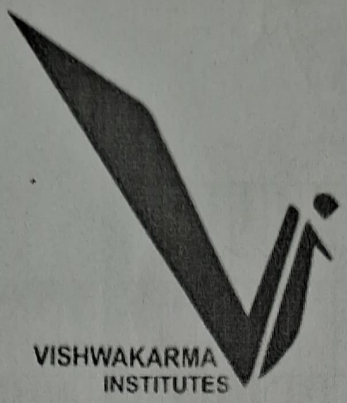

Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Technology

(An Autonomous Institute affiliated to Savitribai Phule Pune University formerly University of Pune)

Structure & Syllabus of

B.Tech. (Mechanical Engineering)

SY, TY and Final year B.Tech. Mechanical Engineering
Applicable for A.Y. 2026 - 27

Prepared by:

Board of Studies in Mechanical Engineering

Approved by:

Academic Board, Vishwakarma Institute of Technology, Pune

Signed by

Chairman – BOS **Chairman – Academic Board**

Vishwakarma Institute of Technology

Title : Course Structure

Issue 1 : Rev No. 00: Dt. 03/07/26

Department of Mechanical Engineering

FF No. 653_A

Branch : MECH **Year:** SY 2026-27 **Pattern:** 2025

SY MECH Module - III (Semester III & IV)

Course Code	NEP Course Category	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks													Credits			
			Theory	Tutorial	Practical	CVV	CP	LAB/ TUT	GD/ PPT	HA	MSE (W)	MSE (R)	MSE (O)	ESE (R)	ESE (W)	ESE (O)	PRACT+ CVV	ESE-Direct Evaluation	Theory	Tutorial	Practical	Total
Semester III & IV																						
ME2301	PCC	ENGINEERING MATERIALS	2		2	20	30	10			40								2		1	3
ME2302	PCC	MANUFACTURING PROCESSES	2		2	20	30	10							40				2		1	3
ME2303	PCC	STRENGTH OF MATERIALS*	3		2	20	30	10							40				3		1	4
ME2308	PCC	MACHINE DRAWING AND CAD	2		2		20								40		40		2		1	3
MDM	MDM	MULTI DISCIPLINARY MINOR #	2	1		20	20			20	40								2	1		3
HS2001	AEC	REASONING AND APTITUDE DEVELOPMENT –3*	1															100	1			1
HS2002	HSSM	FROM CAMPUS TO CORPORATE –1*	2									50		50)					2			2
ME2310	VSEC	DESIGN THINKING 1*		1														100		1		1
ME2311	FP	ENGINEERING DESIGN AND INNOVATION –I*			4							30		70							2	2
Total			**14**	**2**	**12**														**14**	**2**	**6**	**22**

Abbreviations Used	
PPT	Powerpoint Presentation
GD	Group Discussion
CVV	Comprehensive Viva Voce
LAB	Laboratory
TUT	Tutorial
CP	Course Project
PR	Practical
HA	Home Assignment
MSE	Mid Semester Examination
ESE	End Semester Examination
R /W/O	Review /Written/Online

MDM List
MM1532:DATA ANALYTICS AND MACHINE LEARNING
MM1533:INDUSTRY 4.0
MM1534:SUSTAINABLE ENERGY SYSTEMS
MM1535:AUTOMOBILE ENGINEERING

BOS Chairman

Dean Academics

B. R. A. C. TRUST ★ Vishwakarma Institute of Technology ★ विश्वकर्मा इन्स्टिट्यूट पुणे - ३७.

Vishwakarma Institute of Technology

Title : Course Structure

Department of Mechanical Engineering

Issue 1 : Rev No. 00: Dt. 03/07/26

FF No. 653_A

Branch : MECH **Year:** SY 2026-27 **Pattern:** 2025

SY MECH Module - IV (Semester III & IV)

Course Code	NEP Course Category	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks													Credits			
			Theory	Tutorial	Practical	CVV	CP	LAB/ TUT	GD/ PPT	HA	MSE (W)	MSE (R)	MSE (O)	ESE (R)	ESE (W)	ESE (O)	PRACT+ CVV	ESE-Direct Evaluation	Theory	Tutorial	Practical	Total
Semester III & IV																						
ME2304	PCC	THERMODYNAMICS	2		2	20	30	10			40								2		1	3
ME2305	PCC	MACHINE DESIGN**	3		2	20	30	10							40				3		1	4
ME2306	PCC	FLUID ENGINEERING	2		2		20								40		40		2		1	4
ME2309	PCC	KINEMATICS OF MACHINES AND MECHANISMS	2		2	20	30	10							40				2		1	3
MDM	MDM	MULTI DISCIPLINARY MINOR #	2	1		20	20			20	40								2	1		3
HS2004	AEC	REASONING AND APTITUDE DEVELOPMENT –4**	1															100	1			1
HS2003	HSSM	FROM CAMPUS TO CORPORATE –2**	2									50		50					2			2
ME2312	VSEC	DESIGN THINKING –2**		1														100		1		1
ME2313	FP	ENGINEERING DESIGN AND INNOVATION –II**			4							30		70							2	2
Total			**14**	**2**	**12**														**14**	**2**	**6**	**22**

Abbreviations Used	
PPT	Powerpoint Presentation
GD	Group Discussion
CVV	Comprehensive Viva Voce
LAB	Laboratory
TUT	Tutorial
CP	Course Project
PR	Practical
HA	Home Assignment
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MDM List
MM1532:DATA ANALYTICS AND MACHINE LEARNING
MM1533:INDUSTRY 4.0
MM1534:SUSTAINABLE ENERGY SYSTEMS
MM1535:AUTOMOBILE ENGINEERING

BOS Chairman

B. R. A. C. TRUST ★ विश्वकर्मा इन्स्टिट्यूट पुणे - ३७. ★ Vishwakarma Institute of Technology

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Vishwakarma Institute of Technology

Issue 1 : Rev No. 00: Dt. 03/07/26

FF No. 653_A

Department of Mechanical Engineering

Title : Course Structure

Branch : MECH **Year:** TY 2026-27 **Pattern:** 2025

TY MECH Module -V (Semester V & VI)

Course Code	NEP Course Category	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks													Credits			
			Theory	Tutorial	Practical	CVV	CP	LAB/ TUT	GD/ PPT	HA	MSE (W)	MSE (R)	MSE (O)	ESE (R)	ESE (W)	ESE (O)	PRACT+ CVV	ESE-Direct Evaluation	Theory	Tutorial	Practical	Total
(Semester V& VI)																						
ME3266	PCC	APPLIED THERMAL ENGINEERING	3		2	20									40		40		3		1	4
ME3262	PCC	DYNAMICS OF MACHINES	2		2	20	30	10							40				2		1	3
--	PEC1	PROGRAM ELECTIVE CORE - 1#	3		2	20	40		20	20									3		1	4
--	PEC2-Coursera	PROGRAM ELECTIVE CORE - 2#	3															100	3			3
--	OE 1 Coursera	OPEN ELECTIVE -1#	4															100	4			4
MDM	MDM-3	MULTI DISCIPLINARY MINOR 3 #	2	1			30		20	10					40				2	1		3
ME3207	VSEC -DT	DESIGN THINKING - 3*		1														100		1		1
ME3206	ERI	ENGINEERING RESEARCH AND INNOVATION-1*			4							30		70							2	2
Total			17	2	10														17	2	5	24

Abbreviations Used	
PPT	Powerpoint Presentation
GD	Group Discussion
CVV	Comprehensive Viva Voce
LAB	Laboratory
TUT	Tutorial
CP	Course Project
PR	Practical
HA	Home Assignment
MSE	Mid Semester Examination
ESE	End Semester Examination
R /W/O	Review /Written/Online

PEC-1
ME3209A: COMPUTER AIDED DESIGN AND MANUFACTURING
ME3209B: METROLOGY AND QUALITY CONTROL
ME3209C: REFRIGERATION AND AIR CONDITIONING

PEC-2 Coursera / Online
MD3162:DIGITAL MANUFACTURING & DESIGN TECHNOLOGY
MD3163:APPLIED COMPUTATIONAL FLUID DYNAMICS
MD3164:DESIGN OF INDUSTRIAL PIPING SYSTEMS SPECIALIZATION
MDXXXX:CAD CENTRIC FUTURE OF ENGINEERING & DIGITAL PRODUCT DEVELOPMENT

Open Elective -Coursera
MD3205:SUPPLY CHAIN MANAGEMENT SPECIALIZATION

MDM-3
MM1501A:MECHATRONICS
MM1501B:ADVANCE MANUFACTURING
MM1501C:ICE & ALTERNATIVE FUELS
MM1501D:PRODUCT LIFE CYCLE MANAGEMENT

BOS Chairman

Dean Academics

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Vishwakarma Institute of Technology

Issue 1 : Rev No. 00: Dt. 03/07/26

Title : Course Structure

Department of Mechanical Engineering

FF No. 653_A

Branch : MECH **Year:** TY 2026-27 **Pattern:** 2025

TY MECH Module -VI (Semester V & VI)

Course Code	NEP Course Category	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks													Credits			
			Theory	Tutorial	Practical	CVV	CP	LAB/ TUT	GD/ PPT	HA	MSE (W)	MSE (R)	MSE (O)	ESE (R)	ESE (W)	ESE (O)	PRACT+ CVV	ESE-Direct Evaluation	Theory	Tutorial	Practical	Total
(Semester V & VI)																						
ME3205	PCC	HEAT TRANSFER	3		2	20									40		40		3		1	4
ME3202	PCC	MECHANICAL SYSTEM DESIGN	2		2	20	30	10							40				2		1	3
–	PEC1	PROGRAM ELECTIVE CORE - 4 #**	3		2	20	40		20	20									3		1	4
–	PEC2-Coursera	PROGRAM ELECTIVE CORE -4 #**	3															100	3			3
–	OE 1 Coursera	OPEN ELECTIVE -2**	4															100	4			4
MDM	MDM-4	MULTI DISCIPLINARY MINOR -4 #	2	1			30		20	10					40				2	1		3
ME3208	VSEC -DT	DESIGN THINKING – 4**		1														100		1		1
ME3209	ERI	ENGINEERING RESEARCH AND INNOVATION-2**			4							30		70							2	2
Total			17	2	10														17	2	5	24

Abbreviations Used	
PPT	Powerpoint Presentation
GD	Group Discussion
CVV	Comprehensive Viva Voce
LAB	Laboratory
TUT	Tutorial
CP	Course Project
PR	Practical
HA	Home Assignment
MSE	Mid Semester Examination
ESE	End Semester Examination
R /W/O	Review /Written/Online

PEC-1
ME3211A:HYBRID AND ELECTRIC VEHICLES
ME3211B:HYDRAULIC MACHINES AND FLUID POWER
ME3211C:FINITE ELEMENT ANALYSIS

PEC-2 Coursera / Online
MD3165:ADDITIVE MANUFACTURING
MD3166:VENTILATION & AIR CONDITIONING SYSTEM FOR BUILDINGS
MD3167:INTRODUCTION TO SEMICONDUCTOR AND MEMS FABRICATION
MDXXXX:CAD CENTRIC FUTURE OF ENGINEERING & DIGITAL PRODUCT DEVELOPMENT

Open Elective -Coursera
MD3206:DIGITAL PRODUCT MANAGEMENT SPECIALIZATION

MDM-4
MM1501E:ROBOTICS & AUTOMATION
MM1501F:DATA SCIENCE
MM1501G:INDUSTRIAL ENGINEERING
MM1501D:PRODUCT LIFE CYCLE MANAGEMENT

BOS Chairman

Dean Academics

B.R.A.C. TRUST ★ विश्वकर्मा इन्स्टिट्यूट पुणे - ३७. ★ Vishwakarma Institute of Technology

Course Structure-FF: 653_A

B.Tech. MECH. MODULE-VII AY: 2026-27

Sub. No.	Sub. Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination scheme						Total	Credits
			Th.	Lab	Tut	CA			MSE	ESA			
						HA				ESE	CVV		
S1	-	Open Elective-I	2							100		100	2
S2	-	Open Elective-II	2			10			30	30	30	100	2
S3	-	Open Elective-III	2			10			30	30	30	100	2
S4	ME4255	Major Project		18					30	70		100	9
	ME4256**	Major Project		20					30	70		100	10
S5	ME4381*	Design Thinking-7		2						100		100	1
Total			**6**	**20**									**16**

*Irrespective of module course in Sem-1 **Irrespective of module course in Sem-2

Course Structure-FF: 653_A

B.Tech. MECH. MODULE-VIII AY: 2026 - 27

Sub. No.	Sub. Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination scheme						Total	Credits
			Th	Lab	Tut	CA			MSE	ESA			
										ESE			
S1	-	Internship*		30					30	70		100	15
	-	Internship**		32					30	70		100	16
S2	ME4381*	Design Thinking-7		2								100	1
Total				**32**									**16**

***Internship code sem-1**

ME4276	INDUSTRY INTERNSHIP	ME4275	PROJECT INTERNSHIP
ME4273	RESEARCH INTERNSHIP	ME4277	INTERNATIONAL INTERNSHIP

****Internship code sem-2**

ME4293	INDUSTRY INTERNSHIP	ME4296	PROJECT INTERNSHIP
ME4295	RESEARCH INTERNSHIP	ME4294	INTERNATIONAL INTERNSHIP

Electives

	Subject Head	Course	Credits
Elective -1 A	s01	MD4274: Large Language Models Skill Development	1
	s01	MD4275: Mastering Microsoft Power BI	1
	s01	MD4276: Generative AI Skills for Developers	1
	s01	MD4277: Career in Data Analysis	1
	s01	MD4278: Concepts of Data Visualization and Storytelling	1
	s01	MD4279: AWS Certified Solutions Architect	1
	s01	MD4280: IT Security Specialist	1
	s01	MD4281: Technical Program Management	1
Elective -1 B	s02	MD4282: Natural Language Processing Skill Development	1
	s02	MD4283: Prompt Engineering Skills	1
	s02	MD4284: Essentials in Generative AI	1
	s02	MD4285: Python in Finance	1
	s02	MD4286: Understanding Quantum Computing	1
	s02	MD4287: Foundational Maths for Machine Learning	1
	s03	ME4251: CAD/CAM/CAE	2

Elective -2	s03	ME4254: REFRIGERATION AND AIR CONDITIONING	2
	s03	ME4261: POWER PLANT ENGINEERING	2
Elective -3	s04	ME4311: APPLIED COMPUTATIONAL FLUID DYNAMICS	2
	s04	ME4315: Fundamentals of Electric Vehicle Powertrain Design	2
	s04	ME4316: Fundamentals of Electric Vehicle Battery Pack Design	2

Asst. Head

MECHANICAL ENGINEERING DEPARTMENT ★ विश्वकर्मा इंस्टिट्यूट पुणे-३७.

Dr. S. S. Kore
HOD, Mech

Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Technology

(An Autonomous Institute affiliated to Savitribai Phule Pune University Formerly University of Pune)

Structure & Syllabus of

S.Y. Mechanical Engineering

S.Y. Mechanical Engineering (A 25 Pattern) Applicable for A.Y. 2026 - 27

Prepared by:

Board of Studies in Mechanical Engineering

Approved by:

Academic Board, Vishwakarma Institute of Technology, Pune

Index

Vision:

To be recognized as one of the pre-eminent Mechanical Engineering Programs

Mission:

- To prepare students competent to make their careers in Mechanical Engineering
- To provide value education to students to make them responsible citizen
- To strengthen collaborations with Industries, Academia and Research Organizations to enrich learning environment and to enhance Research Culture
- To be recognized as a leading Mechanical Engineering Department in the field of knowledge, skill and research

Program Educational Objectives

- To work independently as well as in team to formulate, design, execute solutions for engineering problems and also analyze, synthesize technical data for application to product, process, system design & development
- To understand & contribute towards social and environmental issues, following professional ethics and codes of conduct and embrace lifelong learning for continuous improvement
- To develop expertise towards use of modern engineering tools, instruments, programming languages and software's
- To acquire and develop careers in industries, Research organizations, academia and demonstrate entrepreneurial skill

Program Outcomes and Program Specific Outcomes (POs & PSOs)

PO1:-Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2:-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.

PO3:-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.

PO4:-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.

PO5:-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.

PO6:-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.

PO7:-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.

PO8:-Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9:-Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10:-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 receiving clear instructions.

PO11:-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.

PO12:-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 (PSO) Mechanical Engineering

Mechanical Engineering Graduates will be able to:

PSO1:- Demonstrate knowledge and understanding about machine drawing and modelling of mechanical engineering components & systems and selection of appropriate materials and manufacturing processes for their production.

PSO2:- Understand the working of mechanical engineering components & systems and thereby design, analyse and conduct experiments for enhancement of performance.

