Scheme and Syllabus of

VII and VIII semesters

B.E. Mechanical Engineering

AY: 2025-26

(NEP2-2022 Scheme)

Scheme & Syllabus 160 Credits

Our Motto: Work is Worship

Institute Vision:

To develop thoughtful and creative young minds in a learning environment of high academic ambience by synergising spiritual values and technological competence.

Institute Mission

1. To continuously strive for the total development of students by educating them in state-of-the-art-technologies and managerial competencies providing best in class learning experience with emphasis on skills, values and learning outcomes and helping them imbibe professional ethics and societal commitment.

2. To create research ambience that promotes interdisciplinary research catering to the needs of industry and society.

3. To collaborate with premier academic and research institutions and industries to strengthen multidisciplinary education, applied research, innovation, entrepreneurship and consulting ecosystems.

Department Vision

To be one of the Premier Centre for technical education and applied Research in Mechanical Engineering and to bring out globally acclaimed competent engineers with innovative ideas and ethical values to fulfil the societal needs.

Department Mission

M1- Develop as a Centre of Excellence in Mechanical Engineering by Facilitating the state-of-the-art infrastructure, industry relevant curriculum and effective skill oriented teaching-learning -teaching process.

M2- Contribute to the development of Nation by preparing the younger generation to pursue research and development in the thrust areas of mechanical engineering such as thermal power engineering, Manufacturing engineering, Material science engineering, Mechanical Design, Product design and Management.

M3- To Prepare mechanical engineering graduates to be professionally competent with strong entrepreneurial, ethical and spiritual values to fulfil societal requirements.

Program Outcomes:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **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.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **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.
7. **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.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **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.
11. **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.
12. **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.

Program Specific Outcomes (PSOs)

PSO1: Mechanical Engineering graduates will be able to pursue research on Advanced Materials and Manufacturing, Thermal sciences, and Advanced Management concepts.

PSO2: Mechanical Engineering graduates will be able to Design and Develop various Mechanical Equipment's for general and Advanced Applications.

PSO3: Mechanical Engineering graduates will be able to use Interdisciplinary Modern I.T tools in various applications.

Program Educational Objectives (PEOs)

PEO-1 - Graduates of mechanical engineering are working as competent technical and managerial leaders in Design, Manufacturing, Materials, Thermal, Automation and Management fields.

PEO-2 - Graduates of mechanical engineering exhibit leadership qualities with strong communication skills and able to work in team or individually with professional and ethical values which leads to improvement in the performance of the organization.

PEO-3 - Graduates of mechanical engineering program are involved in professional practices addressing societal needs, environmental issues with life-long learning.

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B.E. in Mechanical Engineering

SCHEME OF TEACHING AND EXAMINATION (NEP2-2022 Scheme) (For AY 2025-26)

VII Semester (Swappable VII and VIII Semester)

Sl. No.	Course and Course Code		Course Title	Teaching / Paper setting Dept.	Teaching Hours					Evaluation Duration in hrs.		Total No. of Hours	Examination			Credits
					Lecture	Tutorial	Practical/ Drawing	Study Hour	Term Work/ Self-Study	CIE	SEE		CIE Marks	SEE Marks	Total Marks	
					L	T	P	SH	TW/SS							
1.	IPCC	S7MEI01	Heat and Mass Transfer	ME	42	0	28	14	29	4	3	120	50	50	100	4
2.	IPCC	S7MEI02	Linear Dynamic Systems and Control Engineering	ME	42	0	28	14	29	4	3	120	50	50	100	4
3.	PCC	S7ME01	Operations Research	ME	42	28	0	14	27	4	3	120	50	50	100	4
4.	PEC	S7MEE0X	Professional Elective Course-III	ME	42	0	0	14	27	4	3	90	50	50	100	3
5.	OEC	OEXX	Open Elective Course-II		42	0	0	14	27	4	3	90	50	50	100	3
6.	PROJ	S7MEP01	Major Project Phase -II	ME	One day in a week is earmarked for carrying out Project work					3	3		100	100	200	6
												Total	**350**	**350**	**700**	**24**
AAP			AICTE Activity Points (Applicable for both Regular and Lateral Entry students)	40 hours community service to be documented and produced for the examination												

Note: IPCC: Integrated Professional Core Course, **PCC**: Professional Core Course; **PEC**: Professional Elective Course**; OEC:** Open Elective Course; **PROJ:** Project Phase –I; **PCCL**: Professional Core Course laboratory; **AEC**: Ability Enhancement Course, **SEC**: Skill Enhancement Course; **NCMC**: Non Credit Mandatory Course; **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation.

Professional Elective Course (PEC) (Offered by the Department)

S7MEE01	Smart Manufacturing	S7MEE05	Design For Manufacture & Assembly
S7MEE02	Tool Engineering	S7MEE06	Composite Materials
S7MEE03	Production & Operations Management	S7MEE07	Design of Transmission Systems
S7MEE04	Power Plant Engineering	S7MEE08	Introduction to Computational Fluid Dynamics

Note: VII and VIII semesters of IV years of the program: 1) Institutions can swap the VII and VIII Semester Schemes of Teaching and Examinations to accommodate research internships/ industry internships after the VI semester. 2) Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether the VII or VIII semesters is completed during the beginning of the IV year or the later part of IV years of the program.

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering (B.E.) 2022-23 may please be referred.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of Engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering a professional elective is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Open Elective Courses: Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor. The minimum numbers of students' strength for offering Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.

Project Work Phase III and IV: 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:

1) 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 ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

2) 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 ratio 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 ratio 50:25:25.

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SCHEME OF TEACHING AND EXAMINATION (NEP2-2022 Scheme)

VIII Semester (Swappable VII and VIII Semester)

Sl. No.	Course and Course Code		Course Title	Teaching / Paper setting Dept.	Teaching hrs./week				Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	Self-Study Component	Duration in hrs.	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1.	PEC		Professional Elective (Online Courses) *[Details of the scheme will be intimated soon]*		3	0	0		3	50	50	100	3
2.	OEC		Open Elective (Online Courses) *[Details of the scheme will be intimated soon]*		0	2	0		3	50	50	100	3
3.	INT		Internship (Industry/Research) (14-20 weeks)		0	0	12		3	100	100	200	10
			Total							**200**	**200**	**400**	**16**
		AAP	AICTE Activity Points (Applicable for both Regular and Lateral Entry students)	40 hours community service to be documented and produced for the examination									

Note: PEC: Professional Elective Course**; OEC:** Open Elective Course (Online); **INT:** Industry Internship / Research Internship / Rural Internship
L: Lecture, **T**: Tutorial, **P**: Practical, **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation,
SEE: Semester End Evaluation.

Professional Elective (Online Courses – suggested by BoS, NPTEL)			
	Materials & Manufacturing		**Design**
	Thermal		**Management / Quality**
Open Elective (Online Courses – suggested by BoS, NPTEL)			

Note: VII and VIII semesters of IV years of the program

1) Institutions can swap the VII and VIII Semester Schemes of Teaching and Examinations to accommodate research internships/ industry internships after the VI semester.
2) Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether the VII or VIII semesters is completed during the beginning of the IV year or the later part of IV years of the program.

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 center, Start-up, center 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.

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. University shall not bear any cost involved in carrying out the internship by students. However, students can receive any financial assistance extended by the organization.

Professional Elective /Open Elective Course: These are ONLINE courses suggested by the respective Board of Studies. Details of these courses shall be made available for students on the VTU web portal.

