Applications, Single Electron Transistor, JFETs. Hetero-junctions ,Metal-Semiconductor Contacts, Metal-Insulator-Semiconductor Capacitors. MESFETs and MODFETs

Case Study / Applications	Investigate the fabrication mechanisms of MOSFETS
Text Book	Text Book : 3.1, 3.3, 3.8, 3.12

MODULE-3	**TUNNEL DEVICES AND IMPATT DIODES**	**22MEE825.3, 22MEE825.4**	**8 Hours**

TUNNEL DEVICES : Tunnel Diode, Related Tunnel Devices, Resonant Tunneling Diode. IMPATT Diodes: Static Characteristics, Dynamic Characteristics, Power and Efficiency Noise Behavior, Device Design and Performance, BARITT Diode, TUNNETT Diode

Self-study	Explore the Bio inspired environmental constructions and development.
Text Book	Text Book 2: 5.2, 5.4, 5.6

MODULE-4	**PHOTODETECTORS, SOLAR CELLS AND SENSORS**	**22MEE825.4 22MEE825.5**	**8 Hours**

Photodiodes, Avalanche Photodiode and Phototransistor, Charge-Coupled Device (CCD), Metal-Semiconductor-Metal Photo detector, Quantum-Well Infrared Photodetector, Solar Cell Sensors: Thermal Sensor, Mechanical Sensors, Magnetic Sensors and Chemical Sensors

Self-study	Study the usefulness of doping and exploitation of compound semiconductors.
Text Book	Text Book 2: 6.1, 6.3,6.4

MODULE-5	**FABRICATION OF SEMICONDUCTORS**	**22MEE825.6**	**8 Hours**

Semiconductor Growth Techniques and Device Fabrication – Wafer Processing, Solid state circuit Construction, Etching process

Case Study	Study the Applications of semiconductor devices in Medical and space Technologies
Text Book	Text Book 2:8.2, 8.4, 8.8, 8.9

CIE Assessment Pattern (50 Marks – Theory)

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

SEE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Text Books:

1.SupriyoDatta, Quantum Transport Atom to Transistor, Cambridge University Press, 2005

2. A.K. Maini, All in One Electronics Simplified, Khanna Publishing House, Delhi

Reference Books:

1.J. P. Colinge and C. A. Colinge, "Physics Of Semiconductor Devices", Kluwer Academic Publishers

2.B. G. Streetman and S. Banerjee Solid state electronics devices, 5th Edition, PHI.

Web links and Video Lectures (e-Resources):

- https://youtu.be/QpSr2OQdCfQ?si=y7PSyOLbMdLbK_km
- https://youtu.be/pk0XAUpZVMQ?si=LiEJGrgy3X5AhUy2
- https://youtu.be/_t1G-qTL8UU?si=dqi90-yiZxaydppA

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

- Video demonstration of latest trends in semiconductor design.
- 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

INTERNSHIP

Course Code	**22MEE83**	**CIE Marks**	**100**
L:T:P:S	**0:0:10:0**	**SEE Marks**	**100**
Hrs / Week	**20**	**Total Marks**	**200**
Credits	**10**	**Exam Hours**	**03**

Course outcomes:

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

22MEE83.1	Apply and test the basic theoretical knowledge learnt during the study on to projects in industry/Startup/CoE/Study Centre etc.
22MEE83.2	Cater to the recent industrial demands by analysing and designing complex engineering solutions.
22MEE83.3	Work in real-life scenarios.
22MEE83.4	Perform either as an individual or as a team to communicate the complex engineering activities with the community and with the society and comprehend the work through articles/reports.

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
22MEE83.1	3	3	3	-	3	-	-	-	-	-	-	3	-	3
22MEE83.2	3	3	3	-	3	-	-	-	-	-	-	3	-	3
22MEE83.3	3	3	3	-	3	-	-	-	-	-	-	3	-	3
22MEE83.4	3		3	-	3	-	-	-	-	-	-	3	-	3

Elucidation:

At the beginning of IV years of the program i.e., after VI semester, VII semester classwork and VIII semester Internship shall be permitted to be operated simultaneously by the University so that students have ample opportunity for an internship. In other words, a good percentage of the class shall attend VII semester classwork and a similar percentage of others shall attend to Internship.