PSO3:- Ability to apply multidisciplinary approach and usage of modern hardware & software tools for the development of smart mechanical engineering components & systems

Module -III

Title : Course Structure

Vishwakarma Institute of Technology

Issue 1 : Rev No. 00: Dt. 03/07/25

Branch : MECH Year: SY 2026-27

Department of Mechanical Engineering

FF No. 653_A

Pattern: 2025

SY MECH Module - III (Semester III & IV)

Course Code	NEP Course Category	Course Name	Teaching Scheme (Hr./week)			Examination Scheme and Marks												Credits			
			Theory	Tutorial	Practical	CTV	CP	LAB/ TUT	GD/ PPT	HA	MSE (W)	MSE (R)	MSE (O)	ESE (R)	ESE (W)	ESE (O)	PRACT+ CTV	ESE-Direct Evaluation	Theory	Tutorial	Practical	Total
Semester III & IV																					
ME2301	PCC	ENGINEERING MATERIALS	2		2	20	30	10			40								2		1	3
ME2302	PCC	MANUFACTURING PROCESSES	2		2	20	30	10							40				2		1	3
ME2303	PCC	STRENGTH OF MATERIALS*	3		2	20	30	10							40				3		1	4
ME2308	PCC	MACHINE DRAWING AND CAD	2		2		20								40		40		2		1	3
MDM	MDM	MULTI DISCIPLINARY MINOR #	2	1		20	20			20	40								2	1		3
HS2001	AEC	REASONING AND APTITUDE DEVELOPMENT -3*	1															100	1		1	1
HS2002	HSSM	FROM CAMPUS TO CORPORATE -1*	2									50		50					2		2	2
ME2310	VSEC	DESIGN THINKING 1*		1														100		1		1
ME2311	FP	ENGINEERING DESIGN AND INNOVATION -I*			4							30		70							2	2
	Total		14	2	12														14	2	6	22

MDM List

MM1332:DATA ANALYTICS AND MACHINE LEARNING

MM1333:INDUSTRY 4.0

MM1334:SUSTAINABLE ENERGY SYSTEMS

MM1335:AUTOMOBILE ENGINEERING

Abbreviations Used	
PPT	Powerpoint Presentation
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CTV	Comprehensive Viva Voce
LAB	Laboratory
TUT	Tutorial
CP	Course Project
PR	Practical
HA	Home Assignment
MSE	Mid Semester Examination
ESE	End Semester Examination
K.TWO	Kashyap, Thirteen Online

BOS Chairman

Dean Academics

Module -VI

Title : Course Structure

Department of Mechanical Engineering

Issue 1 : Rev No. 00: Dt. 03/07/25

FF No. 653_A

Branch : MECH Year: SY 2026-27 Pattern: 2025

SY MECH Module - IV (Semester III & IV)

Course Code	NEP Course Category	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks												Credits			
			Theory	Tutorial	Practical	CVV	CP	LAB/ TUT	GD/ PPT	HA	MSE (W)	MSE (R)	MSE (O)	ESE (R)	ESE (W)	ESE (O)	PRACT+ CVV	ESE-Direct Evaluation	Theory	Tutorial	Practical	Total
Semester III & IV																					
ME3304	PCC	THERMODYNAMICS	2		2	20	30	10			40								2		1	3
ME3305	PCC	MACHINE DESIGN**	3		2	20	30	10							40				3		1	4
ME3306	PCC	FLUID ENGINEERING	2		2		20										40		2		1	4
ME3309	PCC	KINEMATICS OF MACHINES AND MECHANISMS	2		2	20	30	10							40				2		1	3
MDM	MDM	MULTI DISCIPLINARY MINOR #	2	1		20	20			20	40								2	1		3
HS2004	AEC	REASONING AND APTITUDE DEVELOPMENT-4**	1															100	1			1
HS3003	HSSM	FROM CAMPUS TO CORPORATE-2**	2									50		50					2			2
ME3312	VSEC	DESIGN THINKING -2**		1														100		1		1
ME3313	FP	ENGINEERING DESIGN AND INNOVATION -II**			4							30		70							2	2
		Total	14	2	12														14	2	6	22

MDM List

MM1332:DATA ANALYTICS AND MACHINE LEARNING

MM1333:INDUSTRY 4.0

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MM1335:AUTOMOBILE ENGINEERING

Abbreviations Used	
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ESE	End Semester Examination
R /W/ O	Review /Written/Online

BOS Chairman

Dean Academics

ME2301: Engineering Materials

Teaching Scheme	Examination Scheme
Credits : 3	CP: 30 Marks
Lectures : 2 Hrs/week	LAB/GD/PPT/HA: 10 Marks
Practical : 2 Hrs/week	MSE (W): 40 Marks
Tutorial : - Hrs/week	s
	CVV: 20 Marks

Course Prerequisites: Nil

Course objectives:

- To understand the structure, properties and processing of engineering materials for selecting and developing for different engineering applications.
- To learn the principles of material testing and characterization to measure the performance of materials for various functional applications.

Course Outcome

1. Students will be able to **classify** materials and its structures and properties
2. The student will be able to **understand** solidification behavior and design of alloys.
3. The student will be able to **select** appropriate ferrous materials and heat treatments for different engineering applications.
4. The student will be able to **select** appropriate mechanical testing and characterization technique for materials application
5. The student will be able to apply appropriate non-destructive techniques for characterization of different engineering materials
6. The student will be able to **select** nonferrous materials and cast irons as per the functional requirements of the component

SECTION-I

Unit 1: Materials Structure & Properties **Lecture: 5 hrs**

Introduction to Material Science, Structures and their property relationship in relation to engineering materials. material science tetrahedron, Classification of Engineering Materials**:** Metals, ceramics, glasses, elastomers, polymers, composites, smart materials. Crystal Structures: Study of Crystal structures BCC, FCC, HCP and lattice parameters & properties, Miller indices, Crystal imperfections, and Diffusion Mechanisms. Mechanisms of plastic deformation in metals.

Unit 2: Solid Solutions & Phase Diagrams **Lecture: 6 hrs**

Solid solutions, Hume Rothery's rule, Lever arm rule**, Numerical on Lever rule,** Phase rule**, Phase diagrams**, Types of Phase diagrams, Cu-Ni, Fe-Fe_3C Equilibrium diagrams Critical temperatures, Allotropy, Classification of steels based on carbon percentage

Unit 3: Ferrous Materials: Steels and Heat Treatment **Lecture: 6 hrs**

Steels: Effects of NI Cr Ti W alloying elements on properties of plain carbon steels. Introduction of alloy steels like HSLA, Stainless Steels, Tool steels, specifications of some commonly used steels like BIS, EN, AISI,

Cooling curves, TTT diagram, Heat treatments processes; Annealing, Normalizing, Hardening, Introduction to Surface Hardening techniques

SECTION-II

Unit 4: Mechanical Properties & Testing **Lecture: 4 hrs**

Tensile Testing-Engineering and True Stress - True strain curves, Evaluation of properties. Engineering stress - Strain curves of different materials. Compression Test

Hardness Tests – Brinell, Poldi, Vickers, Rockwell, Microhardness test Impact tests, Fatigue and Creep tests.

Unit 5: Non-destructive tests **Lecture: 3 hrs**

Visual Inspection, Magna flux test, Dye penetrant test, Sonic and Ultrasonic test, Radiography, Eddy current test. Examples of selection of NDT for selected components like crankshafts, gears, razor blades, welded joints, steel and cast-iron castings, rolled products, forged products. micro & macro examination. Introduction of Optical metallurgical microscope process

Unit 6: Non-Ferrous Metals and Cast Irons **Lecture: 4 hrs**

Introduction to non-ferrous alloys Copper alloys like Brasses, Bronzes (Tin, Aluminum, Beryllium,) Copper nickel alloys, Aluminum and Aluminum alloys - Precipitation hardening alloys, **Introduction** to Nickel & Nickel base superalloys advantages and limitation, **Introduction** to Titanium and Titanium alloys advantages and limitation

Cast Irons: Classification of cast irons, Gray cast iron, White cast iron, Malleable cast iron, Ductile Iron(Spheroidal Grey CI), Chilled cast iron manufacturing, applications and properties.

List of Practical's: (Any Six)

1. Hardness test on ferrous and nonferrous materials by Brinell
2. Hardness test on ferrous and nonferrous materials by Vickers and Microhardness tester.
3. Hardness test on ferrous and nonferrous materials by Rockwell
4. Dye Penetrant and Magnaflux Test for Detection of materials discontinuity
5. Compression tests of steel and Aluminum samples.
6. Impact tests of ferrous and nonferrous materials, one each.
7. Heat treatment of steels such as annealing, Normalizing and Hardening
8. Solution Treatment and Aging of heat treatable Al alloys.
9. Metallographic techniques and sample preparation for microstructure analysis
10. Hardness and Microstructure analysis of Heat-treated steel samples.

List of Course Projects Areas

1. Cold working of Metals to study its mechanical properties and microstructures.
2. Hot working of metals to study its mechanical properties and microstructures.
3. Surface treatment of metals to improve wear resistance properties.
4. Design of new alloy and characterization for functional applications.
5. Failure analysis of Engineering component
6. To study the effect of heat treatment of ferrous materials.
7. To study the effect of heat treatment of Nonferrous materials.
8. Application of advanced processing techniques and characterization.

Reference Print Book -

1. Dr. V. D. Kodgire, Material Science and Metallurgy for Engineers, Everest Publishing House, Pune.
2. Raymond A. Higgins, Engineering Metallurgy, Part 1: Applied Physical Metallurgy,
    i. 5th Edition, English Language Book Society.
3. K.G. Budinski, M. K. Budinski, Engineering Materials, Prentice –Hall India Pvt. Ltd.
4. Sidney H. Avner, An Introduction to Physical Metallurgy, Indian Edition

Reference Electronic Book –

1.E.C. Rollason, Metallurgy for Engineers, English Language Book Society

2. Donald Clark and Wilbur Varney, Physical Metallurgy for Engineers, East- West Press Pvt. Ltd. New Delhi.

3. Donald. Askeland and P.P. Phule, The science and engineering of materials, 4th edition, Thomson learning Inc.

4. A.S.M. Metals Handbook Volume 4, Heat Treatments.

For MOOCs and other learning Resources

1. http://nptel.ac.in/courses/113105024/
2. http://nptel.ac.in/courses/113105024/1
3. http://nptel.ac.in/courses/113105024/2
4. http://nptel.ac.in/courses/113105024/3
5. http://nptel.ac.in/courses/113105024/4
6. http://nptel.ac.in/courses/113105024/5
7. http://nptel.ac.in/courses/113105024/6
8. https://www.youtube.com/watch?v=PVnftOMxl6w&list=PLbMVogVj5nJQbjE_u2KZhUmCypfLunjG4
9. https://www.youtube.com/watch?v=FrhvKcjKdPo&index=5&list=PLbMVogVj5nJQbjE_u2KZhUmCypfLunjG4

CO PO Map

PO	1	2	3	4	5	6	7	8	9	10	11	12	PS1	PS2	PS3
CO1	2	3	3									1	2	1	1
CO2	3	2	2									1	2	1	1
CO3	3	3	3									1	2	1	1
CO4	3	2	3									1	2	1	1
CO5	2	3	3									1	2	1	1

CO3	**2**	**2**	**3**									**1**	**2**	**1**	**1**

CO attainment levels

CO1	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
4	**5**	**5**	**4**	**3**	**4**

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	✓								
CO2		✓			✓				
CO3				✓					
CO4		✓							
CO5						✓			
CO6				✓				✓	

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓						
CO2	✓		✓				
CO3	✓		✓				
CO4		✓					
CO5	✓		✓				
CO6	✓		✓				✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓				
CO2			✓		
CO3					
CO4	✓		✓		
CO5	✓		✓		
CO6				✓	✓

CO – SDG Mapping (Sustainable Development Goals) Sample Table

CO	SDG(s) Addressed	Justification / Linkage
CO1	4, 9	Builds the analytical foundation (SDG 4) that drives data-led innovation (SDG 9).
CO2	9	Supervised models power industrial and predictive applications (SDG 9).
CO3	3, 9	Statistical learning supports health diagnostics (SDG 3) and broader innovation (SDG 9).
CO4	8, 9	Classifiers enable fraud detection and economic applications (SDG 8, 9).
CO5	9	Decision-tree and ensemble models support data-driven industry solutions (SDG 9).
CO6	9, 11	Clustering / RL enable smart-city and resource applications (SDG 9, 11).

ME2302: MANUFACTURING PROCESSES

Teaching Scheme	Examination Scheme
Credits : 3	CP: 30 Marks
Lectures: 2 Hrs/week	LAB/GD/PPT/HA: 10 Marks
Practical: 2 Hrs/week	MSE (W): Marks
Tutorial: - Hrs/week	ESE (W):40 Marks
	CVV: 20 Marks

Course Prerequisites: Engineering

Drawing **Course objectives:** Students

will be able to-

- Gain knowledge of different manufacturing processes like casting, forming, machining, and joining, including their principle, equipment, and applications.
- Select the most suitable manufacturing process for a given product with a view to have minimum waste and better efficiency.

Course outcomes:

At the end of the course student should be able to:

1. Explain various casting, moulding, and bulk deformation processes including their principles, equipment, product design considerations, and applications.
2. Compare various joining processes considering their principles, equipment, design considerations, and applications.
3. Calculate punch and die dimensions and press capacity for sheet metal processes.
4. Calculate the process characteristics such as machining time and material removal rate considering the effect of process parameters for various conventional machining processes.
5. Describe the principles, equipment, and industrial applications of various advanced manufacturing processes
6. Explain the most appropriate additive manufacturing process based on the type of the material and process to be carried out

SECTION-I

Unit –I

Casting, Molding and Forming Processes (6 hrs.)

Introduction to casting processes- Sand casting, other expendable-mold casting processes, permanent-mold casting processes. Plastic molding processes– Extrusion, injection molding, compression, and blow molding. Bulk deformation processes– Rolling, forging, extrusion, and wire drawing.

Unit – II

Joining Processes (4 hrs.)

Introduction of joining processes, fusion welding processes: Gas welding, arc welding, resistance welding, high energy beam welding processes. Solid-state welding processes, Solid-liquid state welding: brazing, soldering; adhesive bonding; mechanical fastening.

Unit – III

Sheet Metalworking (4 hrs.) Sheetmetal operations such as cutting operations, bending operations, drawing, etc., dies and presses for sheet-metal processes, force, and power calculations for sheet metal operations.

SECTION-II

Unit – IV

Conventional Machining Processes (6 hrs.)

Introduction of material removal processes; chip removal processes: turning, milling, drilling, shaping, broaching, gear cutting; abrasion processes: polishing, grinding, honing, and lapping.

UNIT - V

Introduction to Advanced Machining Processes (4 hrs.)

Introduction, chemical machining, electro chemical machining, electric discharge machining, electron beam machining, laser beam machining, abrasive jet machining, ultrasonic machining.

UNIT – VI

Introduction to Additive Manufacturing Processes (4 hrs.)

Importance and overview of additive manufacturing processes; classification of additive manufacturing processes: Vat polymerization, Powder bed fusion; Material extrusion; Material jetting; Binder jetting; Direct energy deposition; Sheet laminations.

List of Practical:

To prepare a green sand mold from the prepared pattern.

Gating design and pouring time and solidification time calculations for the selected object.

To Prepare a Plastic product using Injection moulding machine.
To prepare a sheet metal product considering the design of a strip layout, die, and punch design. Also calculate the strip utilization factor, shear force, and power requirement
To prepare a butt joint with mild steel strip using MAG/brazing/MIG/TIG welding techniques.
A composite job that involves machining processes such as turning, milling, and drilling.
To prepare a component using 3D printing.
A case study supported with industrial visit of electrical discharge machining (EDM)/ abrasive jet machining (AJM)/ Electro chemical machining (ECM)/additive manufacturing processes.

Project-based learning guidelines: Students can design and manufacture a simple component using different manufacturing processes like casting, machining, or forming. They can also investigate how varying process parameters (e.g., cutting speed, feed rate, depth of cut in machining) affects product characteristics like surface roughness, dimensional accuracy, or material properties. Students can research and present on emerging trends in advanced manufacturing, such as additive manufacturing (3D printing), non-conventional manufacturing and welding processes. Students are encouraged to integrate AI-enabled tools and techniques in their projects to promote innovation and stay aligned with evolving technological advancements.

List of Projects (Indicative):

Design and fabrication of a simple sand-casting mould
Design and fabrication of drop forging die design for a specific component
Sheet metal component design and simulation using CAD software
Welding Fixture for Circular Pipe Welding
Comparison of mechanical properties of MIG vs TIG welded joints
Microstructural analysis of dissimilar metal welding
Optimization of welding parameters
Weld defect analysis using NDT (Dye Penetrant / Ultrasonic Testing)
Comparative study of tool wear in different turning operations
Optimization of drilling parameters for surface finish and tool life
Study of machining time estimation for different operations
Design of Jig/Fixture for batch production in lathe or milling
Industry-Linked Projects - Productivity improvement in manufacturing line (Time Study)
Ultrasonic machining for hard materials – Case Study
Laser Cutting vs Water Jet Cutting – Performance Comparison
Design and fabrication of low-cost 3D printer (FDM-based)

3D printed prosthetic hand components – Design and functionality

Text Books (As per IEEE format):

- Manufacturing Processes for Engineering Materials, S. Kalpakjian and S.

R. Schmid, 7th ed. Boston, MA, USA: Pearson, 2021.

- Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, M. P. Groover, Hoboken, NJ: John Wiley & Sons, Jan. 7, 2010.
- Manufacturing Technology, P. N. Rao, Vol. 1, 5th ed. New Delhi, India: McGraw Hill Education, 2018.
- Non-Conventional Machining, P. K. Mishra, New Delhi, India: Narosa Publishing House, 2008.

Reference Books (As per IEEE format):

- Advanced Machining Processes, V. K. Jain, New Delhi, India: Allied Publishers, 2009.
- Modern Welding Technology, H. B. Cary and S. Helzer, 6th ed. Upper Saddle River, NJ, USA: Pearson Education, 2004.

- Additive Manufacturing Technologies, I. Gibson, D. Rosen, and B. Stucker, 3rd ed. Cham, Switzerland: Springer, 2021.
- Additive Manufacturing: Design, Methods, and Processes, S. W. Killi, 1st ed. Boca Raton, FL, USA: CRC Press, 2017.

CO PO Map

CO	PO1	2	3	4	5	6	7	8	9	10	11	12	PSO1	2	3
1	2	1	1	1	1	0	1	2	2	2	2	1	3	1	1
2	2	1	1	1	1	0	1	2	2	2	2	1	3	1	1
3	2	1	1	1	1	0	1	2	2	2	2	1	3	1	1
4	2	2	1	2	1	0	1	2	2	2	2	1	3	1	1
5	2	1	1	1	1	0	1	2	2	2	2	1	3	1	1
6	2	1	1	1	1	0	1	2	2	2	2	1	3	1	1

CO attainment levels

CO1	CO2	CO3	CO4	CO5	CO6
2	2	2	4	2	2

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓	✓					
CO2		✓	✓	✓		✓			
CO3		✓	✓						
CO4		✓	✓	✓		✓		✓	✓
CO5			✓	✓		✓			✓
CO6			✓	✓	✓			✓	✓

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓						
CO2	✓		✓				
CO3	✓		✓				
CO4	✓	✓					
CO5		✓	✓	✓	✓	✓	✓
CO6			✓		✓	✓	✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓	✓			
CO2	✓		✓		
CO3	✓		✓		
CO4	✓	✓	✓	✓	✓
CO5	✓	✓			✓
CO6	✓			✓	✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	4, 8, 12	Develops engineering knowledge, analytical skills, manufacturing-process understanding, and professional competencies (SDG 4). Supports productivity, industrial skills, efficient manufacturing, occupationally responsible production, and industrial growth (SDG 9) and reduced waste (SDG 12)
CO2	4, 8, 12	Develops engineering knowledge, analytical skills, manufacturing-process understanding, and professional competencies (SDG 4). Supports productivity, industrial skills, efficient manufacturing, occupationally responsible production, and industrial growth (SDG 9) and reduced waste (SDG 12)

CO	SDG(s) Addressed	Justification / Linkage
CO3	4, 8, 12	Develops engineering knowledge, analytical skills, manufacturing-process understanding, and professional competencies (SDG 4). Supports productivity, industrial skills, efficient manufacturing, occupationally responsible production, and industrial growth (SDG 9) and reduced waste (SDG 12)
CO4	4, 8, 12	Develops engineering knowledge, analytical skills, manufacturing-process understanding, and professional competencies (SDG 4). Supports productivity, industrial skills, efficient manufacturing, occupationally responsible production, and industrial growth (SDG 9) and reduced waste (SDG 12)
CO5	4, 8, 12, 13	Develops engineering knowledge, analytical skills, manufacturing-process understanding, and professional competencies (SDG 4). Supports productivity, industrial skills, efficient manufacturing, occupationally responsible production, and industrial growth (SDG 9) and reduced waste (SDG 12). Relevant through energy-efficient manufacturing, reduced material waste, advanced manufacturing, and sustainable additive manufacturing (SDG 13).
CO6	4, 8, 12, 13	Develops engineering knowledge, analytical skills, manufacturing-process understanding, and professional competencies (SDG 4). Supports productivity, industrial skills, efficient manufacturing, occupationally responsible production, and industrial growth (SDG 9) and reduced waste (SDG 12). Relevant through energy-efficient manufacturing, reduced material waste, advanced manufacturing, and sustainable additive manufacturing (SDG 13).