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List of MOOCs for VIII semester for 2025-26

Professional Elective (PE)

(All courses are of 12-week duration)

Sl.No.	Course	Offered By	Course Mentor / Faculty	Stream
1.	Advanced Dynamics	IIT Kharagpur	Prof. Anirvan DasGupta	Design
2.	Applied Elasticity	IIT Bhubaneswar	Prof. Soham Roychowdhury	
3.	Design of Mechatronic Systems	IIT Bombay	Prof. Prasanna Gandhi	
4.	Engineering Fracture Mechanics	IIT Madras, Amrita Vishwa Vidyapeetham	Prof. K. Ramesh, Dr. Hariprasad M P	
5.	Design of Precision Machines	IIT Delhi	Prof. Jitendra P. Khatait	
6.	Experimental Modal Analysis	IIT Delhi	Prof. Subodh V. Modak	
7.	Artificial Intelligence and Machine Learning in Materials Engineering	IIT Kanpur	Prof. Krishanu Biswas	Materials & Manufacturing
8.	Rapid Manufacturing	IIT Kanpur	Prof. J. Ramkumar, Prof. Amandeep Singh	
9.	Mathematical Modelling of Manufacturing Processes	IIT Guwahati	Prof. Swarup Bag	
10.	Fundamentals of Additive Manufacturing Technologies	IIT Guwahati	Prof. Sajan Kapil	
11.	Automation in Manufacturing	IIT Guwahati	Prof. Shrikrishna N. Joshi	
12.	Industrial Engineering and Operations Research	IIT Guwahati	Prof. Uday Shanker Dixit	
13.	Corrosion/Environmental Degradation/Surface Engineering	IIT Delhi	Prof. (HAG) Harish Hirani	
14.	Material Processing (Metallurgical Aspects): Fundamentals and Practical	IIT Roorkee	Prof. D K Dwivedi	
15.	Joining Technologies for Metals	IIT Roorkee	Prof. D K Dwivedi	
16.	Knowledge Management	IIT Kharagpur	Prof K B L Srivastava	
17.	Strategic Management	,IISc	Prof R Srinivasan	

Sl.No.	Course	Offered By	Course Mentor / Faculty	Stream
18.	Management Information System	IIT Kharagpur	Prof Kunal Nanti Ghosh & Prof Saini Das	Management
19.	E-Business	IIT Kharagpur	Prof Jenamani	
20.	Management Accounting	IIT Roorkee	Prof Anil K Sharma	
21.	Production Operations Management : Theory & Applications	IIT Kharagpur	Prof Sanjib Chowdury	
22.	Project Management	IIT Kharagpur	Prof Sanjib Chowdury	
23.	Marketing Management	IIT Kanpur	Prof Jayanth Chatterjee & Prof Shashi Shekar Mishra	
24.	Customer Relationship Management	IIT Kharagpur	Prof Swagato Chaterjee	
25.	Artificial Intelligence in Industrial & Management Engineering	IIT Kanpur	Prof Deepu Philip & Prof Prabal Pratap Singh	
26.	Explosions and Safety	IIT Madras	Prof. Prasad Patnaik BSV, Prof. K. Ramamurthi	Thermal Engineering
27.	Advanced Fluid Mechanics	IIT Madras	Prof. Anubhab Roy	
28.	Convective Heat Transfer	IISc Bangalore	Prof. Saptarshi Basu	
29.	Fundamentals of Convective Heat Transfer	IIT Guwahati	Prof. Amaresh Dalal	
30.	Fundamentals of Conduction and Radiation	IIT Guwahati	Prof. Amaresh Dalal, Prof. Dipankar N.Basu	
31.	Aircraft Propulsion	IIT Guwahati	Prof. Vinayak N. Kulkarni	
32.	Sustainable Power Generation Systems	IIT Guwahati	Prof. Pankaj Kalita	
33.	Energy Conservation and Waste Heat Recovery	IIT Kharagpur	Prof. Prasanta Kumar Das, Prof. A Bhattacharya	
34.	Heat Exchangers: Fundamentals and Design Analysis	IIT Kharagpur	Prof. Prasanta Kumar Das, Prof. Indranil Ghosh	
35.	Rocket Propulsion	IIT Madras	Prof. K. Ramamurthi, Prof. P. A. Ramakrishna	

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Open Elective (OE)

(All courses are of 12-week duration)

Sl. No.	Course	Offered By	Course Mentor / Faculty
1.	Artificial Intelligence and Machine Learning in Materials Engineering	IIT Kanpur	Prof. Krishanu Biswas
2	Industrial Engineering and Operations Research	IIT Guwahati	Prof. Uday Shanker Dixit
3	E-Business	IIT Kharagpur	Prof Jenamani
4	Management Accounting	IIT Roorkee	Prof Anil K Sharma
5	Production Operations Management : Theory & Applications	IIT Kharagpur	Prof Sanjib Chowdury
6	Explosions and Safety	IIT Madras	Prof. Prasad Patnaik BSV, Prof. K. Ramamurthi

VII & VIII Semester

(NEP2-2022 Scheme)

Scheme & Syllabus 160 Credits

AY 2025-26

Heat and Mass Transfer

Contact Hours/ Week:	3+0+2 (L+T+P)	Credits:	4.0
Total Lecture Hours:	39(L)+0+26(P)	CIE Marks:	50
Course Code:	S7MEI01	SEE Marks:	50

Course objectives:
This course will enable students to:

1.	Understanding the fundamental laws and mechanisms of heat transfer:
2.	know the heat conduction, convection equation for problem solving involving different geometries, materials, and boundary conditions.
3.	Learn convection heat transfer mechanism to find heat transfer coefficients for various heat transfer scenarios.
4.	Understand the different types of heat exchanger to optimize the performance parameters.
5.	know the principles of radiation and mass transfer to solve problems.

UNIT I

Introductory Concepts and Definitions:
Modes of heat transfer; basic laws governing conduction, convection and radiation heat transfer; thermal conductivity; convective heat transfer coefficient; Stefan Boltzmann constant. Derivation on three dimensional conductions in rectangular coordinate system, Boundary conditions of first, second and third kinds. Numerical problems.

Self-study: Discussion on three dimensional conduction equation in cylindrical and spherical coordinate systems. **(only for CIE not for SEE)**

6 Hours

UNIT II

One- Dimensional Heat Conduction:
One dimensional, steady state heat conduction without heat generation through plane slabs, cylinders and spheres. Concept of thermal resistance, Electrical analogy, Heat transfer through composite slabs, cylinders and spheres, contact resistance, Combined conduction and convection, overall heat transfer co-efficient, Numerical problems.

Unsteady State Conduction:
Transient conduction in solids with negligible internal temperature gradients (Lumped system analysis) and Heisler's Charts for slabs, cylinders and spheres. Numerical problems.

Heat transfer through Extended surfaces: necessity of fins, discussion on different boundary conditions (no derivation, numerical problems.)

Self-study: Derivation of one-dimensional heat transfer through slab, cylinder, sphere and composite slab, cylinder, sphere, variable thermal conductivity. **(only for CIE not for SEE)**

10 Hours

UNIT III

Convection:
Buckingham π Theorem for free and forced convection, Dimensionless numbers in convection & their physical significance. Use of various correlations for free convection heat transfers from

vertical surface, horizontal surfaces and forced convection heat transfer, flow over a flat plate, Flow through circular ducts. Numerical problems.

Boiling and Condensation: Types of condensation: use of correlations for condensation on vertical surfaces, horizontal tube and horizontal tube banks; Reynolds number for condensate flow; regimes of pool boiling, pool boiling correlations, Numerical problems

Self-study: Nusselt theory for laminar condensation **(only for CIE not for SEE)**

9 Hours

UNIT IV

Heat Exchangers:

Classification of heat exchangers, flow arrangements, fouling factor, derivation of LMTD for parallel flow and counter flow heat exchangers, Effectiveness, NTU method, Effectiveness of a parallel flow and counter flow heat exchangers (No Derivation), Numerical problems.

Self-study: Fouling factor, effect of fouling factor **(only for CIE not for SEE)**

7 Hours

UNIT V

Radiation:

Definitions of various terms used in radiation heat transfer, concept of a black body, Kirchhoff's law, Lambert's Cosine Law, Stefan-Boltzmann's law, Planck's distribution law, Wein's displacement law, thermal radiation, Radiation heat exchange between two parallel infinite black surfaces, between two parallel infinite gray surfaces, determination of view factors or configuration factor, radiation shielding, radiation heat exchange in an enclosure. Numerical problems.

Mass Transfer: Definitions of terms used in mass transfer analysis; Fick's first law of diffusion.

7 Hours

TEXT BOOKS		
1	Holman, J. P.	Heat Transfer, McGraw Hill,10th Edition,2020
2	Frank P. Incropera , David P. DeWitt	Introduction to Heat Transfer, John Wiley & Sons,3rd edition,2001.