Internship: The mandatory Internship is for 14 to 20 weeks. The internship shall be considered as a head of passing and shall be considered for the award of a degree. Those, who do not take up/complete the internship shall be declared to fail and shall have to complete it during the subsequent SEE examination after satisfying the internship requirements. If the students are opting for the 8th semester, the following internship options are available:

- Industry Internship
- Research Internship
- Skill Enhancement Courses
- Post-Placement Training as Internship
- Online Internship

Industry internship: It is an extended period of work experience undertaken by students to supplement their degree for professional development. It also helps them learn to overcome unexpected obstacles and successfully navigate organizations, perspectives, and cultures. Dealing with contingencies helps students recognize, appreciate, and adapt to organizational realities by tempering their knowledge with practical constraints. Students undertaking industry internships must ensure the organization is listed on the VTU Internship Portal. If not, request the organization to register on the portal.

Research internship: A research internship is intended to offer the flavor of current research going on in the research field. It helps students get familiarized with the field and imparts the skill required for carrying out research. Research internships must be carried out in recognized research centers. Ensure that these centers are registered on the portal.

Skill Enhancement Courses: Students can take Skill-based courses with credits totalling the same as those of the internship. Students must be taken from registered providers listed on the VTU Internship Portal.

Post-Placement Training as Internship: The post-placement training is also considered an internship. For students placed during their 6th/7th semester and willing to take the training during their final year, colleges must inform the recruiting companies in advance to register on the VTU Internship Portal.

Online Internship: Reputed online internship platforms, including those identified by NSDC, are already listed on the VTU Internship portal. If colleges come across other eligible organizations not yet listed, they are informed to ask the organization to register on the VTU Internship portal.

The faculty coordinator or mentor has to monitor the student's internship progress and interact with them to guide for the successful completion of the internship. The students are permitted to carry out the internship anywhere in India or abroad. University shall not bear any expenses incurred in respect of the internship. With the consent of the internal guide and Principal of the Institution, students shall be allowed to carry out the internship at their hometown (within or outside the state or abroad), provided favorable facilities are available for the internship and the student remains regularly in contact with the internal guide.

CIE Assessment Pattern (100 Marks)

RBT Levels		Marks Distribution	
		Review 1 (50 Marks)	Review 2 (50 Marks)
L1	Remember	-	-
L2	Understand	10	10
L3	Apply	10	10
L4	Analyze	10	10
L5	Evaluate	10	10
L6	Create	10	10

SEE Assessment Pattern (100 Marks – Theory)

RBT Levels		Exam Marks Distribution (100)
L1	Remember	-
L2	Understand	20
L3	Apply	20
L4	Analyze	20
L5	Evaluate	20
L6	Create	20

INDIAN KNOWLEDGE SYSTEMS

Course Code	**22IKK84**	**CIE Marks**	**50**
L:T:P:S	**0:0:0:0**	**SEE Marks**	**--**
Hrs / Week	**1**	**Total Marks**	**50**
Credits	**0**	**Exam Hours**	**--**

Course outcomes:

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

22IKK84.1	Provide an overview of the concept of the Indian Knowledge System and its importance.
22IKK84.2	Appreciate the need and importance of protecting traditional knowledge.
22IKK84.3	Recognize the relevance of Traditional knowledge in different domains.
22IKK84.4	Establish the significance of Indian Knowledge systems in the contemporary world.

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
22IKK84.1	2	-	-	-	-	-	-	3	-	-	-	1
22IKK84.2	-	-	-	-	-	2	-	-	-	-	-	-
22IKK84.3	-	-	2	2	-	-	-	-	-	-	-	-
22IKK84.4	-	-	-	-	-	3	2	-	-	-	-	-

MODULE-1	**INTRODUCTION TO INDIAN KNOWLEDGE SYSTEMS (IKS)**	**22IKK84.1, 22IKK84.2**	**5 Hours**

Overview, Vedic Corpus, Philosophy, Character scope and importance, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge vs. western knowledge.

MODULE-2	**TRADITIONAL KNOWLEDGE IN PROFESSIONAL DOMAIN**	**22IKK84.3**	**5 Hours**

Linguistics, Number and measurements- Mathematics, Chemistry, Physics, Art, Dyes and painting technology, Astronomy, Astrology, Crafts and Trade in India and Engineering and Technology.