ME2203: Strength of Materials

Teaching Scheme	**Examination Scheme**
Credits : 4	CP: 30 Marks
Lectures : 3 Hrs/week	Lab: 10 Marks
Practical : - 2 Hrs/week	CVV: 20 Marks
Tutorial : NA	ESE (W): 40 Marks

Prerequisites:	
•	Students should have a basic understanding of Engineering Mechanics
Course Objectives:	The student will be able to
•	Apply knowledge of mechanics of materials to understand component behavior under various loading conditions.
•	Understand the concept of Principal stresses and theories of failure.
Course Outcomes:	
	After completion of the course, student will be able to
1.	Transform the stresses in various planes and compute the principal stresses and maximum shear stress.
2.	apply failure theories in evaluating the strength of machine elements.
3.	Perform the stress analysis of the component under axially loaded condition
4.	Draw shear force and bending moment diagrams and perform the stress analysis of the component subjected to pure / varying bending moment.
5.	Perform the stress analysis of the circular shaft subjected to torsion (centroidal moment).
6.	Compute slope and deflection for the given beam and analyze long and short columns subjected to axial loads for buckling.

Section1:	**Topics/Contents**

Unit 1: Simple Stress and Strain under axial loading:

Concept of stress and strain, types of stresses and strains, Thermal stresses, stress-strain diagram for ductile and brittle material, properties of material: Poisson's ratio, material strengths, proof stress, Factor of safety, stress analysis of axially loaded members.

Unit 2: Transformation of Stresses:

Stresses on oblique plane, Principal planes and planes of maximum shear, Principal stresses and maximum shear stresses, Mohr's circle for two-dimensional state of stress.

Unit 3: Theories of failure:

Theories of Elastic Failure, Modes of failure, Factor of safety.

Section2:	**Topics/Contents**

Unit 4: Analysis of Circular Shafts under torsional moment:

Deformations in solid and hollow shafts, strains and Stresses in the elastic range, Angle of twist in the elastic range, statically indeterminate shaft.

Unit 5: Analysis of Beams for Bending:

Shear forces & bending moments of determinate beams due to concentrated loads, uniformly distributed loads, uniformly varying loads & couples, relation between SF & BM diagrams for cantilevers, simply supported and compound beams. Theory of Simple Bending (Pure bending), Flexure formula (Euler-Bernoulli Beam theory for thin sections), bending stress distribution, shear stress distribution, shear stress distribution diagram for common cross sections, Maximum and average shear stresses.

Unit 6: Deflection of Beams:

Relation between bending moment and slope, slope and deflection of determinate beams, Double integration method (Macaulay method), slopes and deflections for standard cases. buckling of columns under centric axial load, Euler's formula for critical buckling load for column with hinged ends, equivalent length of column for various end conditions, Limitations of Euler's formula, Rankine's formula for critical buckling load, Energy method for estimation of deformation of axially loaded members under gradual, sudden, and impact loads.

Text Books: ***(As per IEEE format)***

1	Mechanics of Materials, Sixth Edition, by F. P. Beer, E. R. Johnston, Jr., J T. Dewolf & D. F. Mazurek. Publisher, McGraw-Hill
2	Mechanics of Materials, Nineth Edition, by James M Gere & Barry J Goodno, Publisher, Global Engineering

3	Mechanics of Materials, by R. C. Hibbeler, Pearson Education Limited, 10th edition
Reference Books: ***(As per IEEE format)***	
1	Mechanics of Materials, vol I & II, by E J Hearn, Butterworth Heinemann, Oxford
2.	Mechanics of Material, by Popov E. P., Pearson publication
3.	Elements of Strength of Materials, D. H. Young, S. P. Timoshenko, East West Press Pvt. Ltd.

List of Practical's:

1. Write a program for evaluation of state of stress along the oblique plane

2. Write a program for evaluation of principle stresses

3. Write a program to determine the dimensions of the component (subjected to complex load condition) based on various theories of failures

4. Draw Shear force and Bending moment diagram for various load conditions

5. Estimation of critical buckling load for various end conditions

6. Determine the lateral deflection of beam under various load conditions

7. Tensile Test

8. Compression Test

9. Torsion Test

10. Direct Shear Test

List of Project areas:

1. Stress analysis of a machine component subjected to axial load condition

2. Stress analysis of a machine component subjected to tortional load condition

3. Stress analysis of a machine component subjected to bending load condition

4. Determination of the axial / lateral / torsional defection of the component

5. Stress analysis of a machine component under combined load condition

6. Determination of the critical buckling load of a column subjected to axial compression load

Analysis should be performed based on the strength of materials approach. Further,

any software / computer program may be used to perform the analysis and compare the results with the classical approach.

CO-PO Mapping

CO	Program Outcomes (PO)												PSO		
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	1	2	2	0	1	0	0	3	3	1
CO2	3	3	3	2	3	1	2	2	0	1	0	0	3	3	1
CO3	3	3	3	2	3	1	2	2	0	1	0	0	3	3	1
CO4	3	3	3	2	3	1	2	2	0	1	0	0	3	3	1
CO5	3	3	3	2	3	1	2	2	0	1	0	0	3	3	1
CO6	3	3	3	2	3	1	2	2	0	1	0	0	3	3	1

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓	✓	✓			✓	
CO2		✓		✓	✓	✓			
CO3		✓		✓	✓	✓		✓	
CO4		✓		✓	✓	✓			
CO5		✓		✓	✓	✓		✓	
CO6		✓		✓	✓	✓		✓	

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓		✓				
CO2	✓		✓				
CO3	✓		✓				
CO4	✓	✓	✓				

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO5	✓	✓	✓				
CO6	✓		✓				✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓				
CO2	✓		✓		
CO3	✓		✓		
CO4	✓		✓		
CO5	✓		✓		
CO6	✓		✓	✓	✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	4, 9	Builds the analytical foundation (SDG 4) that drives data-led innovation (SDG 9).
CO2	9	Supervised models power industrial and predictive applications (SDG 9).
CO3	9	broader innovation (SDG 9).
CO4	8, 9	Classifiers enable fraud detection and economic applications (SDG 8, 9).
CO5	9	Decision-tree and ensemble models support data-driven industry solutions (SDG 9).
CO6	9, 11	Clustering / RL enable smart-city and resource applications (SDG 9, 11).

ME2308: Machine Drawing & CAD

Teaching Scheme	Examination Scheme
Credits : 3	CP: 20 Marks
Lectures: 2 Hrs/week	LAB/GD/PPT/HA: Marks
Practical: 2 Hrs/week	ESE (P): 40 Marks
Tutorial: - Hrs/week	ESE (W): 40 Marks
	CVV: Marks

Prerequisites: Engineering Drawing

Course objectives:

Reading, reproducing and implementing machine drawing concepts in manufacturing

Course Outcome

Students shall:

1. Interpret and extract all dimensions, material specifications, tolerances, fits, GD&T requirements, and surface finish information from the drawing.
2. Analyze orthographic and sectional views to identify critical features such as holes, slots, keyways, threads, fillets, chamfers, radii, ribs, and other manufacturing features.
3. Identify, label, and correlate all components shown in the assembly and exploded views with the corresponding Bill of Materials (BOM).
4. Explain the function, assembly sequence, and working principle of the mechanical system represented in the drawing.
5. Prepare selected detailed part drawings and assembly drawings in CAD software following BIS/ISO/ASME standards.
6. Generate CAD-based manufacturing documentation including dimensions, tolerances, annotations, balloons, exploded views, and BOM

I Introduction to Machine Drawing (4 Hours)

1. **Importance and Scope of Machine Drawing** – Role of machine drawing in design, manufacturing, assembly, inspection, maintenance, and industrial communication.
2. **Drawing Standards and Documentation Practices** – Drawing sheet layout, sheet sizes, scales, title blocks, revision tables, drawing numbering, and standard engineering documentation.
3. **BIS/ISO Conventions for Mechanical Components** – Standard representation of fasteners, shafts, bearings, gears, springs, couplings, welds, and other machine elements.

4. **Orthographic Projections and Sectional Views** – Preparation and interpretation of Multiview drawings, sectional views, hatching, dimensioning, tolerances, fits, and surface finish symbols.

II Fasteners and Joints (4 Hours)

- **Thread Terminology and Types** – Thread nomenclature, metric threads, square threads, ACME threads, and their engineering applications.
- **Threaded Fasteners** – Bolts, nuts, washers, screws, studs, and various locking arrangements used in mechanical assemblies.
- **Keys and Cotters** – Types, construction, applications, and standard practices for keys, keyways, and cotter joints.
- **Pin and Riveted Joints** – Knuckle joints, pin joints, riveted joints, types of rivets, and applications in structural and machine components.
- **Shaft Couplings and Bearings** – Classification, construction, working principles, and engineering applications of shaft couplings and bearings.

III Pipe Drawing and Welded Joints (4 Hours)

Introduction to Pipe Drawings – Pipe sizes, schedules, fittings (elbows, tees, reducers, flanges), and interpretation of piping drawings and P&IDs.
Types of Welded Joints – Study of Butt, Lap, Tee, Corner, and Edge joints with their applications in piping and fabrication industries.
Welding Symbols and Standards – Elements of welding symbols (reference line, arrow, tail) and interpretation as per AWS/IS standards.
Common Weld Symbols – Fillet, Square Groove, V-Groove, Bevel Groove, U-Groove, J-Groove, Plug, Slot, Spot, Seam, All-around, and Field Weld symbols.
CAD Applications in Pipe and Weld Drawings – Preparation of pipe layouts, welded assemblies, weld symbol annotation, and fabrication drawings using AutoCAD/SolidWorks.

IV Limits, Fits, and Tolerances (6 Hours)

- **Fundamentals of Tolerancing** – Concepts of limits, deviations, allowances, unilateral, bilateral, and compound tolerance systems used in manufacturing and quality control.
- **ISO/BIS Tolerance Systems** – Hole basis and shaft basis systems, standard tolerance grades, designation of fits, and selection of tolerances for engineering applications.
- **Types of Fits and Applications** – Clearance, transition, and interference fits; selection criteria and industrial applications in shafts, bearings, couplings, and machine assemblies.
- **Geometric Dimensioning and Tolerancing (GD&T)** – Introduction to form, orientation, location, runout, and profile tolerances; GD&T symbols and engineering interpretation.
- **Surface Texture and Manufacturing Specifications** – Surface finish symbols, roughness values, machining allowances, and drawing notations as per BIS/ISO standards.

- **Tolerance Analysis and Industrial Practices** – Functional dimensioning, tolerance stack-up analysis, inspection methods, and manufacturing considerations for precision engineering components.

V Assembly and Detailed Part Drawings (4 Hours)

- **Principles of Assembly Drawings** – Purpose, conventions, sectional assemblies, exploded views, and assembly documentation used in manufacturing industries.
- **Production Drawings and Standards** – Preparation of detailed manufacturing drawings as per ASME Y14.5, BIS, and ISO standards including dimensioning, tolerancing, and annotations.
- **Part Drawings and Bill of Materials (BOM)** – Generation of detailed component drawings, material specifications, part numbering systems, and preparation of BOM.
- **Machine Element Assemblies** – Detailed and assembly drawings of couplings, clutches, bearings, gear assemblies, valves, screw jacks, plummer blocks, and machine vices.
- **Mechanical System Assemblies** – Assembly drawings of I.C. engine components, lathe tailstock, shaper tool head, and other industrial machine subsystems.
- **CAD-Based Assembly Modeling and Documentation** – Creation of assembly drawings, exploded views, balloons, BOM tables, and manufacturing documentation using CAD software.

VI Industrial Drawing Interpretation and CAD Applications (Blueprint Reading) (4 Hours)

- **Blueprint Reading and Drawing Interpretation** – Reading and interpretation of industrial drawings, manufacturing layouts, assembly drawings, and engineering case studies.
- **CAD Standards for Manufacturing and Fabrication** – Industry-standard drafting practices, drawing templates, layers, annotations, and documentation workflows.
- **Bill of Materials and Product Documentation** – Preparation and interpretation of BOMs, part lists, engineering change records, and revision control systems.
- **Assembly Documentation and Exploded Views** – Understanding exploded assemblies, assembly sequences, service manuals, and installation documentation.
- **Tolerance Stack-Up and Manufacturing Analysis** – Interpretation of dimensional chains, fit analysis, tolerance accumulation, and quality requirements in assemblies.
- **Sheet Metal and Fabrication Drawings** – Development and interpretation of sheet metal layouts, bend allowances, welding details, fabrication drawings, and shop-floor documentation.

List of Practicals

1. Machine Drawing Standards and Blueprint Reading using CAD

Task: Create detailed CAD drawings of machine components such as stepped shafts, flanges, brackets, bushes, spacers, mounting plates, etc., incorporating BIS/ISO standards, title blocks, dimensions, sectional views, line conventions, and surface finish symbols.

2. Fasteners and Mechanical Joints using CAD

Task: Prepare detailed CAD drawings of standard machine elements such as hexagonal bolts, nuts, washers, screws, studs, keys, cotter joints, knuckle joints, riveted joints, couplings, bearing arrangements, etc., with appropriate dimensions and standard conventions.

3. Limits, Fits, Tolerances, and GD&T using CAD

Task: Develop CAD drawings of shaft-hole assemblies, bearing-seat arrangements, coupling assemblies, pulley-shaft assemblies, gear-shaft assemblies, etc., incorporating limits, fits, tolerances, GD&T symbols, and surface finish specifications as per BIS/ISO standards.

4. Pipe Drawings and Welded Joints using CAD

Task: Create CAD drawings of piping layouts comprising pipes, elbows, tees, reducers, flanges, valves, welded pipe spools, support brackets, pressure vessel connections, etc., and apply standard welding symbols and fabrication details.

5. Assembly and Detailed Part Drawings using CAD

Task: Prepare complete 2D CAD detailed part drawings and assembly drawings of mechanical systems such as Plummer Block, Machine Vice, Screw Jack, Flange Coupling, Universal Coupling, Oldham Coupling, Knuckle Joint, Foot Valve, Non-Return Valve, Steam Stop Valve, Tailstock of Lathe, Tool Head of Shaper, Bearing Housing, Gear Assembly, Connecting Rod Assembly, Eccentric Assembly, Drill Jig, etc.

Note: All drawings shall be prepared using CAD software and shall include sectional views, exploded views, balloons, dimensions, tolerances, and Bill of Materials (BOM).

6. Industrial Drawing Interpretation and CAD Documentation

Task: A detailed 2D CAD drawing of a mechanical component or assembly, such as a gearbox assembly, bearing housing, machine vice, pump assembly, valve assembly, plummer block, screw jack, coupling assembly, etc., will be provided/obtained. The drawing may include orthographic views, sectional views, dimensions, tolerances, GD&T symbols, surface finish specifications, welding symbols (if applicable), exploded views, and Bill of Materials (BOM).

List of Projects

1.0 Production Drawing of a Mechanical Assembly

Select a mechanical system comprising more than ten machine parts such as a machine vice, screw jack, gearbox, centrifugal pump, plummer block assembly, valve assembly, etc.

Study functional requirements, assembly and disassembly procedures, identify tools used, measure all components using appropriate measuring instruments, and prepare complete 2D and 3D CAD part and assembly drawings with BOM.

2.0 Development of a GD&T Measurement and Inspection Setup

Design and develop a physical setup for the measurement and verification of geometrical tolerances such as flatness, straightness, circularity, concentricity, perpendicularity, parallelism, and runout.

Prepare inspection reports and CAD documentation of the setup.

3.0 Industry-Based Reverse Engineering Project

Visit a manufacturing industry and study a manufactured component or assembly such as fixtures, couplings, housings, brackets, valves, etc.

Measure dimensions using precision measuring instruments and prepare production drawings, assembly drawings, and 3D CAD models.

4.0 Design and Development of a Tolerance Stack-Up Analysis System

Select a mechanical assembly and perform dimensional chain analysis and tolerance stack-up calculations.

Validate assembly functionality through CAD models and engineering drawings.

5.0 GD&T Inspection Fixture Design

Design and model an inspection fixture for verifying geometric tolerances of a machined component.

Generate detailed CAD drawings, assembly drawings, BOM, and inspection procedures.

6.0 Welded Structure Design and Fabrication Drawing Project

Develop fabrication drawings for a welded structure such as a machine frame, support stand, pipe rack, trolley, or workstation.

Apply welding symbols, dimensional tolerances, and manufacturing documentation standards.

7.0 Pipe Routing and Industrial Piping Documentation Project

Create complete CAD documentation for a piping system including pipe layouts, fittings, flanges, valves, welded joints, isometric drawings, and BOM.

Generate fabrication and installation drawings.

8.0 Machine Element Modeling and Standardization Project

Develop a CAD library of standard machine elements such as bolts, nuts, washers, keys, bearings, couplings, springs, gears, etc., following BIS/ISO standards.

Create detailed drawings and parametric CAD models.

9.0 Digital Inspection and CAD-Based Quality Control Project

Create CAD models of mechanical components and develop inspection plans for critical dimensions, fits, tolerances, GD&T features, and surface finish requirements.

Generate quality control reports and engineering documentation.

Textbooks

1. N.D. Bhatt, V M Panchal, "Engineering Drawing", Charotar Publishing House Pvt.Ltd.
2. N.D. Bhatt, V M Panchal, "Machine Drawing", Charotar Publishing House Pvt.Ltd.
3. K. L. Narayana, P. Kannaiah, K. Venkata Reddy, "Machine Drawing" 3rd edition, New Age International (P) Ltd.
4. Sham Tickoo, "CATIA V 5 for Engineers and Designers", DreamTech Press.
5. N. Sidheswar, P. Kanniah and V.V.S. Sastry, Machine Drawing, Tata McGraw-Hill, 2001
6. SP 46: 1988 Engineering Drawing Practice for Schools & Colleges. Bureau of Indian Standards
7. K. R..Gopalakrishna, Machine Drawing, 9th Ed.., Subhas Stores, Bangalore, 2005.