REFERENCE BOOKS		
1	M. N. Ozisik	A Heat Transfer- A Basic Approach, McGraw Hill,1985.
2	Yunus A Çengel	Heat and Mass Transfer: Fundamentals and Applications, McGraw Hill,6th Edition,2007.

ONLNINE RESOURCES		
1	Conduction and convective heat transfer by PROF. SUMAN CHAKRABORTY PROF. SANKAR KUMAR SOM Department of Mechanical Engineering IIT Kharagpur	https://archive.nptel.ac.in/courses/112/105/112105271/
2	e learning source on Heat and mass Transfer developed by IISC Bangalore	https://archive.nptel.ac.in/courses/112/108/112108149/#

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Differentiate basic modes of heat transfer and apply their governing equations to Solve heat transfer problems.
CO2	Identify, Formulate and Analyze 1-D Steady and Unsteady State Heat Transfer for different geometry using heat transfer charts and steady state equations.
CO3	Analyze Convection heat transfer for different flow configurations to determine rate of heat transfer by convection, boiling and condensation.
CO4	Differentiate and classify heat exchangers to solve problems on effectiveness of different heat exchangers.
CO5	Apply the basic principles of radiation to solve problems and basic principles of mass transfer phenomena.

Course Articulation Matrix

		POs												**PSOs**		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
COs	**CO1**	3							1		1			3		
	CO2	2	3						1		1			3		
	CO3	2	3						1		1			3		
	CO4	2	3						1		1			3		
	CO5	2	3						1		1			3		

List of Experiments (Heat and Mass Transfer)	
1	Determination of thermal conductivity of a metal rod.
2	Determination of thermal conductivity of a given liquid.
3	Determination of thermal conductivity of insulating material.
4	Heat transfer through natural convection.
5	Heat transfer through forced convection.
6	Heat transfer through pin fin (Natural and Forced)
7	Estimation of Stefen Boltzmann constant.
8	Emissivity of a surface.
9	Heat transfer through a composite wall.
10	Parallel flow and counter flow heat exchangers.
11	Dropwise and film wise condensation (New experiment included)
	26 Hours

Linear Dynamic Systems and Control Engineering

Contact Hours/ Week:	3+0+2 (L+T+P)	Credits:	4.0
Total Lecture Hours:	39+0+26	CIE Marks:	50
Course Code:	S7MEI02	SEE Marks:	50

Course objectives:

This syllabus outlines a comprehensive study of mechanical vibrations and control systems, aiming to equip students with a solid foundation in both theoretical and practical aspects. From this course the students will be able to:

1.	learn causes and classification of vibrations.
2.	comprehend undamped single degree of freedom systems
3.	understand the concepts of automatic controls, distinguish between open and closed loop systems and develop mathematical models of mechanical systems.
4.	understand transient response specifications with examples of underdamped, critically damped, and overdamped systems.
5.	develop skills of creating and analysing Root locus and Bode plots

UNIT I

Introduction to mechanical vibrations causes of vibration, classification of vibrations, and different types of vibrations. Single Degree of Freedom (SDOF) systems: fundamentals and applications. Principle of superposition applied to Simple Harmonic Motions (SHM). Vector representation of displacement, velocity, and acceleration in SHM. Introduction to the phenomenon of beats.

Undamped single degree of freedom systems: Analysis of undamped free vibrations; determination of the natural frequency of free vibration systems using Newton's method and the Energy method (simple illustrative problems).

9 Hours

UNIT II

Introduction to damping: different types of damping, the concept of critical damping, and classification based on the damping ratio. Definition and significance of logarithmic decrement. Analysis of the effects of damping and principles of vibration isolation.

Forced vibrations: Fundamentals and analysis of forced vibrations under constant harmonic excitation (simple problems). Introduction to transmissibility ratio, magnification factor, and critical speeds of shafts.

8 Hours

UNIT III

Introduction to automatic control systems: Basic concepts, open-loop and closed-loop systems. Transfer function and mathematical modeling of linear mechanical systems. Overview of different types of controllers: Proportional (P), Integral (I), Proportional-Integral (PI), and Proportional-Integral-Derivative (PID) controllers (basic concepts only). Block diagram representation of control systems. Introduction to signal flow graphs and application of Mason's Gain Formula.

8 Hours

UNIT IV
Overview of system response: first-order and second-order system responses to step, ramp, and impulse inputs. Definition and interpretation of transient response specifications. Examples of underdamped, critically damped, and overdamped system behaviors (without detailed derivations). Introduction to system stability and analysis using Routh-Hurwitz stability criterion.
7 Hours
UNIT V
Introduction to frequency domain methods: construction and interpretation of Bode plots. Concept and determination of stability margins — gain margin and phase margin. Root Locus: Definition, general rules for constructing root loci, and stability analysis using root locus plots. Effect of poles and zeros on system dynamics. Basic techniques for system compensation.
7 Hours

TEXT BOOKS		
1	G.K. Grover	Mechanical Vibrations, 8th Edition, Nemchand and Bros. Roorkee, 2013, ISBN: 9788185240565, 9788185240565,
2	Benjamin C Kuo	Automatic Control Systems, Wiley Publishers, 9th edition, 2014, ISBN: 9788126552337, 978-8126552337

REFERENCE BOOKS		
1	S S Rao	Mechanical Vibrations, Pearson Education, 6th edition, 2018, ISBN: 935306256X, 978-9353062569
2	Norman S. Nise	Control Systems Engineering, Wiley India Ed, Edition, 2018, ISBN: 8126571837, 978-8126571833

ONLNINE RESOURCES		
1	Prof. Anil Kumar IIT Roorkee	Introduction to Mechanical Vibration https://onlinecourses.nptel.ac.in/noc21_me80/preview
2	Prof. Anil Kumar IIT Roorkee	Automatic Control https://nptel.ac.in/courses/112107240

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	**model** vibratory systems, **identify** different types of vibrations, principles of displacement, velocity, and acceleration in vibratory motion
CO2	**analyze** undamped single degree of freedom systems and calculate the natural frequency of such systems using both Newton's method and the energy method.
CO3	**model** mechanical systems using transfer functions and **identify** different types of controllers and **analyze** signal flow graphs using Mason's gain formula.
CO4	**analyze** transient and steady-state response analysis, system stability using Routh's-Hurwitz Criterion
CO5	**analyze** stability analysis using frequency response and root locus methods

Course Articulation Matrix

		POs												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
COs	CO1	3	3	2												
	CO2	3	3	2												
	CO3	3	3	2												
	CO4	3	2													
	CO5	3	3	3												

Linear Dynamic Systems and Control Lab	
Part A	
1	Free longitudinal vibrations of a spring – mass system
2	Torsional vibration of single rotor shaft systems
3	Free vibrations of two rotor system
4	Longitudinal vibrations of a spring-mass-damper system
5	Damped torsional oscillations
6	Whirling of shafts
Part B	
7	Linear Spring Mass Damper system using Simulink open and Closed loop
8	Simulation on P Controller using Simulink and Kit
9	Simulation on P+I Controller using Simulink and Kit
10	Simulation on P+D Controller using Simulink and Kit
11	Bode plot simulation using
12	System design using Root locus
	26 Hours

Operations Research

Contact Hours/ Week:	3 +2+0 (L+T+P)	Credits:	4
Total Lecture Hours:	39(L)+26(T)	CIE Marks:	50
Course Code:	S7ME01	SEE Marks:	50