MODULE- 3	**TRADITIONAL KNOWLEDGE IN GOVERNANCE AND ECONOMICS**	**22IKK84.4**	**5 Hours**

Governance and public administration, United Nations Sustainable development goals, an overview of Indian economic thought–Arthasastra and Nitisastra, Leadership and Motivation, Planning and Organizing, Financial Management

CIE Assessment Pattern (50 Marks – Theory)

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

Suggested Learning Resources:

Reference Books:

1. **Introduction to Indian Knowledge System- concepts and applications**, B Mahadevan, Vinayak Rajat Bhat, Nagendra Pavana R N, 2022, PHI Learning Private Ltd, ISBN-978-93- 91818-21-0

2. **Traditional Knowledge System in India**, Amit Jha, 2009, Atlantic Publishers and Distributors (P) Ltd., ISBN-

13: 978-8126912230
3. **Knowledge Traditions and Practices of India**, Kapil Kapoor, Avadesh Kumar Singh, Vol. 1, 2005, DK Print World (P) Ltd., ISBN 81-246-0334

Web links and Video Lectures (e-Resources):

1. https://iksindia.org/lectures-and-videos.php
2. http://nptel.ac.in/courses/121106003/
3. http://nbaindia.org/uploaded/docs/traditionalknowledge_190707.pdf
4. https://www.youtube.com/watch?v=LZP1StpYEPM

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

- Reflection and Discussion
- Case Studies

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.

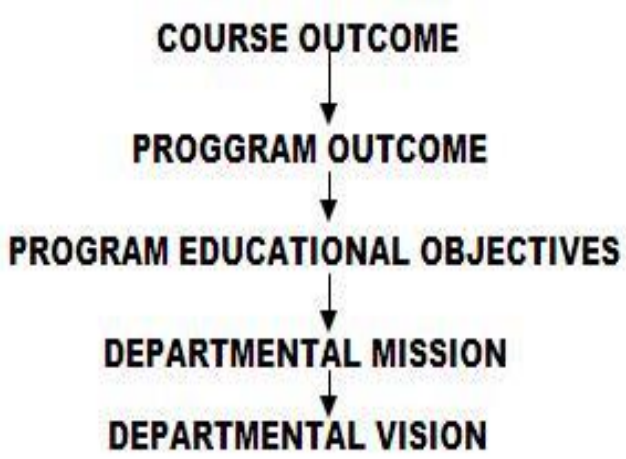
There are three educational Outcomes as defined by the National Board of Accreditation:

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.

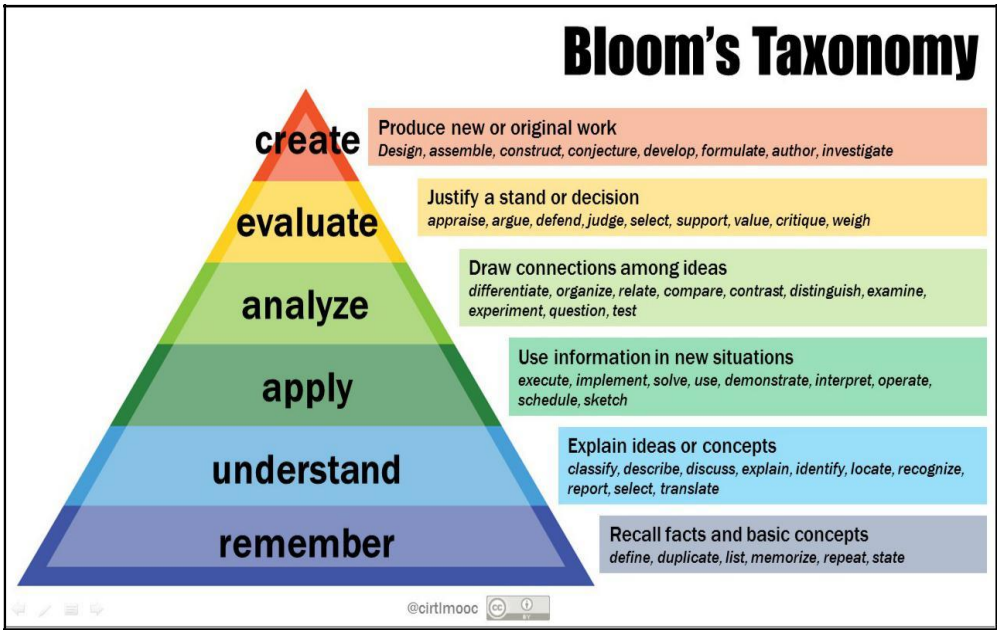
Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

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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