Reference Books

1. IS Code " Engineering Drawing Practice for schools and colleges: SP 46: 1988
2. "Design Data Book" PSG College of Technology, Coimbatore.
3. "Westermann Tables for metal trade" Wiley Publication
4. Warren Luzzader, "Fundamentals of Engineering Drawing", Prentice Hall of India, New Delhi

Course Outcomes:

The student will be able to –

10. Represent the IS convention of standard machine parts
11. Understand concepts of fitness, tolerances, surface finish, and machine components.
12. Develop the ability to interpret and create technical drawings as per the industry standards.
13. Gain hands-on experience in CAD software for 2D and 3d drawings.
14. Create Part and Assembly Drawing with BOM
15. Use the Generative Design(AI) in machine drawing

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1			✓	✓				✓	
CO2		✓			✓				
CO3						✓			
CO4		✓							
CO5									
CO6				✓		✓		✓	

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓						
CO2	✓		✓				
CO3			✓		✓		
CO4		✓					✓
CO5					✓		
CO6	✓		✓				✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓				
CO2	✓		✓		
CO3	✓		✓		
CO4	✓		✓		
CO5	✓		✓		
CO6	✓		✓	✓	✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	4, 9	Builds the analytical foundation (SDG 4) that drives data-led innovation (SDG 9).
CO2	9	Supervised models power industrial and predictive applications (SDG 9).
CO3	3, 9	Statistical learning supports health diagnostics (SDG 3) and broader innovation (SDG 9).
CO4	8, 9	Classifiers enable fraud detection and economic applications (SDG 8, 9).
CO5	9	Decision-tree and ensemble models support data-driven industry solutions (SDG 9).
CO6	9, 11	Clustering / RL enable smart-city and resource applications (SDG 9, 11).

MM1532: Data Analytics and Machine Learning

Teaching Scheme	**Examination Scheme**
Credits : 3	CP: 20 Marks
Lectures: 2 Hrs/week	LAB/GD/PPT/HA: 20 Marks
Practical: Hrs/week	MSE (W): 40 Marks
Tutorial: -1 Hrs/week	ESE (W): Marks
	CVV: 20 Marks

Prerequisites:	**nil**
•	-
Course Objectives:	
•	This course aims to introduce mechanical engineering students to the fundamentals of data science, data analytics, and machine learning with a strong emphasis on engineering data and applications.
•	The course builds analytical thinking, statistical understanding, and basic predictive modeling skills required for data-driven engineering decision-making.
Course Outcomes:	
	After completion of the course, student will be able to
CO1.	Apply fundamental concepts of data science, data analytics, machine learning, and their relevance to mechanical engineering applications.
CO2.	Apply statistical and data analytics techniques to analyze and interpret mechanical engineering datasets.
CO3.	Develop regression-based analytical and predictive models using suitable mathematical and computational tools.
CO4.	Implement basic machine learning models and evaluate their performance for engineering decision-making.

Unit 1:	**Overview of Data Science, Data Analytics, and ML**
Introduction to data-driven engineering; Evolution from traditional engineering analysis to data science; Definitions and scope of: Data Science, Data Analytics, Machine Learning, Artificial Intelligence. Types of data: Structured, semi-structured, unstructured; Experimental data, sensor data, simulation data. Types of machine learning: Supervised, Unsupervised, Reinforcement (conceptual) Typical data science workflow: Data acquisition, Data cleaning, Feature selection, Modeling, Validation, Deployment; Mechanical engineering use cases	
Unit 2:	**Statistical Foundations for Data Analytics**
Nature of engineering data and variability; Descriptive statistics: Mean, median, mode; Range, variance, standard deviation; Measures of dispersion and interpretation, Probability concepts: Random variables; Sample space; Events; Probability distributions: Normal distribution, Uniform distribution, Exponential distribution (concept + applications), Engineering interpretation of statistical parameters; Introduction to uncertainty.	
Unit 3:	**Data Analytics Techniques and Mathematical Modeling**

Types of Variables, Physical interpretation of variable relationships, Scatter plots and trend identification Correlation Analysis: Correlation and covariance, Mathematical formulation, Interpretation of correlation coefficient, Limitations of correlation in engineering data Feature Understanding and Engineering (Conceptual): Meaning of features in data analytics, Regression Analysis: Concept of regression, Regression as an analytical model, Least squares principle (basic derivation), Simple Linear Regression Multiple Linear Regression (Conceptual + Mathematical Form), Equation representation, Multivariable engineering systems, Collinearity (conceptual) Error Analysis and Goodness of Fit: MAE, MSE, RMSE; R^2 as goodness-of-fit measure
Unit 4: Machine Learning for Prediction
Difference between analytical models and learning models, Regression as a machine learning approach, Prediction Modeling Framework: Problem formulation, Input–output mapping, Training data vs unseen data Linear Regression as a Machine Learning Model: Hypothesis function, Cost function (Mean Squared Error), Concept of optimization Gradient Descent (Conceptual and Mathematical Intuition): Need for optimization, Direction of steepest descent, Learning rate (qualitative) Model Generalization and Validation: Train–test split, Concept of generalization, Overfitting and underfitting Introduction to Classification: Classification vs regression, k-Nearest Neighbors (k-NN): Working principle.
Text Books:

1	Montgomery, D. C., & Runger, G. C. (2010). *Applied statistics and probability for engineers*. John wiley & sons.
2	VanderPlas, J. (2016). *Python data science handbook: Essential tools for working with data*. " O'Reilly Media, Inc.".
3	Géron, A. (2022). *Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow*. " O'Reilly Media, Inc.".
Reference Books: ***(As per IEEE format)***	
1	Raschka, S., & Mirjalili, V. (2019). *Python machine learning: Machine learning and deep learning with Python, scikit-learn, and TensorFlow 2*. Packt publishing ltd.
2	Alpaydin, E. (2020). *Introduction to machine learning*. MIT press.

List of Tutorial's:

1. Data Cleaning and Outlier Identification
2. Data Scaling and Feature Transformation
3. Descriptive Statistics and Visualization
4. Data Handling and Feature Preparation
5. Introduction to Python for Data Analytics
6. Data handling using NumPy and Pandas
7. Data visualization using Matplotlib and Seaborn
8. Statistical analysis using Python

9. Correlation and covariance using Python

10. Linear regression model implementation

11. Error metrics and model evaluation

12. Polynomial regression

CO-PO Mapping

CO	Program Outcomes (PO)												PSO		
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS21	PSO2	PSO3
CO1	3	1										1			
CO2	3	3	1	1											
CO3	3	3	3	1	3										
CO4	3	3	3	3	3							1			
Average	3.0	2.5	2.3	1.7	3.0							1.0			

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓	✓		✓			
CO2		✓	✓			✓			
CO3		✓	✓	✓		✓			
CO4		✓	✓	✓		✓			

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1							
CO2							
CO3	✓						
CO4	✓		✓				

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1					
CO2	✓				
CO3	✓		✓		✓
CO4	✓		✓		✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	4, 9	Develops data science and data-driven engineering competencies supporting quality education and industrial innovation. .
CO2	4, 9	Develops statistical and analytical capability for evidence-based engineering decisions and industrial applications.
CO3	9	Enables predictive mathematical modelling for engineering systems and industrial process improvement.
CO4	9	Develops machine-learning-based prediction and evaluation skills for intelligent engineering applications.

MM1533: Industry 4.0

Teaching Scheme	Examination Scheme
Credits : 3	CP: 20- Marks
Lectures: 2 Hrs/week	CVV: 20 Marks
Practical: -	HA: 20 Marks
Tutorial: 1 Hrs/week	MSE: 40 Marks

Prerequisites:	Manufacturing processes
•	-
Course Objectives:	
•	To develop an understanding of key Industry 4.0 technologies such as IoT, artificial intelligence, robotics, additive manufacturing, and industrial communication systems
•	To familiarize learners with the application of Industry 4.0 across different industrial sectors, including smart logistics, warehousing, mining, and manufacturing, through real-world case studies and IIoT business models
Course Outcomes:	
	After completion of the course, student will be able to
CO1.	Explain the evolution of Industry 4.0 and analyze the role of digital manufacturing technologies in achieving sustainability goals.
CO2.	Apply knowledge of IoT, AI, robotics, additive manufacturing, and communication protocols to understand modern manufacturing systems.
CO3.	Evaluate lean production systems and value stream concepts in the context of smart factories and Industry 4.0-enabled value creation.
CO4.	Analyze Industry 4.0 applications across various sectors and assess IIoT business models, reference architectures, and emerging business opportunities.

Unit 1: Introduction to Industry 4.0 and digital Manufacturing
Overview of Industry 4.0: Historical context and evolution, Core technologies of Industry 4.0: IoT, AI, robotics, and additive manufacturing, digital manufacturing and sustainability goals

Unit 2: Industry 4.0 technologies
IoT (Internet of Things) and its applications in industries, Artificial Intelligence and Machine Learning in manufacturing processes, Robotics and automation technologies, Additive manufacturing (3D printing), communication protocols
Unit 3: Lean Production system
Types of wastes, value streams in lean, lean production in Industry 4.0, value creation in smart business, examples of smart and connected business model. Smart factories
Unit 4: Industry 4.0- different sectors
Smart robotics, intelligent manufacturing, smart warehousing, improved mining, smart logistics, track and trace innovation, case studies. Business models and reference architecture for IIOT business models, business opportunities in IIOT

Text Books:	
1	*Industry 4.0: The Industrial Internet of Things – Alasdair Gilchrist*
2	*Industry 4.0 Concepts, Processes and Systems – Ravi Kant & Hema Gurung*
Reference Books: ***(As per IEEE format)***	
1	Intelligent Manufacturing: Exploring AI, Blockchain & Smart Technologies in Industry 4.0 – Navroop Kaur et al
2	*Industry 4.0, Smart Manufacturing, and Industrial Engineering: Challenges and Opportunities*

List of Tutorial's:

- Study evolution of industrial revolutions with special emphasis on Industry 4.0 and digital manufacturing
- Comparative analysis of core Industry 4.0 technologies such as IoT, artificial intelligence, robotics, and additive manufacturing
- Role of digital manufacturing in achieving sustainability and circular economy goals
- Applications of IoT in manufacturing and service industries with real-world examples
- Case study on use of artificial intelligence and machine learning for predictive maintenance or quality control in manufacturing

- Identification of wastes and value stream mapping for a selected manufacturing or service process
- Integration of lean production systems with Industry 4.0 for smart factory implementation
- Case study analysis of Industry 4.0 applications in smart logistics, warehousing, or intelligent manufacturing sector

CO-PO Mapping

CO	Program Outcomes (PO)												PSO		
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS21	PSO2	PSO3
CO1	3	1										1			
CO2	3	3	1	1											
CO3	3	3	3	1	3										
CO4	3	3	3	3	3							1			
Average	3.0	2.5	2.3	1.7	3.0							1.0			

CO – WK Mapping (Knowledge & Attitude Profiles)

"✓" indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1			✓	✓			✓		
CO2			✓	✓	✓				
CO3				✓		✓	✓		
CO4				✓			✓	✓	

CO – WP Mapping (Complex Engineering Problems)

"✓" indicates the complex engineering problem attribute addressed by the CO.

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓			✓			
CO2	✓	✓	✓				
CO3	✓		✓			✓	
CO4	✓			✓			✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓				
CO2	✓		✓		
CO3	✓		✓		
CO4	✓		✓		

CO – SDG Mapping (Sustainable Development Goals)

Subject: Industry 4.0

CO	SDG(s) Addressed	Justification / Linkage
CO1	4, 9	Introduces core Industry 4.0 concepts and enabling technologies, building the educational foundation (SDG 4) that underpins industrial innovation (SDG 9).
CO2	9, 11	Covers IoT and Cyber-Physical Systems (CPS) that connect machines and processes, driving resilient infrastructure (SDG 9) and enabling smarter, connected industrial ecosystems (SDG 11).
CO3	9, 12	Applies big data analytics and cloud computing to optimize manufacturing processes, promoting innovation (SDG 9) and resource-efficient, responsible production (SDG 12).
CO4	8, 9	Explores robotics, automation, and AI-driven decision-making, enhancing productivity and decent industrial work environments (SDG 8) while advancing technological innovation (SDG 9).

MM1534 Sustainable Energy System

Teaching Scheme	**Examination Scheme**
Credits : 3	HA: 20 Marks
Lectures : 2 Hrs/week	CP : 20 Marks
Tutorial : 1 Hr/week	CVV : 20 Marks
	MSE(W) : 40 Marks

Prerequisites:	
•	**Basic Mechanical System Engineering, Mathematics, Physics**
Course Objectives:	
•	To understand energy fundamentals, sustainability, and environmental impact concepts.
•	To develop understanding of solar thermal and photovoltaic technologies.
•	To understand wind energy principles and basic wind turbine technologies.
•	To familiarize with hydrogen energy and fuel cell systems
Course Outcomes:	
After completion of the course, student will be able to,	
1.	Understand energy concepts and sustainability principles.
2.	Analyze basic level solar radiation and solar thermal system performance.
3.	Apply photovoltaic principles for basic system design.
4.	Understand the fundamentals of wind energy & evaluate basic wind turbine performance
5.	Compare various types of wind turbine technologies and understand project economics.
6.	Understand hydrogen production, storage, and fuel cell applications.

Section1 :	**Topics/Contents**

Unit–1: Introduction to Energy and Sustainability

Basic concepts of energy systems (energy, power, load, capacity factor), renewable and non-renewable energy resources, carbon footprint and carbon credit, global and Indian energy scenario, sustainability and sustainable development, environmental impacts of energy systems, energy conservation and efficiency, and overview of energy policies and incentives in India.

Unit-2: Solar Radiation & Thermal Systems

Solar geometry, Earth-Sun angles, Solar radiation data and estimation, Instruments for measurement, Solar thermal systems: flat plate and concentrating collectors, Performance parameters and applications (water heating, drying, space heating, cooking)

Unit- 3: Solar Photovoltaic (PV) Systems

PV effect and cell types (mono-crystalline, poly-crystalline, thin film), PV module characteristics, I-V curve, Arrays, tracking systems, Balance of System (BOS) components, Stand-alone and grid-connected PV systems, Basic PV system sizing and design

Section2 :	**Topics/Contents**

Unit-4: Wind Energy fundamentals

wind energy scenario in India, Site selection criteria, Wind availability data, basic components of wind mills, aerodynamics and design of wind turbine, performance operating characteristics

Unit-5: Wind Turbine Technology

Types of wind turbines (horizontal & vertical axis), Components of wind energy conversion systems, Power coefficient, Betz limit, Performance evaluation and power curves, Wind farm layout and energy estimation, wind solar hybrid power plants, Grid integration challenges, Economic aspects: cost estimation, payback, incentives, Environmental impact and life cycle aspects

Unit- 6: Hydrogen Energy & Geothermal Technology

Hydrogen as future fuel – need and importance, Hydrogen production methods, Hydrogen storage techniques: compressed, liquid, metal hydrides, Transportation and safety aspects with challenges, Fuel cell fundamentals and working principle, Types of fuel cells, Applications of fuel cells.

Geothermal Power Plant Technologies, Applications of Geothermal Energy

Text Books:

1	S. P. Sukhatme, *Solar Energy: Principles of Thermal Collection and Storage*. New Delhi, India: Tata McGraw-Hill Education.
2	N. Saini and D. P. Kothari, *Wind and Solar Energy Systems*. New Delhi, India: Oxford University Press.
3	G. Boyle, *Renewable Energy: Power for a Sustainable Future*, 3rd ed. Oxford, U.K.: Oxford University Press, 2021

Reference Books: ***(As per IEEE format)***

1	P. Jain, ***Wind Energy Engineering***, 2nd ed. New York, NY, USA: McGraw-Hill Education, 2016.

2	P. Kalita and P. Singh, *Solar Energy Conversion Technologies: Fundamentals, Design and Applications*. New York, NY, USA: Routledge, 2026
3	S. A. Sherif, D. Y. Goswami, E. K. Stefanakos, and A. Steinfeld, *Handbook of Hydrogen Energy*. Boca Raton, FL, USA: CRC Press, 2014.

List of Tutorials/ Course Projects:

1. Carbon Footprint Assessment of a College Campus
2. Rooftop Solar PV System Design for Residential Building
3. Design & Performance evaluation of Solar Thermal Water Heating System
4. Design of Solar Pump for Farm Irrigation.
5. Design and Performance Evaluation of a Miniature Wind Energy System for Domestic Applications
6. Green Hydrogen generation, storage & safety
7. Hydrogen Powered Fuel Cell Based Electric Vehicle System
8. Case Study on existing Geothermal power plant
9. Integration of ML with Thermal Systems (Solar/Wind/Hydrogen/Geothermal)
10. Integration of AI/DS with Thermal Systems (Solar/Wind/Hydrogen/Geothermal)

CO-PO Mapping

CO	Program Outcomes (PO)												PSO		
CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2				2	3					1			
CO2	3	2	2				3					1			
CO3	3	2	2				3					1			
CO4	3	2	2				3					1			
CO5	3	2	2				3					1			
CO6	3	2				2	3					1			
Avg	3	2	1.3			0.6	3					1			

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1			✓	✓				✓	
CO2		✓		✓	✓	✓			
CO3		✓		✓		✓		✓	
CO4		✓		✓		✓			
CO5				✓		✓		✓	

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO6				✓	✓	✓		✓	

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓						
CO2	✓		✓				
CO3	✓		✓				
CO4	✓	✓	✓				
CO5	✓	✓	✓				
CO6	✓		✓				✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓				
CO2	✓		✓		
CO3	✓		✓		
CO4	✓		✓		
CO5	✓		✓		
CO6	✓		✓	✓	✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	4, 9	Builds the analytical foundation (SDG 4) that drives data-led innovation (SDG 9).

CO	SDG(s) Addressed	Justification / Linkage
CO2	9	Supervised models power industrial and predictive applications (SDG 9).
CO3	3, 9	Statistical learning supports health diagnostics (SDG 3) and broader innovation (SDG 9).
CO4	8, 9	Classifiers enable fraud detection and economic applications (SDG 8, 9).
CO5	9	Decision-tree and ensemble models support data-driven industry solutions (SDG 9).
CO6	9, 11	Clustering / RL enable smart-city and resource applications (SDG 9, 11).

MM1535 Automobile Engineering

Teaching Scheme	**Examination Scheme**
Credits : 3	CP:20 Marks
Lectures : 2 Hrs/week	GD/PPT:20 Marks
Practical :	HA:20 Marks
Tutorial :1 Hrs/week	ESE (W):40 Marks

Prerequisites:	
•	Students should have a basic understanding of Basic mechanical Engineering Thermodynamics, Fluid Engineering, Engineering Graphics, and Machine Drawing
Course Objectives:	The student will be able to understand
•	Vehicle layouts and clutches
•	Manual transmission gear boxes and automatic gear box
•	Steering systems and itsbasics
•	Suspension and braking systems
•	Power train systems
•	EV and HEV basic components
Course Outcomes:	
	After completion of the course, student will be able to
1.	Understand and analyze engine types, vehicle classifications and layouts, and explain the construction, working, and applications of various clutch systems and components. .
2.	Demonstrate the construction and working of a gearbox and analyse vehicle resistances and performance and working of various manual Automatic transmission.
3.	Demonstrate construction and working of steering systems and analyze steering geometry.
4.	Demonstrate construction and working of suspension and braking system.

5.	Demonstrate construction and working of power transmitting devices in an automobile system.
6.	Demonstrate various components of Hybrid and Electric vehicles and.