UNIT I
Introduction: Definition of OR, Historical development, Applications of Operations Research, Features of OR, Main phases of Operations Research study, Limitations of OR. Linear programming: Introduction, Formulation of LP Problems, Graphical solution of two variable problems, Solution space, Types of solution – Basic feasible solution, Optimal solution, Infeasible solution, Unbounded solution, Multiple optimum solution, Assumptions in Linear programming problem, Limitations of Linear programming, Applications of Linear programming. Simplex method: Slack and Surplus variables, Artificial variable, Standard form of Linear programming, the simplex table, Big M-method (Charnes Penalty Method), Unbounded solution, Multiple optimum solution, Pseudo optimum solution.
8(L) + 6(T) Hours
UNIT II
Duality , Dual Simplex Method: Concept of duality, General rules for converting primal to its dual, Duality theory, Advantages of duality, Dual simplex method, Advantages of dual simplex method.
7(L) + 6(T) Hours
UNIT III
Transportation model: Introduction, Mathematical Formulation of Transportation problem, Matrix form of Transportation problem, The transportation algorithm, Initial basic feasible solution using North-West corner method, Matrix Minima method and Vogals Approximation method(VAM), Optimal solution using Modified distribution method(MODI), Unbalanced transportation problems, Degeneracy in transportation problem, Alternate optimum solution.
8(L) + 6(T) Hours
UNIT IV
Assignment problem: Introduction, Mathematical Formulation of Assignment problem, Solution to assignment problems using Hungarian method, Unbalanced assignment problem, Restriction in assignment problems, Traveling salesman problem. **Game Theory:** Introduction, Basic definitions, Strategy, pure strategy, mixed strategy, Maxmin and Minmax criterian,, Saddle point, Optimal strategies and Value of the game, Solution of (mxn) games with and without Saddle point(s), Two-by-Two(2x2) games without Saddle point, Principle of Dominance to reduce the size of the game, Arithmetic method, Modified dominance rule, Graphical method for (2xn) and (mx2) games.
8(L) + 4(T) Hours
UNIT V
PERT-CPM Techniques:- Introduction,, Applications of PERT/CPM techniques, Basic steps in PERT/CPM techniques, Network diagram representation, Rules for drawing network diagram, Common errors in drawing network diagram, Fulkerson's i-j Rule, Time estimates and Critical path in network analysis, Probability of completion time of project, Determination of Float and Slack times, Crashing of networks, normal time, crash time, normal cost, crash cost, cost slope, Optimum and Minimum project duration, Optimum and Minimum project cost.
8(L) + 4(T) Hours

TEXT BOOKS		
1	**Taha H A**	"Operations Research: An Introduction", 8/E, Pearson Education India, 2008, ISBN- 8131711048, 9788131711040.
2	**S D Sharma**	"Operations Research: Theory, Methods and Applications", 15/E, Kedarnath Ramnath and Co. 2013.

REFERENCE BOOKS		
1	**Philips, Ravindran and Soleberg**	"Operations Research- Principles and practice", 2/E, John Wiley & Sons, 2007, ISBN- 9788126512560.
2	**Hiller and Lieberman**	Introduction to Operations Research, 7/E, McGraw Hill, 2001, ISBN : 9780072416183.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	**Identify, formulate, solve** and **interpret** the results of linear programming problems by graphical/simplex method.
CO2	**Identify, formulate and solve** the linear programming problems by duality and dual simplex concepts.
CO3	**Identify, formulate and solve** the transportation problems for optimum cost / time / distance by Modified distribution method.
CO4	**Identify, Formulate** and **solve** assignment problems for optimum cost by Hungarian method, Travelling Salesman problem for shortest route and game theory problems for identifying best strategies of the game.
CO5	**Apply** network techniques like PERT/CPM for managing projects for optimum time/cost, least time schedule and corresponding cost

Course Articulation Matrix

		POs												**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
COs	**CO1**		2													
	CO2		2													
	CO3		2													
	CO4		2													
	CO5		3													

Smart Manufacturing

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3.0
Total Lecture Hours:	40	CIE Marks:	50
Course Code:	S7MEE01	SEE Marks:	50

Course objectives: This course will:	
1.	introduce the concepts and principles of Smart Manufacturing.
2.	familiarize students with enabling technologies like IoT, AI, and robotics in manufacturing.
3.	develop an understanding of digital integration, automation, and smart factories.
4.	help to understand the Smart Factory paradigm
5.	understand transformation of industrial processes through the integration of modern technologies such as sensors, communication, and computational processing

UNIT I
Introduction to Smart Manufacturing: Need for Industry 4.0, Comparison of 4th Industrial 4.0 with previous revolutions, Why Industry 4.0?, Characteristics and Benefits of Industry 4.0, Building blocks of Industry 4.0 (I4.0), Framework for I4.0, Industry 4.0 Design Principles, Architecture of Industry 4.0, RAMI Model for Industry 4.0.
8 Hours
UNIT II
Technologies enabling Smart Manufacturing: Introduction, Sensors, Miniaturization of sensors, Cyber-Physical Systems, Wireless Technology, Connectivity Protocols, IP Mobility, Proximity Network Communication Protocols, Cloud Computing & Cloud technologies, Big Data, Digital Twins.
8 Hours
UNIT III
Data Analytics in Smart Manufacturing: Introduction, Cases on Predictive analytics, Methodology, Techniques used for predictive analytics, Forecast Accuracy Calculation. **Robotics in the era of Smart Manufacturing:** Introduction, Advanced Sensor Technologies, Internet of Robotic things, Cloud Robotics, Cobots.
8 Hours
UNIT IV
Machine Vision for Smart Manufacturing: Introduction, Need for vision systems, Functions of machine vision system, Imaging devices – Vidicon Camera, CCD, Lightning Techniques, Analog to Digital Signal Conversion, Image Storage, Simple numerical, Image processing and analysis – Techniques, Training the vison system, Applications.
8 Hours
UNIT V
Virtualization in Smart Manufacturing: Types of AR and VR, Hardware and software technologies, Industrial applications of AR. **Cyber Security:** Ethics in cyberspace, Security threats and vulnerability of IOT, Industrial challenges, Evolution of Cyber Attacks, Cyber security measures.
8 Hours

TEXT BOOKS		
1	Gilchrist, Alasdair	Industry 4.0: The Industrial Internet of Things, 1st Edition, 2016, APRESS Publisher, Springer

REFERENCE BOOKS		
1	Alp Ustundag, Emre Cevikcan	Industry 4.0: Managing the Digital Transformation, 1st Edition, 2018, Springer
2	Mikell P Groover, Mitchel Weiss	Industrial Robotics, Second Edition, 2017, Tata McGraw Hill

ONLNINE RESOURCES (OTHER RESOURCES)		
1	Prof.Sudip Misra, IIT Kharagpur - Swayam	Introduction to Industry 4.0 and Industrial Internet of Things

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Explain the principles and scope of Smart Manufacturing
CO2	Identify and apply enabling technologies (IoT, AI, AM, robotics).
CO3	Apply data analytics and AI techniques for smart decision-making in manufacturing.
CO4	Demonstrate the application of machine vision systems for quality inspection, measurement, and automation
CO5	Analyze AR systems required to make factory as smart factory and evaluate the importance of cyber security in industrial networks.

Course Articulation Matrix

		POs												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
COs	CO1	3								1				2		
	CO2	3												2		
	CO3	3	1			1								2		
	CO4	3												2		
	CO5	3							2	1				2		

Tool Engineering

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3.0
Total Lecture Hours:	39	CIE Marks:	50
Course Code:	S7MEE02	SEE Marks:	50

Course objectives: This course will enable students to:	
1.	Learn basics of sheet metal operations
2.	Understand the working of press tool for various sheet metal cutting operations
3.	Understand the techniques for manufacturing metallic components.
4.	Understand the techniques for manufacturing plastic components.
5.	Identify the parting surface, feed system and ejection systems for the components.
6.	Understand the principle of jigs and fixtures and their applications.

UNIT I
Introduction: Bending dies – Introduction, bend allowance, spring back, edge bending die design. Drawing dies – Single action, double action and triple action dies, factors affecting drawing, drawing die design. Design problems on bend allowance calculation for simple components.
8 Hours
UNIT II
Press Tool: Working on power press and classification of presses. Components of a simple die, press tool operation, die accessories, shearing action in punch and die, clearance, shear on punch and die, center of pressure and problems, scrap strip layout. Simple, progressive, compound, combination and inverted dies. Design problems on blanking and piercing dies for simple components
8 Hours
UNIT III
Die casting : Terminology: Core, cavity, sprue, slug, fixed and movable cores, finger cams, draft, ejector pins ejector plates, gate, goosenozzle, over-flow, platten, plunger, runner, vent, water-line etc. Types of Dies: Single cavity, multicavity dies, combination dies, unit dies, advantages and disadvantages of types of dies. Die casting dies: Die casting alloys, defects in die casting, finishing trimming and inspection of die casting components, safety.
8 Hours
UNIT IV
Injection Moulding: Injection moulding machine and its elements, general configuration of a mould. 2 plate and 3 plate mould. Introduction, to gate, runner, parting surface, ejection system. Core and cooling system. Introduction to compression, transfer, blow moulding, extrusion, forming and calendaring.
8 Hours
UNIT V
Jigs and Fixtures: Definition of Jigs and Fixtures, Difference between jigs and fixtures, Advantages, Steps for design. Location, Degree of freedom, 3-2-1 principles, choice of location, redundant location.
7 Hours

TEXT BOOKS		
1	Pye R. G.W.	Injection mould design, New York, John Wiley & Sons 12nd Edition, 1989.
2	R.G.W.Pye	Injection Mould Design, Affiliated East-West Press Pvt., Ltd., New Delhi, 4th Ed., 2000, ISBN: 9788176710107.
3	Joshi P. H.	Jigs and Fixtures, Tata McGraw-Hill Pub. Co. Ltd., 11th Ed., 2010, ISBN: 0070680736,
4	Kempster M. H.A.	An introduction to Jigand Tool Design, Butterworth-Heinemann, Ltd., 3rd Ed., 1974, ISBN-13: 9780340182215.