Section1:	**Topics/Contents**

Unit 1: Engine Basics and Clutches (5 Hours)

Engine components, basic engine nomenclature, engine classification, working of four stroke & two stroke engines, Vehicle specifications, classification, layout, applications, Purpose of clutch, classification, single plate clutch, multiple plate clutch, clutch plate, lining material

Unit 2: Gearbox (5 Hours)

Function, various resistances, tractive effort, performance curves, sliding mesh gearbox, constant mesh gearbox and synchromesh gearbox, epicyclic gearbox, torque convertor, automatic transmission, overdrive.

Unit 3: Steering System (5 Hours)

Purpose, requirement, steering mechanisms, wheel alignment and wheel Balancing, centre point steering, cornering force, slip angle, scrub radius, reference frame, toe-in, toe-out, wheel camber, caster and kingpin angle, steering offset, steering Characteristic, steering gearboxes, power steering.

Section2:	**Topics/Contents**

Unit 4: Suspension System and Braking System (5 Hours)

Object, various types of springs, shock absorbers, sprung weight and un-sprung weight, basic suspension movements, conventional suspension system, independent suspension systems, air suspension, hydro elasticity suspension, hydra-gas suspension, interconnected suspension

Braking System- Purpose, classification, mechanical, hydraulic, air brakes, antiskid braking system, ABS system

Unit 5: Power Transmitting Systems (4 Hours)

Propeller shaft, universal joints, final drive, differential and their types, rear axle arrangements, two speed rear axles, single, double and triple reduction rear axles. Driving thrust, torque reaction

Unit 6: HEV and EV Power trains (4 Hours)

Difference between Conventional vehicles and EV power trains, Types of Hybrid Vehicles, Topologies, Types of EV batteries and battery pack, battery pack selection and design. EV Motors, EV onboard chargers and power Electronics

Text Books: ***(As per IEEE format)***

1	Singh Kripal, 'Automobile Engineering', Vol.I and Vol. II, Standard Publishers Distributors.
2	R.K. Rajput, A Textbook of Automobile Engineering, Laxmi Publications Pvt.Ltd.
3	"Electric and Hybrid Vehicles Design Fundamentals" (2nd Edition), by Iqbal Husain
Reference Books: ***(As per IEEE format)***	
1	Automotive Engineering: Power train, Chassis System and Vehicle Body Edited By David A. Crolla.
2	Modern Electric, Hybrid Electric and Fuel Cell Vehicles Fundamentals, Theory and Design By Mehrdad Ehsani, Yimin Gao and Ali Emadi
3	A Book of Car. Available: https://ebookcentral.proquest.com
4	Automotive Engineering Fundamentals by Richard Stone and Jeffrey K. Ball.

List of Tutorials

1. Study of vehicle Layout with all components Practically
2. Design of Conventional Drive Train using MATLAB/Simulink
3. A comparative study of two common driveline systems used in rear-wheel-drive vehicles.
4. Demonstrations of front and rear axle of the heavy vehicles
5. Study on Vehicle Stability and Control
6. Study of Electrical and Hybrid Vehicle Layout
7. Study of Battery Components of Li-ion Battery pack
8. Design and Analysis of Li-Ion Battery Discharge Circuit
9. Design of EV PowerTrain Using MATLAB/Simulink
10. Visit to any Industry or Auto Expo

List of Project areas:

- Automatic transmission
- Air brakes
- Wireless Steering systems
- Latest Suspension systems
- Gasoline Engine
- Diesel Engine
- CNG Engine
- Engine aftertreatment systems
- EV Motors
- EV battery Technology
- BMS and BTMS

- Engine testing performance and comparison
- Motor testing performance and its comparison
- Battery testing

CO-PO Mapping

CO	Program Outcomes (PO)												PSO		
CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	1	0	0	0	0	0	0	1	1	0	1	2	3	1
CO2	1	0	0	0	0	0	0	0	1	1	0	1	2	3	1
CO3	1	0	0	0	0	1	0	0	1	1	0	1	2	3	1
CO4	3	0	3	3	1	1	1	0	1	1	0	1	2	3	1
CO5	2	0	2	0	2	1	1	1	1	1	1	1	2	3	1
CO6	2	0	2	1	2	1	1	1	1	1	1	1	2	3	1
Average	2	0	2	1	1	1	0	0	1	1	1	1	2	3	1

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1			✓	✓				✓	
CO2		✓		✓	✓	✓			
CO3		✓		✓		✓		✓	
CO4		✓		✓		✓			
CO5				✓		✓		✓	
CO6				✓	✓	✓		✓	

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓						
CO2	✓		✓				
CO3	✓		✓				
CO4	✓	✓	✓				
CO5	✓	✓	✓				
CO6	✓		✓				✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓				
CO2	✓		✓		
CO3	✓		✓		
CO4	✓		✓		
CO5	✓		✓		
CO6	✓		✓	✓	✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	4, 9	Builds the analytical foundation (SDG 4) that drives data-led innovation (SDG 9).
CO2	9	Supervised models power industrial and predictive applications (SDG 9).
CO3	3, 9	Statistical learning supports health diagnostics (SDG 3) and broader innovation (SDG 9).
CO4	8, 9	Classifiers enable fraud detection and economic applications (SDG 8, 9).
CO5	9	Decision-tree and ensemble models support data-driven industry solutions (SDG 9).
CO6	9, 11	Clustering / RL enable smart-city and resource applications (SDG 9, 11).

ME2304: THERMODYNAMICS

Teaching Scheme	Examination Scheme
Credits : 3	CP: 30 Marks
Lectures: 2 Hrs/week	LAB/GD/PPT/HA: 10 Marks
Practical: 2 Hrs/week	MSE (W): 40 Marks
Tutorial: - Hrs/week	ESE (W): Marks
	CVV: 20 Marks

Course Prerequisites: 1. Mathematics 2. Physics

Course Objectives:

- To learn the significance of thermodynamics, and terms and definitions used.
- To learn thermodynamic interactions.
- To learn laws of thermodynamics and their significance and limitations.
- To learn applications of thermodynamics laws to various thermal systems.
- To learn the concept of steam formation and its utility in engineering applications.
- To learn use of Steam Table, Mollier Chart in the analysis of simple steam systems.

Course Outcomes:

After completing this course students will be able;

1. To demonstrate energy balance in systems involving thermodynamic interactions
2. To evaluate changes in thermodynamic properties of substances
3. To apply the knowledge of temperature scale and Thermometry
4. To apply laws of thermodynamics to processes and cycle
5. To evaluate performance of refrigerator, heat pump etc
6. To explain steam properties and evaluate changes

SECTION-I

UNIT I: Introduction **Lecture: 4 hrs**

Basic Terms and Definitions; Thermodynamic System, Surroundings, Boundary, Property, State, Process, Cycle,

UNIT II: First Law of Thermodynamics **Lecture: 5 hrs**

First law of thermodynamics, Joules experiment, Concept of Thermal energy, Flow energy and Enthalpy, Limitations of First Law of Thermodynamics, Application of first law to flow and non-flow processes and cycles, Macro and Microscopic approach, Perpetual Motion Machine I

UNIT III: Zeroth Law of Thermodynamics **Lecture: 5 hrs**

Zeroth Law of Thermodynamics, Limitations of Zeroth Law of Thermodynamics, Temperature and Temperature scales, Thermometry

SECTION-II

UNIT IV: Second Law of Thermodynamics **(5Hrs)**

Concept of Reversibility, Reversible and Irreversible Processes, Kelvin-Plank and Clausius statement, Equivalence between Kelvin-Plank and Clausius statement, Perpetual Motion Machine II, Carnot theorem, Concept of Entropy. Carnot Cycle for Heat engine, Refrigerator and Heat Pump, Applications of second law to flow and non-flow processes and cycles.

UNIT V: Ideal Gas and Gas Processes **(5Hrs)**

Ideal Gas definition, Gas Laws, Gas Properties, Equation of State, Study and analysis of Gas Processes; Isobaric, Isochoric, Isothermal, Isentropic, Polytropic, Introduction to Gas Power Cycles

UNIT VI: Introduction to Steam Properties **(4Hrs)**

Formation of steam, Phase changes, Steam Properties, Dryness fraction, Use of Steam Tables and Mollier diagram, Steam calorimeters, Rankine Cycle

List of Practical's: (Any Six)

1. Determination of calorific value using gas calorimeter
2. Determination of calorific value using Bomb calorimeter
3. Trial on Flue Gas analysis using gas analyzer
4. Trial for performance determination of Refrigerator
5. Trial for performance determination of Heat pump
6. Demonstration and study of boiler mountings and accessories
7. Determination of dryness fraction of steam using throttling calorimeter
8. Determination of dryness fraction of steam using throttling and separating calorimeter
9. Trial on boiler to determine boiler efficiency, equivalent evaporation
10. Trial for energy balance of any one thermal system

List of Course Projects (Indicative):

- Energy balance in closed systems.
- Energy balance in open systems.
- Performance of Work transfer devices
- Performance of Heat transfer devices
- Performance of neither Heat transfer nor Work transfer devices
- Performance of system involving both Work transfer and Heat transfer devices.
- Demonstration of the First Law of Thermodynamics
- Demonstration of the Second Law of Thermodynamics
- Calibration of a Temperature measuring device
- Construction of Temperature Scale

Text Books: (As per IEEE format)

1. Nag.P.K., "Engineering Thermodynamics", 4th Edition, Tata McGraw-Hill, New Delhi, 2008
2 Kothandaraman and Domkundwar ;Thermodynamics and Heat Engines
3 Ballaney P. L; -Thermal Engineering; Khanna Publishers
4 Natarajan E., "Engineering Thermodynamics: Fundamentals and Applications", Anuragam Publications, 2012

Reference Books: (As per IEEE format)

- Cengel. Y. and MBoles, "Thermodynamics – An Engineering Approach", 7th Edition, Tata McGraw Hill, 2010.
- Rathakrishnan. E., "Fundamentals of Engineering Thermodynamics", 2nd Edition, Prentice- Hall of India Pvt. Ltd, 2006
- Van Wylen and Sonntag, "Classical Thermodynamics", Wiley Eastern, 1987
- RaynerJoel ; Engineering Thermodynamics; ELBS Longman

Moocs Links and additional reading material: www.nptelvideos.in

CO PO Map

CO/ PO	PO :1	PO :2	PO :3	PO :4	PO :5	PO :6	PO :7	PO :8	PO :9	PO: 10	PO: 11	PO: 12	PS O: 1	PS O: 2	PS O: 3
CO:1	3	3	3	2	1	2	3	1	1	3	2	3	2	3	1
CO:2	3	3	3	2	1	2	3	1	1	3	2	3	1	3	1
CO:3	3	3	2	2	1	1	2	1	1	3	2	3	2	3	2
CO:4	3	3	2	2	1	2	3	1	1	3	2	3	1	3	2
CO:5	3	3	2	2	1	1	3	1	1	3	2	3	2	3	2
CO:6	3	3	1	2	1	1	3	1	1	3	2	3	1	3	1

CO attainment levels

CO Number	Level
1. To demonstrate energy balance in systems involving thermodynamic interactions	1
2. To evaluate changes in thermodynamic properties of substances	2
3. To apply the knowledge of temperature scale and Thermometry	3
4. To apply laws of thermodynamics to processes and cycle	3
5. To evaluate performance of refrigerator, heat pump etc	4
6. To explain steam properties and evaluate changes	5

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1			✓	✓				✓	
CO2		✓		✓	✓	✓			
CO3		✓		✓		✓		✓	
CO4		✓		✓		✓			

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO5				✓		✓		✓	
CO6				✓	✓	✓		✓	

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓						
CO2	✓		✓				
CO3	✓		✓				
CO4	✓	✓	✓				
CO5	✓	✓	✓				
CO6	✓		✓				✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓				
CO2	✓		✓		
CO3	✓		✓		
CO4	✓		✓		
CO5	✓		✓		
CO6	✓		✓	✓	✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	4, 9	Builds the analytical foundation (SDG 4) that drives data-led innovation (SDG 9).
CO2	9	Supervised models power industrial and predictive applications (SDG 9).

CO	SDG(s) Addressed	Justification / Linkage
CO3	3, 9	Statistical learning supports health diagnostics (SDG 3) and broader innovation (SDG 9).
CO4	8, 9	Classifiers enable fraud detection and economic applications (SDG 8, 9).
CO5	9	Decision-tree and ensemble models support data-driven industry solutions (SDG 9).
CO6	9, 11	Clustering / RL enable smart-city and resource applications (SDG 9, 11).

ME2305: Machine Design

Teaching Scheme	**Examination Scheme**
Credits : 4	CP: 30 Marks
Lectures : 3 Hrs/week	Lab: 10 Marks
Practical : -2 Hrs/week	CVV: 20 Marks
Tutorial : NA	ESE (W): 40 Marks

Prerequisites:	
•	Students should have a basic understanding of Engineering Mechanics, Strength of Materials.
Course Objectives:	The student will be able to
•	Apply different design considerations to common machine elements for failure prevention and sustainability.
•	Deduce Power transmission system for a particular application.
•	Use manufacturers catalog for selection of standard components.
Course Outcomes:	
	After completion of the course, student will be able to
1.	design the machine components under static load condition.
2.	design the machine components for sustaining finite life and infinite life cycles; when these are subjected to fluctuating loads.
3.	perform stress analysis and design simple machine components like shaft, coupling, power screws, springs.
4.	perform stress analysis and design various joints like, knuckle joint, cotter joint, threaded joints and welded joints.
5.	decide power transmission system for a particular application & select the material and compute the design specifications for spur & helical gears.
6.	select the standard components like belt drive (flat / vee belt), rolling element bearings (deep groove ball bearings) from the manufacturers catalog.

Section1:	**Topics/Contents**

Unit 1:

Introduction, Basic procedure of machine design, Modes of Failure, Factor of Safety

Design of Simple Mechanical Elements under static load condition: Design of levers, wall brackets, frames, cotter joint, knuckle joint,

Unit 2:

Design of threaded joints and welded joints under various (axial/symmetric/asymmetric/eccentric) load conditions.

Design of Power Screws: Torque analysis, square and trapezoidal threads, Self-locking screw, stress analysis, Design of screw jack.

Unit 3:

Design of components under Dynamic loads: – Stress Concentration, Stress Concentration Factors, Reduction of Stress Concentration, Fluctuating Stresses, Fatigue Failure, Endurance Limit, Reversed Stresses- Design for Finite and Infinite Life, Soderberg, Goodman and Gerber criterion.

Section2:	**Topics/Contents**

Unit 4:

Design of Shafts: Based on strength, Torsional Rigidity, lateral Rigidity, ASME Code for Shaft Design, Design of keys, couplings: rigid and flexible couplings, Design of Springs: Helical compression Springs

Unit 5:

Design of Spur and Helical gears:

Introduction to gears: Gear Selection, material selection, Basic modes of tooth failure,

Number of teeth and face width, Force analysis, Beam strength (Lewis) equation, Velocity factor, Service factor, Load concentration factor, Effective load on gear, Wear strength (Buckingham's) equation, Estimation of module based on beam and wear strength, Estimation of dynamic tooth load by velocity factor and Buckingham's equation.

Helical Gears: Terminology of Helical Gears, Virtual number of teeth, and force analysis, Design on Beam Strength, Wear strength

Unit 6:

Belt drives: V-belts and flat belts selection from manufacture's catalog

Bearings: Rolling contact bearings: deep groove ball bearings, static and dynamic load caring capacity, Load-life relationship, selection of bearings from manufacture's catalog	
Text Books: ***(As per IEEE format)***	
1	Bhandari V. B. "Design of Machine Elements". 5thEdition. Tata McGraw Hill Publication Private Ltd. New Delhi
2	David G Ullman, "The Mechanical Design Process", McGraw Hill Pub. Co. Ltd.
3	George E Dieter, Linda C Schmidt, "Engineering Design", McGraw Hill Pub. Co. Ltd.
Reference Books: ***(As per IEEE format)***	
1	Shigley J. E. and Mischke C. R, "Mechanical Engineering Design', 6th international Edition, McGraw Hill Pub. Co. Ltd., Delhi.
2.	Spotts M. F. and Shoup T. E. "Design of Machine Elements", Pearson Education Pvt. Ltd.
3.	"Design Data", P.S.G. College of Technology, Coimbatore

List of Practical's:

Design analysis of following machine elements.

1. cotter joint / knuckle joint

2. Power Screw

3. Couplings

4. Helical Compression Spring

5. Flat / V-Belt selection from catalog

6. Deep groove Ball Bearing selection from catalog

7. Journal Bearing Test: Experimental measurement of the pressure distribution and frictional torque in the journal bearing for different applied load and speed.

8. Dry abrasion test

9. Four-Ball Test: To investigate the Wear preventive ability (WP) / Extreme pressure capacity (EP) and Friction behaviour of lubricants operating under non-conformal (point contact) contact condition.

10. Pin-on-Disc Test: To investigate the behaviour of interacting surfaces in terms of Friction and Wear measurement, under dry condition

11. Experiment of rotating beam fatigue testing machine

List of Project areas:

Design, Modelling & Drafting of

1. spur / helical Gearbox.

2. Screw jack

3. C-clamp

4. Fly Press

5. Protected Flange Coupling

6.Flexible Shaft Coupling

7.Cotter Joint

8. Knuckle Joint

9. Lead Screw of lathe

12.Single / multiplate plate clutch

13. Disk Brake ,

Any other similar # use any CAD software for Modelling & Drafting.

CO-PO Mapping

CO	**Program Outcomes (PO)**												**PSO**		
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	2	1	1	1	0	1	1	0	3	3	1
CO2	3	3	3	3	2	1	1	1	0	1	1	0	3	3	1
CO3	3	3	3	3	2	1	1	1	0	1	1	0	3	3	1
CO4	3	3	3	3	2	1	1	1	0	1	1	0	3	3	1
CO5	3	3	3	3	2	1	1	1	0	1	1	0	3	3	1
CO6	3	3	3	3	2	1	1	1	0	1	1	0	3	3	1

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓	✓	✓			✓	
CO2		✓		✓	✓	✓			
CO3		✓		✓	✓	✓		✓	
CO4		✓		✓	✓	✓			
CO5		✓		✓	✓	✓		✓	
CO6		✓		✓	✓	✓		✓	

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓						
CO2	✓		✓				
CO3	✓		✓				
CO4	✓	✓	✓				
CO5	✓	✓	✓				
CO6	✓		✓				✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓				
CO2	✓		✓		
CO3	✓		✓		
CO4	✓		✓		
CO5	✓		✓		
CO6	✓		✓	✓	✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	4, 9	Builds the analytical foundation (SDG 4) that drives data-led innovation (SDG 9).
CO2	9	Supervised models power industrial and predictive applications (SDG 9).
CO3	9	broader innovation (SDG 9).
CO4	8, 9	Classifiers enable fraud detection and economic applications (SDG 8, 9).
CO5	9	Decision-tree and ensemble models support data-driven industry solutions (SDG 9).
CO6	9, 11	Clustering / RL enable smart-city and resource applications (SDG 9, 11).