REFERENCE BOOKS		
1	D.Eugene Ostergaard	Basic die design, McGraw-Hill, 1963.
2	Dallas B. Daniel,	Progressive dies, springer publication, 2005
3	Dominic V. Rosato P.E.	Plastic processing data handbook
4	Charles A Harper	Modern plastics handbook
5	Charles A.	Harper, Handbook of plastic processes, A john Wiley and sons, 2006, ISBN-13:978-0-471-66255-6

ONLNINE RESOURCES	
1	https://nptel.ac.in/courses/112/105/112105127/
2	https://nptel.ac.in/courses/112/107/112107144/
3	http://www.nitc.ac.in/dept/me/jagadeesha/mev303/
4	CHAPT_INTRODUCTION_TO_JIGS_AND%20FIXTURES.pdf

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Identify and calculate development length of given component and Design problems on bend allowance calculation for simple components.
CO2	Apply the engineering knowledge of different types of press tools and operation for manufacturing process and analyze cutting force and press tonnage.
CO3	Apply the knowledge of engineering to assess the different casting die elements and their functions.
CO4	Apply the knowledge of engineering to the plastic processing, injection molding, extrusion and blow molding.
CO5	Apply the knowledge of engineering to categorize and justify the requirements of Jigs and Fixtures for Manufacturing, Testing and Assembly

Course Articulation Matrix

		POs												PSOs		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
COs	**CO1**			1										2		
	CO2		1											2		
	CO3	2												2		
	CO4	2												2		
	CO5	2												2		

Production and Operations Management

Contact Hours/ Week:	3+0+0 (L+P+T)	Credits:	3.0
Total Lecture Hours:	42	CIE Marks:	50
Course Code:	S7MEE03	SEE Marks:	50

Course objectives:

Operations management has a major role to play in financial success and profitability of an enterprise engaged in producing tangible goods or offering services to its customers. Operation mangers strive to increase utilization of existing facilities and achieve higher productivity to sustain competition and to grow in their success. The main objective of this course is to impart knowledge of Industrial Operations, Productivity concepts in Industrial Environment. It is useful in Forecasting, analysis, development, research, process planning, production planning and controlling activities of an industry. From this course student will learn about the;

1.	Productivity Concepts, Facilities Location, Facilities Layout and its importance with reference to an industry.
2.	Forecasting methods and ways.
3.	Required materials and capacity of machinery with the methods of planning the same.
4.	Proper Scheduling of the process of manufacturing in the industry.
5.	Inventory planning and requirement.

UNIT I

OPEARATIONS AND PRODUCTIVITY CONCEPTS

Introduction. Historical development of POM, Definition, Operations Management system concepts, Types of production systems, Productivity, Factors affecting productivity.

FACILITIES LOCATION

Types of location, Factors to be considered, Facility location models, Mathematical model, Simple median model, Transportation -linear programming.

FACILITIES LAYOUT

Determinants of facility layout, Objectives, Types of layout, Layout models, Simple graphic approach, Load distance analysis.

10 Hours

UNIT II

DEMAND FORECASTING

Cost of forecasting, Factors affecting forecasting, Uses of forecasting, Forecasting decision methodology, Classification of forecasting methods, Opinion and Judgmental methods, Time series methods, Forecasting procedure, Selection of forecasting model, Methods of estimating, trend, Moving average, least squares, seasonal indexes, Forecast controls, Regression or correlation analysis.

8 Hours

UNIT III

MATERIAL AND CAPACITY REQUIREMENT PLAN

MRP, MRP Terminology, material and capacity planning flow chart, MRP components, Master production schedule, Inventory status file, Capacity requirement planning, capacity planning decisions, Decision tree analysis, structure of decision tree, Inputs and Outputs of a CRP system, Just-in-Time production system (JIT), Problems on decision tree.

8 Hours

UNIT IV
SCHEDULING Factors affecting scheduling, Principles of scheduling, Scheduling strategies, Forward and Backward scheduling, Scheduling guidelines, Scheduling methodology, Charts and Boards, Priority decision rules, Johnson's Rule, Johnson's rule of 'N' jobs on three machines, 'N' jobs on 'M' machines.
8 Hours
UNIT V
INVENTORY CONTROL Importance of inventory, Objectives of inventory control, Factors affecting inventory control, Inventory costs, Costs trade-off and economic order quantity (EOQ), Economic lot size, Parameters of inventory control (Re-ordering systems), Deterministic inventory models, ABC analysis.
8 Hours

TEXT BOOKS		
1	Monks, J.G.	Operations Management, McGraw-Hill International Editions, 2000.
2	Sridhar Bhat	Operations Management, New Age Publications 2009

REFERENCE BOOKS		
1	Panneerselvam R.	Production and Operations Management, 2nd Edn.PHI.2002
2	Chary, S.N.	Production and Operations Management, Tata- McGraw Hill. 2002
3	Adam and Ebert	Production and Operations Management, PHI, 2002

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Discuss evolution and trends of operations management and factors affecting productivity and operations decision making (level 1, 2).
CO2	Determine capacity requirement for given processing and examine, analyze, evaluate, and apply Forecasting techniques (Level 2, 3).
CO3	Evaluate and execute Aggregate plan and Material Requirements Plan (Level 3, 4).
CO4	Interpret the concepts of scheduling and sequencing (Level 2, 3).
CO5	Discuss the principles of Inventory planning, requirement and analyze the inventory requirement (level 1, 2, 3).

Course Articulation Matrix

		POs												**PSOs**		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
COs	**CO1**	3	1	-	-	-	2	-	-	-	-	-	2	3	-	-
	CO2	3	2	-	-	-	3	-	-	-	-	-	2	3	-	-
	CO3	3	2	-	-	-	2	-	-	-	-	-	2	3	-	-
	CO4	3	2	-	-	-	2	-	-	-	-	-	2	3	-	-
	CO5	3	2	-	-	-	3	-	-	-	-	-	2	3	-	-

Power Plant Engineering

Contact Hours/ Week:	3+0+0 (L+P+T)	Credits:	3.0
Total Lecture Hours:	39	CIE Marks:	50
Course Code:	S7MEE04	SEE Marks:	50

Course objectives:	
This course will enable students to:	
1.	The student will learn about different methods of power generation using Thermal, hydroelectric and nuclear power plants.
2.	The student is imparted with the skill of calculating cost of power generation and learn about different types of tariff for electrical energy.

UNIT I
Steam Power Plant: Different types of fuels used for steam generation, Equipment for burning coal in lump form, strokers, different types, Oil burners, 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, Coal and ash handling, Generation of steam using forced circulation, high and supercritical pressures, A brief account. of L Mont., Benson, Velox, Schmidt., Loeffer and Ramson steam generators.
8 Hours

UNIT II
Chimneys: Natural, forced, induced and balanced draft, Calculations involving height of chimney to produce a given draft. Accessories for the Steam Generator such as super-heaters desuperheater control of super heaters, Economizers, Air Pre- heaters and re-heaters. Cooling Towers and Ponds: Different types of towers.
7 Hours

UNIT III
Diesel Engine Plant -Engines for Power Generation: Method of starting diesel engines, Cooling and lubrication system for the diesel engine. Filters, centrifuges, Oil heaters, Intake and exhaust system, Layout of a diesel power plant. Gas Turbine Power Plant: Advantages and disadvantages of the gas turbine plant, Open and closed cycle turbine plants with the accessories.Numerical problems on reheater, regenerator and intercoolers.
8 Hours
UNIT IV
Hydro-Electric Plants: Storage and pondage, flow duration and mass curves, hydrographs, Low, medium and high head plants, pumped storage plants, Penstock, water hammer, surge tanks,' gates and valves, power house, general layout. A brief description of some of the important Hydel installations in India. Choice of site for power station, load estimation, load duration curve, load factor, capacity factor, use factor, diversity factor, demand factor Effect of variable load on power plant, selection of the number and size of units
8 Hours

UNIT V
Nuclear Power Plant: Principles of release of nuclear energy fusion and fission reactions. Nuclear fuels used in the reactors. Multiplication and thermal utilization factors. 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, Fast Breeder reactor, Homogeneous graphite reactor and gas cooled reactor.Radiation hazards, Shieldings, Radio active waste disposal.
8 Hours

TEXT BOOKS		
1	P.K Nag	Power Plant Engineering, P.K Nag. Tata Mc Graw Hill 2nd ed. 2001
2	Domakundawar, Dhanpath Rai	Power Plant Engineering, Power Plant Engineering 2003

REFERENCE BOOKS		
1	Morse F.T	Power Plant Engineering, Morse F.T., Van Nstrand.1998
2	M.M. EI-Wakil	Power Plant Technology, M.M. EI-Wakil, McGraw Hill, International, 1994

ONLNINE RESOURCES	
1	https://nptel.ac.in/courses/108/105/108105058/
2	https://nptel.ac.in/courses/112/107/112107291/

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	**Explain** the different systems of steam power plant like boilers, coal and ash handling and different furnaces.
CO2	**Evaluate** the height of chimney and different air circulation systems and boiler accessories.
CO3	**Explain** the working of diesel and gas turbine power plant for power generation.
CO4	**Access** the given site suitability for establishing the hydroelectric power plant and compare its types.
CO5	**Explain** the working of different types of nuclear power plants with their merits and demerits.

Course Articulation Matrix

		POs												**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
COs	**CO1**	3														
	CO2	2	2													
	CO3	3	1													
	CO4	2														
	CO5	2	1													

Design for Manufacture and Assembly

Contact Hours/ Week:	3+0+0 (L+P+T)	Credits:	3.0
Total Lecture Hours:	40	CIE Marks:	50
Course Code:	S7MEE05	SEE Marks:	50

Course objectives: This course will enable students to:	
1.	Understand the historical background, importance, and practical benefits of integrating DFMA in product design.
2.	Equip the knowledge of various manufacturing processes including casting, forging, extrusion, stamping, injection moulding, and powder metallurgy, with emphasis on process-specific design guidelines and cost estimation techniques.
3.	Develop the ability to analyze and optimize products for efficient manufacturing and assembly, incorporating considerations for materials, tooling, production volume, and economic impact.
4.	Foster skills in applying systematic DFMA and DFA methodologies to enhance product quality, reduce manufacturing complexity, and improve cost-effectiveness.
5.	Encourage awareness of the broader impacts of automation and assembly design decisions, including labor, ergonomics, and sustainability.

UNIT I
Introduction to DFMA: History of DFMA, Principles of DFMA, steps for applying DFMA during product design, Advantages of applying DFMA during product design, Reasons for not implementing DFMA, Introduction to Manufacturing Process: Classification of manufacturing process, Basic manufacturing processes, Introduction to materials and material selection: Classification of engineering materials, Material selection for product design, mechanical properties of materials-tensile, compression and shear.
8 Hours
UNIT II
Basic characteristics and Mold preparation, Sand casting alloys, Design rules for sand castings, Example calculations, Investment casting overview, Cost estimation, Number of parts per cluster, Ready to pour liquid metal cost, Design guidelines for Investment casting, Die casting cycle, Determination of optimum number of cavities, appropriate machine size, Die cost estimation, Design principles.
8 Hours
UNIT III
Design for Forging: Forging processes, Forging nomenclature, Suitable materials for forging, Design recommendations, Metal Extrusion: Process, Suitable material for extrusion, Design recommendation for metal extrusion, Metal stamping: Process, Characteristics and application of metal stamping, Suitable materials for stamping, Design Recommendations for metal stamping
8 Hours
UNIT IV
Injection moulding: Introduction to injection moulding, Typical characteristics of injection moulded parts, moulding cycle time, Mold cost estimation, estimation of optimum number of cavities, Assembly techniques, Design Guidelines. Effect of shrinkage, Suitable materials, Design recommendations, Design for powder metal processing: Introduction to powder metal processing, Typical characteristics and applications, Limitations, Design recommendations.
8 Hours

UNIT V
Historical Development, The assembly process, Characteristics and applications, Choice of Assembly method, Social effects of automation, Design guidelines for Manual assembly, Analysis of an assembly, Development of a systematic DFA analysis method, DFA index, classification system for manual handling, Economic significance of assembly, General taxonomies of assembly operation and systems, Assembling a product, Design for Assembly: Introduction, Design consideration, Design for Fasteners: Introduction, Design recommendation for fasteners.
8 Hours

TEXT BOOKS:		
1	Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight	Product Design for Manufacture and Assembly, Third Edition, CRC Press, 2010, **ISBN**: 9781420089271
2	A.K. Chitale and R.C. Gupta	Product Design and Manufacturing, Seventh Edition, PHI Learning Pvt. Ltd., 2023, **ISBN**: 978-9391818722
3	Roberta Gagnon and Andrea Bearman	Design for Manufacture and Assembly, PALNI Press, 2024, **ISBN**: 978-1-956390-25-4

REFERENCE BOOKS:		
1	Gerardus Blokdyk	Design for Manufacture and Assembly: A Complete Guide – 2020 Edition, 5STARCooks, 2020, **ISBN**: 9780655942831.
2	S. Tilley, O. Molloy, E.A. Warman	Design for Manufacturing and Assembly: Concepts, Architectures and Implementation, Springer, 2012, **ISBN**: 9781461376507
3	Henry W. Stoll	Design for Manufacture: Principles and Practices, Marcel Dekker, 2023, **ISBN**: 9780824791766

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Analyze the principles of Design for Manufacture and Assembly (DFMA), identify and apply the structured steps involved in integrating DFMA during the product design process, critically assess the common reasons for its non-implementation in industrial practice.
CO2	Apply design principles to improve manufacturability and cost efficiency in casting processes.
CO3	Describe various forging & stamping processes, including terminology, suitable materials, and design recommendations for effective forging & stamping.
CO4	Apply design guidelines and assembly techniques specific to injection moulding, Implement design recommendations for powder metal processing to optimize product performance and manufacturability.
CO5	Analyze various assembly methods, apply design guidelines for manual assembly, and develop systematic Design for Assembly (DFA) analysis using DFA indices. Implement design recommendations for fasteners to optimize assembly efficiency and product performance.

Course Articulation Matrix

		POs												**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
COs	**CO1**	**3**	**2**	**2**										**2**	1	
	CO2	**3**	**2**	**2**										**2**	1	
	CO3	**3**	**2**	**2**										**2**	1	
	CO4	**3**	**2**	**2**										**2**	1	
	CO5	**3**	**2**	**2**										**2**	1	

Composite Materials

Contact Hours/ Week:	3+0+0 (L+P+T)	Credits:	03
Total Lecture Hours:	39 Hours	CIE Marks:	50
Course Code:	S6MEE06	SEE Marks:	50

Course objectives:

In Composite materials, materials are combined in such a way as to enable us to make better use of their virtues while minimizing to some extent the effects of their deficiencies. This course is intended to impart thorough knowledge of processing aspects of composite materials, properties and their applications.

1.	Understanding composite materials and how they are classified?
2.	Different manufacturing/processing methods used for producing PMC's and MMC's
3.	Introducing various physical, mechanical and elevated temperature properties of MMC's
4.	Knowledge about testing methods used for physical and mechanical evaluation of composites

UNIT I

Introduction to composite Materials:
Definition and Classification of composites based on matrix and reinforcement, Characteristics of composite Materials, Fibrous composites, Laminated Composites and Particulate composites, Factors which determine the properties of composites, Benefits of composites. Properties and types of reinforcements and matrices, Reinforcement-matrix interface.