ME2306: Fluid Engineering

Teaching Scheme	**Examination Scheme**
Credits : 3	CP:20 Marks
Lectures : 2 Hrs/week	Lab: Marks
Practical : 2 Hrs/week	ESE (P) : 40 Marks
Tutorial : NA	ESE (W): 40 Marks

Prerequisites:	
●	1. Mathematics 2. Physics
Course Objectives:	The student will be able to
●	1. To familiarize with properties of fluids and applications of fluid mechanics
●	2. To understand concepts of fluid measurement, types of flows and dimensional analysis
●	3. To formulate and analyse problems related to calculations of forces in fluid structure
Course Outcomes:	
	After completion of the course, student will be able to
1.	Develop an intuitive understanding for Fluid properties and fluid statics.
2.	Obtain the solution of the problems dealing with ship stability, buoyancy etc.
3.	Apply and analyze fluid systems using the integral form of the continuity, momentum
4.	Apply Bernoulli's Equation for various fluid systems and flow measuring devices.
5.	Demonstrate the Dimensional analysis and working of fluid flow measurement devices.
6.	Analyze and explain physical significance of flow through the pipes.

Section1:	**Topics/Contents**
	SECTION-I **Unit-1** **Fluid statics:**-Fluid properties and fluid statics, manometry, buoyancy, Introduction to Hydrostatic forces and Centre of pressure, forces on submerged bodies, stability of floating bodies; **Unit-II** **Fluid Kinematics**:-Control-volume analysis of mass, types of fluid flow, velocity of fluid particle, acceleration of fluid particle; differential equations of continuity, velocity potential and stream function flow net. **Unit-III**

	Fluid Dynamics:-Bernoulli's equation, limitations of Bernoulli's equation, Application of Bernoulli's theorem such as venturimeter, orifice meter, pitot tube and V-notch etc
	SECTION-II **Unit-IV** **Dimensional analysis:**-Buckingham's theorem, Model analysis, similarity laws and dimensionless numbers. Unit-V **Flow through pipes:-** Losses in pipes, bends and fittings, Flow around submerged bodies, drag and lift Unit-VI **Boundary layer theory:**-Introduction to boundary layer theory and its analysis, Elementary turbulent flow

Text Books: ***(As per IEEE format)***

	Name(s) of author(s); Title of the book; Edition No., Publisher Text Books: (As per IEEE format)
1	Som and Biswas, Fluid Mechanics and Fluid Machines, Tata Mcgraw Hill
2	D. S. Kumar, Fluid Mechanics And Fluid Power Engineering, S. K. Kataria& Sons
3	R. K. Bansal, Fluid Mechanics, Laxmi Publication (P) Ltd. New Delhi
4	R. K. Rajput, Fluid Mechanics and Hydraulic Machines, S. Chand & Company Ltd

Reference Books: ***(As per IEEE format)***

	.Name(s) of author(s); Title of the book; Edition No., Publisher
1	1. Frank M White, Fluid Mechanics, 6th Ed., Tata Mcgraw Hill New Delhi
2	2. Yunus A. Çengel, Fluid Mechanics, Tata Mcgraw-Hill Education

List of Practical's:

1. Measurement of viscosity using RedWood viscometer
2. Study and demonstration of pressure measurement using manometers
3. Bernoulli equation in nozzle/diffusers: Loss calculation
4. Calibration of Venturimeter / V-Notch
5. Determination of the metacentric height of a floating body and its stability
6. Demonstration of Pitot tube for velocity measurement
7. Flow pattern in a Hale-Shaw cell
8. Reynolds Experiment
9. Determination of Minor Losses – contraction, expansion and bend
10. Force acting on a plate/hemisphere due to a jet

List of Course Projects-

1. Simulation of Flow over airfoil
2. Design of a piping network
3. Simulation of Flow over cylinder
4. Design of Centrifugal Pump.
5. Study of hydrokinetic Turbine.
6. Flow Analysis of Rocket nozzle using Ansys
7. CFD Analysis of Fluid Flow across Propeller Fan using ANSYS
8. Fluid mechanics of Internal combustion engine
9. Speed Bump: Application of Non-Newtonian fluid.
10. Study of Laminar Flow through pipe by simulation.

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1			✓	✓				✓	
CO2		✓		✓	✓	✓			
CO3		✓		✓		✓		✓	
CO4		✓		✓		✓			
CO5				✓		✓		✓	
CO6				✓	✓	✓		✓	

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓						
CO2	✓		✓				
CO3	✓		✓				
CO4	✓	✓	✓				
CO5	✓	✓	✓				
CO6	✓		✓				✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓				
CO2	✓		✓		
CO3	✓		✓		
CO4	✓		✓		
CO5	✓		✓		
CO6	✓		✓	✓	✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	4, 9	Builds the analytical foundation (SDG 4) that drives data-led innovation (SDG 9).
CO2	9	Supervised models power industrial and predictive applications (SDG 9).
CO3	3, 9	Statistical learning supports health diagnostics (SDG 3) and broader innovation (SDG 9).
CO4	8, 9	Classifiers enable fraud detection and economic applications (SDG 8, 9).
CO5	9	Decision-tree and ensemble models support data-driven industry solutions (SDG 9).
CO6	9, 11	Clustering / RL enable smart-city and resource applications (SDG 9, 11).

ME2309: KINEMATICS OF MACHINES AND MECHANISMS

Teaching Scheme	Examination Scheme
Credits : 3	CP: 30 Marks
Lectures: 2 Hrs/week	LAB/GD/PPT/HA: 10 Marks
Practical: 2 Hrs/week	MSE (W): Marks
Tutorial: - Hrs/week	ESE (W): 40 Marks
	CVV: 20 Marks

Prerequisites: Engineering Physics and Mathematics

Course Objectives:

Course is intended to cover the field of engineering theory, analysis, design and practice with modern tools. This engineering theory is generally described as mechanisms or as kinematics and dynamics of machines. Course is designed primarily for students of mechanical engineering; the content can also be of considerable value to practicing engineers throughout their professional careers.

Course Outcomes:

The student will be able to –

1. Do position, velocity, and acceleration analysis of planar mechanisms
2. Synthesize the mechanisms for various design tasks
3. Take dynamic analysis of mechanisms of a particular application
4. Design the kinematic profile of a cam to achieve a desired follower motion
5. Understand the kinematics of involute tooth profile for power transmission
6. Design, simulate and develop the mechanisms in realistic application

SECTION-1

Unit I (4hrs)

Machines and Mechanisms: Kinematics and dynamics of mechanisms and machines, kinematic diagrams, mobility and range of movement. Kutzbach, Grubler's and Grashof's criterion. Rubbing velocity, mechanical advantage, displacement analysis.

Unit II (5hrs)

Velocity Analysis: Four link planar mechanisms and their applications, such as manufacturing machines, steering mechanism, pumps, valves and valve operating mechanisms, multi-cylinder engines, compressors, robotic devices, actuators, suspension systems, material handling equipment and straight-line mechanisms etc.

Unit III (5hrs)

Acceleration Analysis: Four link planar mechanisms and their applications planar mechanisms using analytical, graphical and computer aided methods. Motion analysis and simulation of mechanism of different applications such as engines, compressors, robotic devices, actuators etc.

SECTION-1I

UNIT IV (4hrs)

Static and Dynamic: Static and dynamic forces in four link planar mechanisms, simulation of forces in slider crank and four bar applications such compressor, engine, crank and rocker etc.

Unit V (4hrs)

Cam Follower Mechanisms: Analysis of cam follower mechanisms for cam profile design and selection in various applications such process automation, valve operating mechanisms and robotics.

UNIT-VI (6hrs)

Gear Kinematics: Kinematics of in-volute gear tooth profile, law of gearing, interference, contact ratio, sliding velocity and profile generation.

List of Lab:

1. Motion simulation of equivalent mechanisms and mobility
2. Velocity analysis of planar mechanisms
3. Acceleration analysis of planar mechanisms
4. Computer based kinematic analysis of planar mechanism
5. Static and dynamic force analysis and simulation
6. Computer based kinematic analysis of cam follower motions.
7. Design and simulation of cam profiles
8. Velocity and torque analysis of gear trains
9. Determine the radius of gyration and mass moment of inertia of mechanical bodies
10. AI based kinematic analysis and simulation of mechanisms

List of Projects:

Project-based learning guidelines: Students can engage in a variety of application-oriented project activities that involve study, analysis, simulation, 2D/3D modelling, mechanism design, and system development. These projects aim to enhance practical understanding and problem-solving skills. Students are encouraged to incorporate AI-enabled tools, techniques, and methodologies to foster innovation and align with modern technological trends. Indicative Project Areas Include:

- Rotary engine
- Pantograph
- Multi cylinder reciprocating engine
- Hydraulic actuators
- Suspension system
- Elliptical trammel
- Reciprocating compressor
- Compound gear box for general purpose
- Peaucelliers mechanism
- Industrial automation cam (profile design)
- Reciprocating plunger (Pump)
- Valve mechanism for i.c engine (cam follower)
- Backhoe (earth moving machine-JCB)
- Ackerman steering mechanism
- Epi-cyclic gear trains for automotive
- Universal joint (Hooke's joint)
- Quick return mechanisms for manufacturing machines
- Cam follower mechanisms and innovative applications
- Different types of gear boxes
- Epicyclic gear train and applications
- Determination of mass moment of inertia of mechanical bodies
- Steering mechanisms
- Straight line mechanisms
- Inversions of slider crank and four bar mechanisms & their applications
- Kennedy's theorem-based velocity analysis (icr)
- Klein's construction
- Planar and spatial mechanisms
- Acceleration analysis & Coriolis theory
- Kinematics of spur gear and interference
- Design of steering mechanisms
- Cams in automation

- Sun and planetary gears in automotive
- Straight line mechanisms and applications
- Inventions of straight-line mechanisms
- Differential gear box
- Scotch yoke mechanism
- Mechanisms with higher pairs
- Frudenstin's mechanism design approach
- Oscillating cylinder mechanisms and applications
- Advance cam curves and design approach

Text Books: (As per IEEE format)

1. Theory of Machines and Mechanisms (Third edition), John Uicker Jr., Gordon R. Pennock and J. E. Shigley, Oxford University Press.
2. Theory of Machines, S. S. Rattan, Tata McGraw-Hill Publication
3. Theory of Machines and Mechanisms, Amitabh Ghosh and A. K. Mallik, Affiliated East-West Press Pvt Ltd.

Reference Books: (As per IEEE format)

1. Theory of Machines, Thomas Bevan, CBS Publications.
2. Machines and Mechanisms Applied Kinematic Analysis, David H. Myszka, Pearson Education, Asia.
3. Design of Machinery, R. L. Norton, McGraw-Hill

CO-PO Mapping

CO	PO 1	2	3	4	5	6	7	8	9	10	11	12	PS O1	2	3
1	2	3	2	1	1	1	0	0	1	1	1	1	1	1	1
2	2	3	2	1	1	0	0	0	1	1	1	0	1	2	1
3	2	3	2	1	1	0	0	0	1	1	1	0	1	2	1
4	2	3	2	1	1	0	0	0	1	1	1	0	1	2	1
5	2	3	2	1	1	0	0	0	1	1	1	1	1	2	1
6	2	3	2	1	1	1	0	0	2	2	2	2	1	2	1

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1			✓					✓	
CO2		✓			✓				
CO3		✓						✓	
CO4		✓				✓			
CO5				✓				✓	
CO6				✓				✓	

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓						
CO2			✓				✓
CO3	✓					✓	
CO4		✓	✓				
CO5		✓			✓		
CO6	✓						✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓				
CO2			✓		✓
CO3	✓		✓		
CO4	✓		✓	✓	
CO5	✓	✓			
CO6	✓		✓		✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	**SDG 4 – Quality Education**	Develops analytical, computational, design and problem-solving competencies through theory, laboratory, simulation and project-based learning.
CO2	**SDG 7 – Affordable & Clean Energy**	Efficient mechanisms, power transmission systems, gear trains and optimized machine operation can contribute to energy-efficient engineering systems.
CO3	**SDG 9 – Industry, Innovation & Infrastructure**	Strongly supports mechanism design, automation, robotics, simulation, manufacturing systems and AI-enabled engineering innovation.
CO4	**SDG 11 – Sustainable Cities & Communities**	Mechanism applications in transportation, steering, suspension, material handling and automation support efficient and sustainable infrastructure.
CO5	**SDG 12 – Responsible Consumption & Production**	Efficient mechanism/gear/cam design, reduced friction, optimized power transmission and design for improved machine performance support resource-efficient production.
CO6	**SDG 9 – Industry, Innovation & Infrastructure SDG 11 – Sustainable Cities & Communities**	Applications (SDG 9, 11)

Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Technology

(An Autonomous Institute affiliated to Savitribai Phule Pune University Formerly University of Pune)

Structure & Syllabus of

T.Y. Mechanical Engineering

T.Y. Mechanical Engineering, applicable for A.Y. 2026 - 27

Prepared by:

Board of Studies in Mechanical Engineering

Approved by:

Academic Board, Vishwakarma Institute of Technology, Pune

Index

Vision:

To be recognized as one of the pre-eminent Mechanical Engineering Programs

Mission:

- To prepare students competent to make their careers in Mechanical Engineering
- To provide value education to students to make them responsible citizen
- To strengthen collaborations with Industries, Academia and Research Organizations to enrich learning environment and to enhance Research Culture
- To be recognized as a leading Mechanical Engineering Department in the field of knowledge, skill and research

Program Educational Objectives

- To work independently as well as in team to formulate, design, execute solutions for engineering problems and also analyze, synthesize technical data for application to product, process, system design & development
- To understand & contribute towards social and environmental issues, following professional ethics and codes of conduct and embrace lifelong learning for continuous improvement
- To develop expertise towards use of modern engineering tools, instruments, programming languages and software's
- To acquire and develop careers in industries, Research organizations, academia and demonstrate entrepreneurial skill

Program Outcomes and Program Specific Outcomes (POs & PSOs)

PO1:-Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2:-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.

PO3:-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.

PO4:-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.

PO5:-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.

PO6:-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.

PO7:-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.

PO8:-Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9:-Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10:-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 receiving clear instructions.

PO11:-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.

PO12:-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 (PSO) Mechanical Engineering

Mechanical Engineering Graduates will be able to:

PSO1:- Demonstrate knowledge and understanding about machine drawing and modelling of mechanical engineering components & systems and selection of appropriate materials and manufacturing processes for their production.

PSO2:- Understand the working of mechanical engineering components & systems and thereby design, analyse and conduct experiments for enhancement of performance.

PSO3:- Ability to apply multidisciplinary approach and usage of modern hardware & software tools for the development of smart mechanical engineering components & systems

TY MECH. MODULE-V AY: 2026-27

Vishwakarma Institute of Technology

Department of Mechanical Engineering

Issue 1 : Rev No. 00: Dt. 03/07/26 FF No. 653_A

Title : Course Structure Branch : MECH Year: TY 2026-27 Pattern: 2025

TY MECH Module -V (Semester V & VI)

Course Code	NEP Course Category	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks											Credits			
			Theory	Tutorial	Practical	CVV	CP	LAB/ TUT	GD/ PPT	HA	MSE (W)	MSE (R)	MSE (O)	ESE (R)	ESE (W)	ESE (O)	PRACT+ CVV	ESE-Direct Evaluation	Theory	Tutorial	Practical	Total
(Semester V& VI)																						
ME3266	PCC	APPLIED THERMAL ENGINEERING	3		2	20								40			40	3		1	4
ME3262	PCC	DYNAMICS OF MACHINES	2		2	20	30	10							40			2	2	1	3
--	PEC1	PROGRAM ELECTIVE CORE -1#	3		2	20	40		20	20								3		1	4
--	PEC2-Courses	PROGRAM ELECTIVE CORE -2#	3															100	3			3
--	OE 1 Courses	OPEN ELECTIVE -1#	4															100	4			4
MDM	MDM-3	MULTI DISCIPLINARY MINOR 3 #	2	1			30		20	10					40				2	1		3
ME3207	VSEC -OT	DESIGN THINKING - 3*		1														100	1			1
ME3206	ERI	ENGINEERING RESEARCH AND INNOVATION-1*			4							30		70						2	2	2
		Total	17	2	10														17	5		24

Abbreviations Used	
PPT	Powerpoint Presentation
GD	Group Discussion
CVV	Course Viva Voce
LAB	Laboratory
TUT	Tutorial
CP	Course Project
PR	Practical
HA	Home Assignment
MSE	Mid Semester Examination
ESE	End Semester Examination
R /W/O	Review /Written/Online

PEC-1

ME3209A: COMPUTER AIDED DESIGN AND MANUFACTURING

ME3209B: METROLOGY AND QUALITY CONTROL

ME3209C: REFRIGERATION AND AIR CONDITIONING

PEC-2 Courses / Online

MD3162:DIGITAL MANUFACTURING & DESIGN TECHNOLOGY

MD3163:APPLIED COMPUTATIONAL FLUID DYNAMICS

MD3164:DESIGN OF INDUSTRIAL PIPING SYSTEMS SPECIALIZATION

MDMXXX:CAD CENTRIC FUTURE OF ENGINEERING & DIGITAL PRODUCT DEVELOPMENT

Open Elective -Courses

MD3205:SUPPLY CHAIN MANAGEMENT SPECIALIZATION

MDM-3

MM4150A:MECHATRONICS

MM4150B:ADVANCE MANUFACTURING

MM4150C:ICE & ALTERNATIVE FUELS

MM4150D:PRODUCT LIFE CYCLE MANAGEMENT

BOS Chairman

Dean Academics

TY MECH. MODULE-VI AY: 2026-27

Title : Course Structure

Vishwakarma Institute of Technology

Department of Mechanical Engineering

Issue 1 : Rev No. 00: Dt. 03/07/25 FF No. 653_A

Branch : MECH Year: TY 2026-27 Pattern: 2025

TY MECH Module -VI (Semester V & VI)

Course Code	NEP Course Category	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks												Credits			
			Theory	Tutorial	Practical	CVV	CP	LAB/ TUT	GD/ PPT	HA	MSE (W)	MSE (R)	MSE (O)	ESE (R)	ESE (W)	ESE (O)	PRACT+ CVV	ESE-Direct Evaluation	Theory	Tutorial	Practical	Total
(Semester V & VI)																					
ME3205	PCC	HEAT TRANSFER	3		2	20									40		40		3		1	4
ME3202	PCC	MECHANICAL SYSTEM DESIGN	2		2	20	30	10							40				2		1	3
--	PEC1	PROGRAM ELECTIVE CORE -4 #**	3		2	20	40		20	20									3		1	4
--	PEC2-Courses	PROGRAM ELECTIVE CORE-4 #**	3															100	3			3
--	OE1 Courses	OPEN ELECTIVE -2**	4															100	4			4
MDM	MDM-4	MULTI DISCIPLINARY MINOR -4 #	2	1			30		20	10						40			2	1		3
ME3208	VSEC-DT	DESIGN THINKING--4**		1														100		1		1
ME3209	ERI	ENGINEERING RESEARCH AND INNOVATION-2**			4							30		70						2		2
		Total	17	2	10														17	2	5	24