8 Hours

UNIT II

Polymer Matrix Composites : Introduction, Polymer matrices, Processing methods like Lay up and curing, open and closed mould process- hand lay up techniques, laminate bag molding, production procedures for bag molding, filament winding, pultrusion, pul-forming, thermo-forming, molding methods. Applications of PMC's. Some Commercial PMC's.

8 Hours

UNIT III

Metal Matrix Composites: Introduction, Metallic matrices, Classification of MMC's, Need for production of MMC's, Interface Reactions Processing methods like powder metallurgy, diffusion bonding. Melt Stirring, Compo/Rheo Casting, Squeeze casting, Liquid melt Infiltration, spray deposition and Insitu Processes.
Metal Matrix Composites : Properties of metal matrix composites, Applications, Some Commercial MMC's.

8 Hours

UNIT IV

Ceramic Matrix Composites : Types of Ceramic matrices, Advantages of CMM'S over other composites, Processing of CMC's, Properties and applications.
Carbon-Carbon Composites: Advantages of Carbon-Carbon Composites over other composites, Processing, Properties and applications.

7 Hours

UNIT V

Fabrication of Composites: Cutting and Machining of Composites: Water jet cutting, Laser Beam Cutting, Reciprocating Knife Cutting, Cutting of Cured Composite, Abrasive water jet cutting. Joining of Composites: Mechanical Fastening, Adhesive Bonding and Welding processes

Mechanics of Composite Materials: Continuous Fibres: Iso-stress Condition, Is strain Condition, Critical Volume Fraction of Fibre and minimum Volume fraction of fibre, Numericals, and Mechanics of Discontinuous fibers, Stress Vs Strain Curves for PMC's, MMC's and CMC's
9 Hours

TEXT BOOKS		
1	K. K. Chawla	Composite Science and Engineering- Springer Verlag, 1998
2	Hull and Clyne	Introduction to composite materials, Cambridge University Press, 2nd edition, 1990
3	F. L. Mathew and R. D. Rawlings -	Composite Materials: Engineering and Science –, Woodhead Publishing Limited

REFERENCE BOOKS		
1	Meing Schwaitz	"Composite Materials Hand book", McGraw Hill Book Company. 1984
2	Narosa Publishing House	Composite Materials – Production Properties, Testing and Applications – Narosa Publishing House
3	Robert M. Jones	"Mechanics of composite Materials", McGraw Hill Kogakusha Ltd. 1998.
4	ASM handbook	Forming Metal Hand Book 9th edition, ASM handbook, and v15. 1988, P327-38.
5	Artar Kaw	Mechanics of composites, CRC Press. 2002.
6	S.C. Sharma	Composite materials, Narora Publishing house, 200.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Describe the properties and synthesis of fibre reinforcements, matrix materials and identify matrix-reinforcement combination for given engineering application – PO1 (1)
CO2	Review research literature to Identify and select a suitable manufacturing technique for FRP's with an understanding about the limitations of the technique – PO2 (2)
CO3	Review research literature to Select an appropriate MMC's synthesizing process for engineering applications such as Filters, Piston, Bearings, connecting rod etc., confirming to given specifications and also compare the advantages of MMC's with monolithic materials - PO2 (2)
CO4	Explore the superiority of Ceramic Matrix composites and Carbon -Carbon Composites over other class of composites and identify a suitable processing technique for producing them
CO5	Identify and Describe the joining and machining methods employed in FRP's and MMC's to achieve joining/machining in composites - PO1 (1)
CO6	Apply the fundamental principles micro mechanics such as rule of mixture to arrive at properties such as density, strength, modulus of an engineering composite – PO2 (2)

Course Articulation Matrix

		POs												**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
COs	**CO1**	**1**												**1**		
	CO2		**2**											**2**	**1**	
	CO3		**2**											**2**		
	CO4	**3**	**1**											**1**		
	CO5	**1**												**2**		
		3	**2**											**2**		

Design of Transmission Systems

Contact Hours/ Week:	3+0+0 (L+P+T)	Credits:	3
Total Lecture Hours:	39	CIE Marks:	50
Course Code:	S7MEE07	SEE Marks:	50

Course objectives: This course will enable students to:	
1.	To understand the various elements involved in a transmission system.
2.	To analyses the various forces acting on the elements of a transmission system.
3.	To design the system based on the input and the output parameters.
4.	Apply various systems, materials and methods and design transmission systems

UNIT I
Flexible transmission elements Introduction to transmission systems –factors -materials selection –stresses – belt & chain drives, Design of flat and V- belts, Design of chain drives.
7 Hours

UNIT II
Design of bearings Lubrication, Design of journal bearings – using Sommerfeld number – using McKee's equations, Design and Selection of rolling contact bearings – problems.
7 Hours

UNIT III
SPUR GEARS: Definitions; Stresses in gear tooth; Lewis equation and form factor. Design for strength, dynamic load and wear load, Specifications and materials – problems.
7 Hours

UNIT IV
Helical Gears: Formative number of teeth, Design based on strength, dynamic load and wear loads, Normal and Transverse pitch – problems **BEVEL GEARS:** Definitions, Formative number of teeth, Design based on strength, dynamic load and wear loads, Cone pitch angle, Back cone radius, problems-right angled bevel gears.
8 Hours

UNIT V
WORM GEARS: Definitions; based on strength, dynamic, wear loads and efficiency of worm gear drives, Thermal equilibrium of worm gears, Self- locking of worm gear drives. **Design of gear boxes** Introduction – Types – Components – gear box housing – progression ratio – kinematic arrangement – ray diagram – design of multi speed gear boxes.
8 Hours

TEXT BOOKS		
1	V. B. Bhandari	Design of Machine Elements, Tata McGraw Hill Publishing Co. Ltd., New -Delhi.2020, **978-9390177479**
2	Joseph Edward Shigley	Mechanical Engineering Design, Tata McGraw Hill, New Delhi 2006. **978-0073121932**

REFERENCE BOOKS		
1	Robert L.	Machine Design Norton -Pearson Education Asia, New Delhi, 2001. 4the edition, 2010, 978-0-13-612370-5
2	Hall, Holowinko, Laughlin,	Theory and Problems of Machine Design, Schaums Outline Series, 2002. **978-0070255951**
	N. C. Pandey and C. S. Shah,	Elements of Machine Design , 2002 -Chorotar Publishing House. 2015, **9385039105**

Data Handbook		
1	Dr. K. Lingaiah	Design Data Hand Book Vol. l, Suma Publications, Bangalore.
2	K. Mahadevan & Balaveera Reddy	Design Data Hand Book, CBS Publication.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Design of pulleys, chain drives and belt drives.
CO2	Design journal bearings and select rolling contact bearings
CO3	Analyze forces acting on spur gear
CO4	Design of various types of gears helical and bevel
CO5	Design of gear boxes and worm gear

Course Articulation Matrix

		POs												**PSOs**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
COs	**CO1**		2	2									1		2	
	CO2			3											2	
	CO3			3											2	
	CO4			3											3	
	CO5			3											3	

Introduction to Computational Fluid Dynamics

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3.0
Total Lecture Hours:	39	CIE Marks:	50
Course Code:	S7MEE08	SEE Marks:	50

Course objectives:

Fundamentals of Computational Fluid Dynamics (CFD) combines principles of fluid mechanics and heat transfer with computational techniques to solve complex problems that are difficult to address with analytical methods or physical experiments alone. It enhances the learning experience for students and researchers in these fields. CFD knowledge can be employed across multiple disciplines and Students have more possibilities for future careers in this field.

By studying this course the student will be able to

1.	Utilize mathematical concepts such as calculus, linear algebra, and differential equations to comprehend numerical approaches for fluid flow and heat transfer problems.
2.	Provides the foundational knowledge needed to identify the appropriate governing equations.
3.	To solve differential equations by approximating them with difference equations derived from Taylor series expansions.
4.	Discretize the domain into small control volumes, and the governing equations are integrated over these volumes to obtain a set of algebraic equations.
5.	Realize domain discretizing, facilitating accurate numerical simulations and types of Turbulence modeling used in CFD.

UNIT I

NUMERICAL SOLUTION METHODS:Roots of algebraic and transcendental equations, Newton-Raphson method, Newton second order method, basics of Matrix, Solution of simultaneous linear algebraic equations, gauss elimination method, Gauss Jordan method, Gauss seidel iterative method, Tridiagonal matrix algorithm (TDMA),successive over relaxation (SOR), Numerical differentiation forward, backward, Numerical Integration trapezoidal rule Simpsons 1/3 rd rule, 3/8 rule, Weddle rule, Gauss quadrature. Ordinary differential equations, second order, fourth order Runge-kutta methods, Numericals

9 Hours

UNIT II

GOVERNING EQUATIONS

Review of equations for governing fluid flow and heat transfer, continuity, momentum, energy,conservation and non-conservation form, differential form, vector form.

Governing partial differential equations in fluid flow and heat transfer, Classification of PDE, elliptic,Parabolic, Hyperbolic equations, Initial and boundary conditions, initial and boundary value problems,Numericals.

8 Hours

UNIT III
FINITE-DIFFERENCE METHOD Introduction, discretization, central, forward, backward, steady one-dimensional heat conduction,steady heat flow in Fin, steady two dimensional heat conduction, 1-D Transient heat conduction, twodimensional transient heat conduction, convection, Explicit, implicit, crank Nicolson methods, solutionfor incompressible flow using SIMPLE algorithms, Numericals.
8 Hours
UNIT IV
FINITE VOLUME METHOD Finite Volume method, Introduction, 1-D steady state diffusion , Steady 1-D convection and diffusion,first order upwind, central difference, second order upwind, QUICK, Hybrid scheme, Numericals.
7 Hours
UNIT V
GRID & TURBULENCE Grid types, Grid generation techniques, 2D Laplace grid Transformation, Turbulence, turbulent flowcharacteristics, Effect of turbulence on Navier-Stokes equations, Turbulence Models, RANS, LargeEddy Simulation, Direct numerical simulation.
7 Hours

TEXT BOOKS		
1	Autar. Kaw & Egwu Eric Kalu	Numerical Methods with Applications: Abridged, 2nd Edition, Autarkaw publication, 2010, ISBN: 9780578057651.
2	PS Ghoshdastidar	Computational fluid dynamics and heat transfer, Cengagepublication,2017, ISBN-10:8131533077.

REFERENCE BOOKS		
1	Versteeg H.K., Malalasekera W.	An introduction to Computational Fluid Dynamics: The Finite Volume Method, Longman Scientific & Technical, 1995. 3rd Edition, ISBN 0-582-21884-5.
2	K Muralidhar, T SundarRajan,	Computational fluid flow and heat transfer 2nd Edition, Narosa Publishing House,Reprint 2014, ISBN-9788173195528.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Apply the Knowledge of Mathematics, Science and Engineering fundamentals to Understand and analyze the Numerical solution methods.
CO2	Review, Identify and formulate the governing equations.
CO3	Identify, Formulate and solve the fluid flow heat transfer problems using finite difference method.
CO4	Identify, Formulate and solve the fluid flow heat transfer problems using Finite volume method.
CO5	Enlist the various grid generation techniques and turbulence modeling.

Course Articulation Matrix

		POs												PSOs		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
COs	**CO1**	3	2											3		
	CO2	3	2											3		
	CO3	3	2											3		
	CO4	3	3											3		
	CO5	3												3		

VIII Semester

160 Credits 2025-26

List of MOOCs for VIII semester
[OE & PE]
for 2025-26

Professional Elective (PE)
(All courses are of 12-week duration)

Sl.No.	Course	Offered By	Course Mentor / Faculty	Stream
1.	Advanced Dynamics	IIT Kharagpur	Prof. Anirvan DasGupta	Design
2.	Applied Elasticity	IIT Bhubaneswar	Prof. Soham Roychowdhury	
3.	Design of Mechatronic Systems	IIT Bombay	Prof. Prasanna Gandhi	
4.	Engineering Fracture Mechanics	IIT Madras, Amrita Vishwa Vidyapeetham	Prof. K. Ramesh, Dr. Hariprasad M P	
5.	Design of Precision Machines	IIT Delhi	Prof. Jitendra P. Khatait	
6.	Experimental Modal Analysis	IIT Delhi	Prof. Subodh V. Modak	
7.	Artificial Intelligence and Machine Learning in Materials Engineering	IIT Kanpur	Prof. Krishanu Biswas	Materials & Manufacturing
8.	Rapid Manufacturing	IIT Kanpur	Prof. J. Ramkumar, Prof. Amandeep Singh	
9.	Mathematical Modelling of Manufacturing Processes	IIT Guwahati	Prof. Swarup Bag	
10.	Fundamentals of Additive Manufacturing Technologies	IIT Guwahati	Prof. Sajan Kapil	
11.	Automation in Manufacturing	IIT Guwahati	Prof. Shrikrishna N. Joshi	
12.	Industrial Engineering and Operations Research	IIT Guwahati	Prof. Uday Shanker Dixit	
13.	Corrosion/Environmental Degradation/Surface Engineering	IIT Delhi	Prof. (HAG) Harish Hirani	
14.	Material Processing (Metallurgical Aspects): Fundamentals and Practical	IIT Roorkee	Prof. D K Dwivedi	
15.	Joining Technologies for Metals	IIT Roorkee	Prof. D K Dwivedi	
16.	Knowledge Management	IIT Kharagpur	Prof K B L Srivastava	

17.	Strategic Management	,IISc	Prof R Srinivasan	Management
18.	Management Information System	IIT Kharagpur	Prof Kunal Nanti Ghosh & Prof Saini Das	
19.	E-Business	IIT Kharagpur	Prof Jenamani	
20.	Management Accounting	IIT Roorkee	Prof Anil K Sharma	
21.	Production Operations Management : Theory & Applications	IIT Kharagpur	Prof Sanjib Chowdury	
22.	Project Management	IIT Kharagpur	Prof Sanjib Chowdury	
23.	Marketing Management	IIT Kanpur	Prof Jayanth Chatterjee & Prof Shashi Shekar Mishra	
24.	Customer Relationship Management	IIT Kharagpur	Prof Swagato Chaterjee	
25.	Artificial Intelligence in Industrial & Management Engineering	IIT Kanpur	Prof Deepu Philip & Prof Prabal Pratap Singh	
26.	Explosions and Safety	IIT Madras	Prof. Prasad Patnaik BSV, Prof. K. Ramamurthi	Thermal Engineering
27.	Advanced Fluid Mechanics	IIT Madras	Prof. Anubhab Roy	
28.	Convective Heat Transfer	IISc Bangalore	Prof. Saptarshi Basu	
29.	Fundamentals of Convective Heat Transfer	IIT Guwahati	Prof. Amaresh Dalal	
30.	Fundamentals of Conduction and Radiation	IIT Guwahati	Prof. Amaresh Dalal, Prof. Dipankar N.Basu	
31.	Aircraft Propulsion	IIT Guwahati	Prof. Vinayak N. Kulkarni	
32.	Sustainable Power Generation Systems	IIT Guwahati	Prof. Pankaj Kalita	
33.	Energy Conservation and Waste Heat Recovery	IIT Kharagpur	Prof. Prasanta Kumar Das, Prof. A Bhattacharya	Thermal Engineering
34.	Heat Exchangers: Fundamentals and Design Analysis	IIT Kharagpur	Prof. Prasanta Kumar Das, Prof. Indranil Ghosh	
35.	Rocket Propulsion	IIT Madras	Prof. K. Ramamurthi, Prof. P. A. Ramakrishna	

Open Elective (OE)
(All courses are of 12-week duration)

Sr. No.	Course	Offered By	Course Mentor / Faculty
1.	Artificial Intelligence and Machine Learning in Materials Engineering	IIT Kanpur	Prof. Krishanu Biswas
2	Industrial Engineering and Operations Research	IIT Guwahati	Prof. Uday Shanker Dixit
3	E-Business	IIT Kharagpur	Prof Jenamani
4	Management Accounting	IIT Roorkee	Prof Anil K Sharma
5	Production Operations Management : Theory & Applications	IIT Kharagpur	Prof Sanjib Chowdury
6	Explosions and Safety	IIT Madras	Prof. Prasad Patnaik BSV, Prof. K. Ramamurthi