PEC-1

ME32114:HYBRID AND ELECTRIC VEHICLES
ME32118:HYDRAULIC MACHINES AND FLUID POWER
ME3211C:FINITE ELEMENT ANALYSIS

MDM-4

MM1501E:ROBOTICS & AUTOMATION
MM1501F:DATA SCIENCE
MM1501G:INDUSTRIAL ENGINEERING
MM1501D:PRODUCT LIFE CYCLE MANAGEMENT

PEC-2 Courses / Online

MD3165:ADDITIVE MANUFACTURING
MD3166:VENTILATION & AIR CONDITIONING SYSTEM FOR BUILDINGS
MD3167:INTRODUCTION TO SEMICONDUCTOR AND MEMS FABRICATION
MDXXXX:CAD CENTRIC FUTURE OF ENGINEERING & DIGITAL PRODUCT DEVELOPMENT

Open Elective -Courses

MD3206:DIGITAL PRODUCT MANAGEMENT SPECIALIZATION

Abbreviations Used	
PPT	Powerpoint Presentation
GD	Group Discussion
CVV	Comprehensive Viva Voce
LAB	Laboratory
TUT	Tutorial
CP	Course Project
PR	Practical
HA	Home Assignment
MSE	Mid Semester Examination
ESE	End Semester Examination
R/W/O	Review /Written/Online

ME3266: APPLIED THERMAL ENGINEERING

Teaching Scheme	**Examination Scheme**
Credits : 3	CVV: 20 Marks
Lectures : 3 Hrs/week	GD/PPT/HA: Marks
Practical : 2 Hrs/week	ESE (W/O): 40 Marks
Tutorial : - Hr/week	ESE (P/O): 40 Marks

Prerequisites:	
•	Thermodynamics
Course Objectives:	The student will be able to
•	Understand Working and Application of Reciprocating Compressors
•	Understand the Working and Application of Rotary Compressors
•	Understand the Working of Steam Turbines
•	Understand the Working Cycle of Gas Turbines and Its Performance
•	Understand the Working and Application of VCR Cycle
•	Understand the Working of Air Conditioning Systems
Course Outcomes:	
	After completion of the course, student will be able to
1.	Understand performance parameters of Reciprocating Air Compressors
2.	Understand performance characteristics of Rotary Compressors
3.	Analyse the performance of Steam Turbines
4.	Analyse the performance of Gas Turbines
5.	Illustrate the fundamental principles and applications of Refrigeration Systems
6.	Illustrate the fundamental principles and applications of Air Conditioning Systems

Section1:	**Topics/Contents**

Unit 1- Reciprocating Air Compressor

Single and Multistage, computation of work done, isothermal efficiency, effect of clearance volume, volumetric efficiency, Free air delivery, Theoretical and actual indicator diagram

Unit 2- Rotary Compressor Rotary

Introduction, Classification, Displacement Compressors, Steady Flow Compressors, Comparison between Reciprocating and Centrifugal Compressors, Comparison between reciprocating and rotary Compressors, Advantages and Disadvantages

Unit 3- Steam Turbines

Classifications, construction details, nozzles, compounding, velocity diagrams, governing, losses in steam turbines.

Section2:	**Topics/Contents**

Unit 4- Gas Turbines

Introduction, Classification, Brayton Cycle, Thermal Efficiency, Work ratio, maximum and optimum pressure ratio, Actual cycle effect of operating variables on thermal efficiency, inter-cooling, reheating and regeneration cycle

Unit 5- Refrigeration

Applications, Refrigerants, Refrigerator and Heat Pump Vapour compression systems, Effect of Operating Conditions on Vapour Compression Cycle, Vapour absorption systems.

Unit 6- Air Conditioning

Psychometric, Psychometric Chart, Air Conditioning Processes, Human Comfort, Air Conditioning Systems, Water Coolers, Ice Plant, Air Coolers.

Text Books: ***(As per IEEE format)***

1	Mahesh M. Rathore, Thermal Engineering, Tata McGraw Hill
2	R.K. Rajput, Thermal Engineering, Laxmi Publications
3	P. K. Nag; Engineering Thermodynamics; Tata McGraw Hill
4	Arora C. P., Refrigeration and Air Conditioning, Tata McGraw Hill

Reference Books: ***(As per IEEE format)***

1	Yunus Cengel and Michael Boles; Thermodynamics - An Engineering Approach; Tata McGraw Hill
2	Dossat Ray J; Principles of refrigeration, S.I. version, Willey Eastern Ltd, 2000

3	Rayner Joel; Engineering Thermodynamics; ELBS Longman
4	Ballaney P. L; -Thermal Engineering; Khanna Publishers

List of Practical's:

1. Trial on Reciprocating Air Compressor
2. Trial on Centrifugal Compressor
3. Trial on Centrifugal Air Blower
4. Trial on Steam Turbine
5. Study of Axial Flow Compressors and Gas Turbines
6. Trial on Vapour Compression System
7. Trial on Vapour Absorption System
8. Trial on Ice Plant Test Rig
9. Trial on Air Conditioning Test Rig: Cooling and Dehumidification Process.
10. Estimation of Cooling Load of Simple Air Conditioning System (case study

List of Project areas: (IoT based approach can be studied and applied)
1. Thermal Analysis of Reciprocating Compressors
2. Thermal Analysis of Rotary Compressors
3. Thermal Analysis of Steam Turbines
4. Thermal Analysis of Gas Turbines
5. Analysis of VCR Cycle with practical approach
6. Analysis of Various market available eco friendly Refrigerants:Analysis & applications
7. Analysis of Human Comfort Zones using Psychrometry
8. Analysis of Air-conditioned Room with Psychrometry and Heat Load Calculation
9. Air Conditioning Processes
10. Study and analysis Central Air Conditioning System

CO – PO / PSO Articulation Matrix

CO	**Program Outcome (PO)**											**PSO**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO1**	**PSO2**	**PSO3**
CO 1														
3	3	2	3	2	2	2	1	2	2	1	1	3	2	
3	3	2	3	2	2	2	1	2	2	1	1	3	2	
3	3	2	3	2	2	2	1	2	2	1	1	3	2	
3	3	2	3	2	2	2	1	2	2	1	1	3	2	
3	3	3	3	2	2	2	1	2	2	1	1	3	2	
3	3	3	3	2	2	2	1	2	2	1	1	3	2	

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	✓	✓	✓	✓	✓			✓	✓
CO2		✓	✓		✓	✓		✓	✓
CO3		✓		✓		✓			
CO4		✓					✓		
CO5		✓		✓		✓		✓	✓
CO6		✓		✓	✓		✓	✓	✓

CO – WP Mapping (Complex Engineering Problems) Sample Table

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓		✓				
CO2	✓		✓				
CO3	✓		✓				
CO4	✓		✓				
CO5	✓		✓				
CO6	✓		✓				✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓	✓			
CO2	✓		✓	✓	
CO3	✓	✓			
CO4			✓		
CO5			✓	✓	
CO6	✓		✓	✓	✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	4, 9	Builds the analytical foundation (SDG 4) that drives data-led innovation (SDG 9).
CO2	9	Supervised models power industrial and predictive applications (SDG 9).
CO3	3, 9	Statistical learning supports health diagnostics (SDG 3) and broader innovation (SDG 9).
CO4	8, 9	Classifiers enable fraud detection and economic applications (SDG 8, 9).
CO5	9	Decision-tree and ensemble models support data-driven industry solutions (SDG 9).
CO6	9, 11	Clustering / RL enable smart-city and resource applications (SDG 9, 11).

Syllabus Template **FF No.: 654-A**

Course Code: DYNAMICS OF MACHINES

Teaching Scheme	**Examination Scheme**
Credits : 3	CP : 30 Marks
Lectures : 2 Hrs/week	LAB: 10 Marks
Practical : 2Hrs/week	CVV : 20 Marks
Tutorial : - Hr/week	ESE (W/O): 40 Marks

Prerequisites:	
•	Engineering Mathematics, Applied Mechanics, Mechanics of Machines and Mechanisms
Course Objectives:	The student will be able to
•	To familiar with various balancing of rotating masses and reciprocating systems.
•	To understand the fundamentals of free and forced vibrations.
•	To develop analytical competency in solving vibration problems.
•	To familiar with various vibrations measurement instruments and vibration control techniques.
Course Outcomes:	
	After completion of the course, student will be able to
1.	Apply balancing techniques for rotating masses and reciprocating systems.
2.	Demonstrate and create mathematical model of vibratory system
3.	Analyze the mathematical model of a linear vibratory system to determine its response.
4.	Estimate natural frequency for single DOF undamped and damped free

	vibratory systems.
5.	Determine response to forced vibrations due to harmonic excitation, base excitation and excitation due to unbalance forces.
6.	Apply technique to use vibration measuring instruments for industrial/real life applications along with suitable method for vibration control.

Section 1:	**Topics/Contents**

1.Balancing:

Static and dynamic balancing, balancing of rotating masses in single and several planes, primary and secondary balancing of reciprocating masses, balancing in single cylinder engines, balancing in multicylinder in-line engines. Balancing of V-Engines.

2.Fundamentals of Vibration:

Brief history of mechanical vibration, importance of the study of vibration, Terminology of vibratory system, Elements of vibratory system, Modeling of system, degree of freedom, discrete and continuous system, Equivalent systems- Springs in series and parallel, Types of vibration, Resonance Phenomenon- practical examples.

3.Free Vibration- Single Degree Freedom Systems:

Evaluation of natural frequency, Equilibrium method, Energy method and Rayleigh's methods, Natural frequency for longitudinal, transverse, and torsional vibratory systems.

Different types of damping, Damped free vibrations with viscous damping, study of vibration response of over damped, critically damped and under damped systems, logarithmic decrement, introduction to damped free torsional vibrations.

Section 2:	**Topics/Contents**

4.Forced Vibrations- Single Degree Freedom Systems:

Type of sources of excitation, resonance phenomenon, forced damped vibrations of longitudinal systems with constant harmonic excitation, magnification factor, frequency response to harmonic excitation phase difference.

5.Two Degree of Freedom Systems:

Introduction of two degree of freedom system, Free undamped longitudinal vibrations of two degrees of freedom system, natural frequency and mode shapes, Free torsional vibrations of two rotor system.

6.Measurement and Control of Vibration:

Vibration measurements- vibration measuring devices, accelerometers, impact hammer, vibration shaker-construction, principles of operation and uses, vibration analyzer, analysis of vibration spectrum.

Vibration control- vibration control methods, passive and active vibration control, control of natural frequency, vibration isolators and undamped dynamic vibration absorbers.

Text Books: ***(As per IEEE format)***

1	G. K.Grover, "Mechanical Vibrations", 8th Edition, New Chand and Bros,Roorkee, ISBN-9888185240565
2	V. P.Singh, " Mechanical Vibrations", Dhanpat Rai and Sons, New Delhi, ISBN- 1234568150209

Reference Books: ***(As per IEEE format)***

1	W.T. Thomson, Marie Dillon Dahleh, "Theory of vibrations with applications", 5th Edition, Pearson Education Pvt. Ltd., ISBN- 9888131804820
2	Leonard Meirovitch, "Fundamentals of vibrations", Waveland PrInc; Reissue edition, ISBN-10- 1588666918
3	J. P. Den Hartog, "Mechanical Vibrations", Dover Publications INC, New York, ISBN- 0486648854
4	S. S. Rao, "Mechanical Vibrations", 5th Edition, Pearson Education Inc. New Delhi, ISBN- 9888188588843

List of Practical's:

Experimental verification of dynamic balancing of rotating masses.

Balancing of wheel / rotor on computerized balancing machine.

To determine natural frequency and stiffness of spring-mass system.

To determine the natural frequency of damped vibration of single degree freedom system and to find it's damping coefficient.

To determine the frequency response curve under different damping conditions for single degree freedom system of vibration.

Experiment on shock absorbers and to plot its characteristic curve.

To verify natural frequency of torsional vibration of two rotor system and position of node.

Experimental verification of principle of Dynamic Vibration Absorber.

Experimental verification of Gyroscopic couple.

To determine natural frequency of transverse vibration of beam using FFT analyzer.

Analysis of machine vibration signature using any analysis software package.

Measurement of noise levels using microphone and analyzer

Determine the free response of an SDOF damped system with different damping using suitable software.

Determine total response of SDOF damped system to harmonic excitation using suitable software.

CO – PO / PSO Articulation Matrix

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	Program Outcome (PO)											PSO		
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PS O1	PS O2	PS O3
CO1														
2	3	2	1	1	1	1			1	1	1	2	1	
2	3	2	1	1	1				1	1	1	2	1	
2	3	2	1	1	1				1	1	1	2	1	
2	3	2	1	1	1				1	1	1	2	1	
2	3	2	1	1	1				1	1	1	2	1	
2	3	2	1	1	1	1	1	2	2	2	1	2	1	

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1			✓	✓				✓	
CO2		✓		✓	✓	✓			
CO3		✓		✓		✓		✓	
CO4		✓		✓		✓			
CO5				✓		✓		✓	
CO6				✓	✓	✓		✓	

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓						
CO2	✓		✓				
CO3	✓		✓				
CO4	✓	✓	✓				
CO5	✓	✓	✓				
CO6	✓		✓				✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓				
CO2	✓		✓		
CO3	✓		✓		
CO4	✓		✓		
CO5	✓		✓		
CO6	✓		✓	✓	✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	4, 9	Builds the analytical foundation (SDG 4) that drives data-led innovation (SDG 9).
CO2	9	Supervised models power industrial and predictive

CO	SDG(s) Addressed	Justification / Linkage
		applications (SDG 9).
CO3	3, 9	Statistical learning supports health diagnostics (SDG 3) and broader innovation (SDG 9).
CO4	8, 9	Classifiers enable fraud detection and economic applications (SDG 8, 9).
CO5	9	Decision-tree and ensemble models support data-driven industry solutions (SDG 9).
CO6	9, 11	Clustering / RL enable smart-city and resource applications (SDG 9, 11).

Syllabus Template **FF No.: 654-A**

ME3209A: COMPUTER AIDED DESIGN AND MANUFACTURING

Teaching Scheme	**Examination Scheme**
Credits : 04	CVV: 20 Marks
Lectures : 3Hrs/week	GD/PPT: 20 Marks
Practical : 2Hrs/week	HA: 20 Marks
Tutorial : Hrs/week	CP : 40 Marks

Prerequisites:	1.Mathematics Engineering Mechanics; Mathematics course related to: Ordinary Differential Equation, Matrices,
Course Objectives:	The students will be able to
●	● Use the underlying algorithms, mathematical concepts, supporting computer graphics. These include but are not limited to: Composite2D & 3D homogeneous matrices for translation, rotation, and scaling transformations. ● Use and demonstrate fundamental knowledge of CAD/CAM. ● Understand the basic theory behind the finite element method. ● Use the finite element method for the solution of practical engineering problems. ●
Course Outcomes:	
	After completion of the course, student will be able to
1.	Able to use the underlying algorithms, mathematical concepts, supporting computer graphics. These include but are not limited to: Composite2D & 3D homogeneous matrices for translation, rotation, and scaling transformations.
2.	Able to use and demonstrate fundamental knowledge of CAD/CAM.
3.	Able to:─ Understand the basic theory behind the finite element method

4.	Able to : ─ Use the finite element method for the solution of practical engineering problems
5.	Able to Create the G-code program (with a standard computer post processor) of a work-piece on a standard numerically controlled machine tool with CNC controls.

Section1 :	**Topics/Contents**

Unit 1: Computer Graphics **6hrs**

Introduction to computer graphics for CAD/CAM/CAE, coordinate systems, geometric transformations, composite and inverse transformations, geometric mapping, orthographic, multiview, isometric, oblique and perspective projections for engineering visualization.

Unit 2: Geometric Modelling **7hrs**

Parametric and freeform curve and surface modelling using Hermite, Bézier and B-spline techniques, solid modelling methods (CSG and B-Rep), feature-based and parametric modelling.

Unit 3: Fundamentals of Finite Element Analysis **8hrs**

Introduction to FEM, modelling procedure, element formulation, shape functions, energy methods, assembly and solution of finite element equations, mesh quality, convergence.

Section2 :	**Topics/Contents**

Unit 4: One- and Two-Dimensional FEA **6Hrs**

Analysis of spring, bar, plane stress, plane strain and axisymmetric problems, triangular and quadrilateral elements, higher-order elements and practical engineering applications using commercial CAE tools.

Unit 5: Computer-Aided Manufacturing

CAD–CAM integration, NC/CNC systems, G and M code programming, tool path generation, APT programming, CAM software

Unit 6: Digital Manufacturing and Industry 4.0

Rapid prototyping, additive manufacturing workflow, digital manufacturing, digital thread, IoT, , smart factories and digital twin concepts for modern product development.

Text Books: ***(As per IEEE format)***	
1	Ibrahim Zeid, "Mastering CAD/CAM", Tata McGraw Hill.
2	Groover M. P., "Automation, production systems and computer integrated manufacturing" Prentice Hall of India.
3	Chandrupatla T. R. and Belegunda A. D., "Introduction to finite elements in engineering", Prentice Hall of India.
4	P.N. Rao -CAD/CAM, Principles & Applications-Tata McGraw Hill.
Reference Books: ***(As per IEEE format)***	
1	Ibrahim Zeid, "CAD/CAM - theory and practice", Tata McGraw Hill.
2	Segerling L. J., "Applied finite elements analysis", John Wiley and Sons
3	Gebhardt A., "Rapid Prototyping", Hanser Publisher.
4	David F. Rogers, J. Alan Adams, Mathematical Elements for Computer Graphics, Tata McGraw-Hill Publishing Company Ltd., New Delhi-8.

List of Practical's:

Project Proposal and Design Requirements

3D CAD Models and Engineering Drawings

CAE Analysis Report

Motion Simulation Report (where applicable)

CNC Program/Additive Manufacturing Process Plan

Prototype (Physical or Virtual)

Final Project Report and Presentation

List of Project areas: Robotic Gripper Design and Optimization

Electric Vehicle Battery Pack Enclosure

Automated Material Handling System

Drone Frame Design and Structural Analysis

Bicycle Crank or Suspension Component Optimization

3D Printed Lightweight Mechanical Component

Smart Manufacturing Cell/Digital Twin Model

CNC Fixture or Jig Design

Hydraulic or Pneumatic Mechanism Development

Sustainable Product Design using Additive Manufacturing

Laboratory Experiments

1. Programming of Geometric Curves and Surfaces (2 Hours)
    - Develop a program (Python/MATLAB/C++) to generate and visualize Bézier Curves, B-Spline Curves, Bézier Surfaces, or B-Spline Surfaces using control points.
2. One-Dimensional Finite Element Analysis (2 Hours)
    - Perform FEA of a bar, truss, spring, or shaft using analytical and CAE software approaches; compare numerical and theoretical results.
3. Static Structural Analysis using CAE Software (4 Hours)
    - Conduct stress, strain, and deformation analysis of mechanical components using 2D and 3D finite elements.
4. Fatigue and Design Validation Analysis (2 Hours)
    - Perform fatigue life estimation and factor of safety evaluation of a mechanical component under cyclic loading conditions.
5. Motion and Kinematic Simulation (2 Hours)
    - Analyze motion, velocity, acceleration, interference, and dynamic behavior of mechanisms using motion simulation software.
6. CAM Programming and CNC Manufacturing (2 Hours)
    - Generate CNC tool paths, create G & M codes using CAM software, simulate machining operations, and manufacture a component on CNC machine.
7. Additive Manufacturing and 3D Printing (2 Hours)
    - Convert CAD models into STL format, perform slicing, generate machine code, fabricate components using a 3D printer, and evaluate dimensional accuracy.
    -

Course Project

Deliverables

- Project Proposal and Design Requirements
- 3D CAD Models and Engineering Drawings
- CAE Analysis Report
- Motion Simulation Report (where applicable)
- CNC Program/Additive Manufacturing Process Plan
- Prototype (Physical or Virtual)

- Final Project Report and Presentation

Suggested Project Areas

- Robotic Gripper Design and Optimization
- Electric Vehicle Battery Pack Enclosure
- Automated Material Handling System
- Drone Frame Design and Structural Analysis
- Bicycle Crank or Suspension Component Optimization
- 3D Printed Lightweight Mechanical Component
- Smart Manufacturing Cell/Digital Twin Model
- CNC Fixture or Jig Design
- Hydraulic or Pneumatic Mechanism Development

CO – PO / PSO Articulation Matrix

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	1	3	-	-	-	2	1	3	2	3	
CO 2	3	2	3	1	3	1	1	-	2	2	2	3	2	
CO 3	3	3	2	3	3	-	-	-	1	1	3	2	3	
CO 4	3	3	3	3	3	1	1	-	2	2	3	3	3	
CO 5	3	2	3	1	3	1	1	-	2	2	3	2	3	

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), - = No correlation.

CO – WK Mapping (Knowledge & Attitude Profiles)

✓ indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	✓	✓	✓						
CO2		✓	✓	✓	✓				
CO3	✓	✓	✓	✓					
CO4	✓	✓	✓	✓	✓				
CO5		✓	✓	✓	✓				

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7

CO1	✓	✓		✓	✓		
CO2	✓	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓		
CO4	✓	✓	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓	✓

CO – EA Mapping (Complex Engineering Activities)

✓ indicates the activity attribute addressed by the CO.

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓	✓	✓		✓
CO2	✓	✓	✓		✓
CO3	✓	✓		✓	✓
CO4	✓	✓	✓	✓	✓
CO5	✓	✓	✓		✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	4, 9	Develops engineering knowledge in computer graphics, geometric transformations, and CAD visualization, supporting quality technical education (SDG 4) and innovation in engineering design (SDG 9).
CO2	9, 12	CAD/CAM knowledge supports digital product development, advanced manufacturing, and efficient product realization, contributing to industry innovation (SDG 9) and responsible production (SDG 12).
CO3	4, 9	Provides fundamental knowledge of Finite Element Method and engineering simulation, strengthening technical education (SDG 4) and advanced engineering analysis (SDG 9).
CO4	9, 12	Application of FEM enables simulation-driven design, design optimization, and validation before manufacturing, reducing material waste and supporting sustainable industrial production (SDG 9, SDG 12).

CO5	9, 12	CNC programming and computer-aided manufacturing support automated, precise, and efficient manufacturing processes, contributing to industrial innovation (SDG 9) and responsible production (SDG 12).

Syllabus Template **FF No.: 654**

ME3209A: Metrology and Quality Control

Teaching Scheme	**Examination Scheme**
Credits : 4	CVV: 20 Marks
Lectures : 3 Hrs/week	GD/PPT: 20 Marks
Practical : 2 Hrs/week	HA: 20 Marks
Tutorial : Hrs/week	CP : 40 Marks

Prerequisites:	Basic Mechanical Engineering, Engineering Graphics, Higher Secondary Science courses, Engineering Physics, Engineering Chemistry.
Course Objectives:	
•	To develop an understanding of the fundamental principles of engineering metrology, measurement systems, and measurement techniques.
•	To explain the principles and applications of interferometry, surface finish measurement, limits, fits, tolerances, and gauge design for ensuring dimensional accuracy and quality in manufacturing processes.
•	To understand the concept of advanced metrology techniques for the measurement of screw threads, gears, and precision components, with Coordinate Measuring Machines (CMM), profile projectors, toolmakers' microscopes.
•	To introduce the concepts of quality management, quality philosophies, quality costs, Seven basic quality tools for problem-solving and continuous quality improvement in manufacturing and service industries.
•	To provide knowledge of Total Quality Management (TQM) principles and modern quality improvement methodologies such as Quality Function Deployment (QFD), 5S, Kaizen, Kanban, Just-in-Time (JIT), Poka-Yoke.
•	To develop the ability to apply statistical quality control techniques, including control charts, process capability analysis, acceptance sampling, and operating characteristic (OC) curves, for monitoring, controlling, and improving product and process quality.
Course Outcomes:	
	After completion of the course, student will be able to
1.	Identify techniques to minimize the measurement errors
2.	Identify methods and devices for measurement of length, angle, and gear and thread parameters, surface roughness and geometric features of parts.

3.	Choose limits for plug and ring gauges
4.	Explain methods of measurement in modern machineries.
5.	Select quality control techniques and its applications.
6.	Plot quality control charts and suggest measures to improve the quality of product and reduce cost using Statistical tools.

Section1:	**Introduction to Metrology**

Unit 1- Introduction to Metrology, Precision, Accuracy, Errors in Measurement, Calibration. Linear Measurement: Standards, Line Standard, End Standard, Precision and Non-Precision Measuring instruments, Slip Gauges. Angular Measurement: Sine bar, Sine Center, Uses of sine bars, Clinometer, Angle gauges, Angle Dekkor, vernier bevel protractor, Auto Collimator.
Comparator: Mechanical, Pneumatic, Optical, Electronic (Inductive), Electrical (LVDT).
Unit 2: Interferometry and Limits, Fits, Tolerances Principle, NPL Interferometer, Flatness measuring of slip gauges, Surface Finish Measurement: Surface Texture, Measuring Surface Finish by Stylus probe, Tomlinson and Talysurf, Design of Gauges: Types of Gauges, Limits, Fits, Tolerance; Terminology for limits and Fits. Indian Standard (IS 919-1963) Taylor's Principle.
Unit 3: Metrology of Screw Thread Gear Metrology: Gear error, Gear measurement, Gear Tooth Vernier; Profile Projector, Tool marker's microscope. Advancements in Metrology: Co-ordinate Measuring Machine, Universal Measuring Machine, Laser in Metrology.

Section2:	**Introduction to Quality Management and Statistical Quality Control**

Unit 4: Introduction to Quality and Quality Tools Quality Statements, Cost of Quality and Value of Quality, Quality of Design, Quality of Conformance, Quality of Performance, Seven Quality Tools: Check sheet, Flow chart, Pareto analysis, cause and effect diagram, scatter diagram, Brain storming, Quality circles.

Unit 5: Total Quality Management Quality Function Deployment, 5S, Kaizan, Kanban, JIT, Poka yoke, TPM, FMECA, FTA, Zero defects.

Unit 6: Statistical Quality Control: Importance of statistical methods in quality control, measuring of statistical control variables and attributes. Measurement/inspection, different types of control charts (X Bars, R, P. charts) and their constructions and their application, Sampling inspection and percentage inspection, basic concept of sampling inspection, operating characteristic curves, conflicting interests of consumer and producer, producer and consumers

Text Books: ***(As per IEEE format)***

1	*I. C. Gupta, "Engineering Metrology", Dhanpat ana Rai Publications, New Delhi, India.*
2	*M. S. Mahajan, "Statistical Quality Control", Dhanpat and Rai Publications*
Reference Books: *(As per IEEE format)*	
1	*R. K. Jain, "Engineering Metrology", Khanna Publications, 17th edition, 1975.*
2	*K. J. Hume, "Engineering Metrology", McDonald Publications, 1st edition, 1950.*
3	*A. W. Judge, "Engineering Precision Measurements", Chapman and Hall, London, 1957.*
4	*K. L. Narayana, "Engineering Metrology", Scitech Publications, 2nd edition.*
5	*J. F. Galyer, C. R. Shotbolt, "Metrology for Engineers", Little-hampton Book Services Ltd., 5 th edition, 1969*

List of Practical's:

1.Determination of linear and angular dimensions of given composite part using precision/non precision measuring instruments.

2. Angular measurements by Sine bar Bevel Protractor.

3. Calibration of measuring instrument. Example – Dial gauge, Micrometer, Vernier (any one)

4. Verification of dimensions & geometry of given components using Mechanical & Pneumatic comparator.

5. Machine tool alignment test on lathe/milling machines.

6. Identification of surfaces using optical flat/interferometers and measure surface roughness using surface roughness tester.

7. Determination of geometry & dimensions of given composite object using profile projector

8. Measurement of thread parameters using floating carriage diameter measuring machine.

9. Measurement of spur gear parameters using Gear Tooth Vernier, Span, Gear Rolling Tester.

10. Determination of given geometry using coordinate measuring machine (CMM).

List of Project areas:

1.Design of limit gauge.

2. Analyze the fault in given batch of specimens by using seven quality control tools for engineering application.

3. Determination of process capability from given components and plot variable control chart/ attribute chart.

4. Case study on various tools in Total Quality Management (TQM)

5. Industrial visit to Calibration lab /Quality control lab / Gear manufacturing unit / Automotive Industry / Engineering Industry.

CO – PO / PSO Articulation Matrix

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	Program Outcome (PO)											PSO		
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PS O1	PS O2	PS O3
CO1														
3	2	-	2	3	-	-	-	-	-	-	2	3	2	1
3	3	2	2	3	-	-	-	-	-	-	2	3	3	1
3	2	2	3	3	-	-	-	-	-	-	2	2	3	2
2	3	2	2	2	2	1	1	2	2	1	2	2	2	3
2	3	3	2	2	2	2	2	2	2	2	3	2	2	3
3	3	2	3	2	1	1	1	1	21	2	2	2	2	3

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1			✓	✓				✓	
CO2		✓		✓	✓	✓			
CO3		✓		✓		✓		✓	
CO4		✓		✓		✓			
CO5				✓		✓		✓	
CO6				✓	✓	✓		✓	

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓						
CO2	✓		✓				
CO3	✓		✓				
CO4	✓	✓	✓				
CO5	✓	✓	✓				
CO6	✓		✓				✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓				
CO2	✓		✓		
CO3	✓		✓		
CO4	✓		✓		
CO5	✓		✓		
CO6	✓		✓	✓	✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	4, 9	Builds the analytical foundation (SDG 4) that drives data-led innovation (SDG 9).
CO2	9	Supervised models power industrial and predictive applications (SDG 9).
CO3	3, 9	Statistical learning supports health diagnostics (SDG 3) and broader innovation (SDG 9).
CO4	8, 9	Classifiers enable fraud detection and economic applications (SDG 8, 9).
CO5	9	Decision-tree and ensemble models support data-driven industry solutions (SDG 9).
CO6	9, 11	Clustering / RL enable smart-city and resource applications (SDG 9, 11).

Syllabus Template **FF No.: 654-A**

MM1501: Mechatronics

Teaching Scheme	**Examination Scheme**
Credits : 3	ESE (W): 40 Marks
Lectures : 2 Hrs/week	GD/PPT: 20 Marks
Practical : - Hrs/week	HA: 10 Marks
Tutorial : 1 Hr/week	CP : 30 Marks

Prerequisites:	
•	Electronics and Electrical Engineering. Applied electromechanics.
Course Objectives:	The student will be able to
•	Learn the integration of different streams as a mechatronics system
•	Model basic engineering systems for implementing control.
•	Analyse system models and system responses for various engineering systems
•	Understand effect of Controllers on system response
•	Demonstrate ladder programming of PLCs for various industry applications.

•	Implement control using various embedded systems for given applications.

Course Outcomes:	
	After completion of the course, student will be able to
1.	Understand different mechatronics systems
2.	Create mathematical models for different systems
3.	Apply knowledge of dynamic response of a system
4.	Implement various types of controllers in different systems
5.	Develop ladder diagram for industrial application
6.	Understand various embedded systems for industrial applications

Section1:	**Topics/Contents**

Introduction to Mechatronics system: Definition and scope of mechatronics, Evolution and applications of mechatronic systems, Integrated design approach, Mechatronic system architecture, Examples: Robots, smart appliances. Sensors and Transducers: Position, displacement, velocity, acceleration, Temperature, pressure, force, flow, and proximity sensors

System Modelling- Feedback and Feed Forward systems, Block Diagram, Definition of Process variable, Set-point, Manipulated variable and Final control element with examples, Open loop and Closed loop systems, Transfer Function Model, Mathematical Modelling of Mechanical, Electrical, Block Diagram reduction,basic fluid power principles, Pneumatic components and circuits, Hydraulic components and circuits.

System Response- Dynamic responses of systems – various types of inputs, natural and forced response for first and second order systems and its examples, system transfer functions – for first and second order systems for various inputs, Percentage overshoot, Rise time, Delay time, Steady state error.

Section2:	**Topics/Contents**

Closed loop controllers : Proportional, Integral and Derivative Controllers, PI, PD, PID controllers and their mechanical applications, Effect of Controllers on transient

response,Stability analysis.

Digital Electronics and PLC- Logic gates and combinational circuits, Sequential logic systems, Timers, counters**,** Introduction to PLC, PLC Architecture, Latching, Timers, Counter, Different scans in PLC, Ladder diagram programming for different types of logic gates, Practical Examples of Ladder logic diagrams,Industrial automation applications.

Micro-controllers and IoT- Microcontroller, embedded system, Arduino controller, practical examples of control using Arduino: vigilance, security, manufacturing etc., control using Raspberry pi and its features, IOT – key features, advantages and challenges, IOT hardware,examples of IOT applications in engineering, safety, household, office, medical, marketing, environmental monitoring fields

Text Books: ***(As per IEEE format)***

1	K.P. Ramchandran, G.K. Vijyaraghavan, M.S. Balasundaram, Mechatronics: Integrated Mechanical Electronic Systems, Willey Publication. ISBN: 9788126518371.
2	Bolton, Mechatronics - A Multidisciplinary approach, 4th Edition, Prentice Hall. ISBN 13: 9780132407632.
3	Smaili.A and Mrad.F , "Mechatronics integrated technologies for intelligent machines", Oxford university press, 2008.
4	Nitaigour Premchand Mahalik, Mechatronics - Principles, Concepts and Applications, Tata McGraw Hill, 1st Edition, 2003 ISBN No. 0071239243, 9780071239240.

Reference Books: ***(As per IEEE format)***

1	Alciatore & Histand, Introduction to Mechatronics and Measurement system, 4th Edition, McGraw Hill publication, 2011. ISBN-10: 0073380237.
2	Bishop (Editor), Mechatronics – An Introduction, CRC Press, 2006. ISBN 13: 9780849363580.
3	Mahalik, Mechatronics – Principles, concepts and applications, Tata Mc-Graw Hill publication, New Delhi.ISBN 13: 9780070483743.
4	C. D. Johnson, Process Control Instrumentation Technology, Prentice Hall, New Delhi. ISBN-13: 978-0134413051. 5. Rajput. R.K, A textbook of mechatronics, S. Chand & Co, 2007.

List of Practical's:

1. Demonstration of CNC Machine

2. Formulation of Feedback control & Feed-forward control system using MATLAB Simulink.

3. Simulation of Response of second order system to various types of inputs.

4.Application of Arduino kit for Interfacing of Sensor

5. Demonstration of Hydraulic /Pneumatic Circuit

6. Study of P, PI,PD, PID Controller

7. PLC Ladder diagram for practical applications

8. Demonstration of signal processing System

9. PlC Based Bottle filling plant

10. Demonstration of Industrial robot

List of Project areas: (Contents beyond syllabus)

1. Artificial Intelligence (AI) in Mechatronics.
2. Machine Learning applications in automation
3. Internet of Things (IoT) for smart systems.
4. Cyber-Physical Systems (CPS)
5. Smart manufacturing and smart factories
6. Industrial robotic arm programming
7. Real-time embedded control systems
8. SolidWorks Motion Analysis
9. MATLAB/Simulink-based controller design
10. Energy-efficient automation systems

CO – PO / PSO Articulation Matrix

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	Program Outcome (PO)											PSO		
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PS O1	PS O2	PS O3
CO1														
3											3	1		
3	3	2	1	1							3	1		

CO	Program Outcome (PO)											PSO		
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PS O1	PS O2	PS O3
3	2	2	1	1							3	1		
3	3	2									3	1		
3		2	1	1							3	1		
3											3	1		
3	2.5	2	1	1										

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1			✓	✓				✓	
CO2		✓		✓	✓	✓			
CO3		✓		✓		✓		✓	
CO4		✓		✓		✓			
CO5				✓		✓		✓	
CO6				✓	✓	✓		✓	

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓						
CO2	✓		✓				
CO3	✓		✓				
CO4	✓	✓	✓				
CO5	✓	✓	✓				
CO6	✓		✓				✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓				
CO2	✓		✓		

CO	EA1	EA2	EA3	EA4	EA5
CO3	✓		✓		
CO4	✓		✓		
CO5	✓		✓		
CO6	✓		✓	✓	✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	4, 9	Builds the analytical foundation (SDG 4) that drives data-led innovation (SDG 9).
CO2	9	Supervised models power industrial and predictive applications (SDG 9).
CO3	3, 9	Statistical learning supports health diagnostics (SDG 3) and broader innovation (SDG 9).
CO4	8, 9	Classifiers enable fraud detection and economic applications (SDG 8, 9).
CO5	9	Decision-tree and ensemble models support data-driven industry solutions (SDG 9).
CO6	9, 11	Clustering / RL enable smart-city and resource applications (SDG 9, 11).

FF No.: 654-A

MM1501B: Advanced Manufacturing

Teaching Scheme	**Examination Scheme**
Credits : 3	ESE (W): 40 Marks
Lectures : 2 Hrs/week	GD/PPT: 20 Marks
Practical : - Hrs/week	HA: 10 Marks
Tutorial : 1 Hr/week	CP : 30 Marks

Prerequisites:	
•	Manufacturing Processes, Engineering Materials
Course Objectives:	Students will be able to-
•	Demonstrate working principles, process parameters and applications of advanced manufacturing processes
•	Select the most suitable manufacturing process for a given product and optimize process parameters to achieve desired performance characteristics
•	Understand the machine configurations, tooling systems, and material removal mechanisms involved in advanced micro- and nano-fabrication processes
•	Explore current research trends and sustainability aspects in advanced manufacturing processes.
Course Outcomes:	
	After completion of the course, student will be able to
1.	Explain the principle and industrial significance of advanced machining processes used in aerospace, automotive, and defense sectors.
2.	Explain the principle and industrial significance of advanced metal forming processes used in precision manufacturing sectors.
3.	Analyze the principle and industrial significance of advanced welding processes used in high-performance engineering applications.
4.	Compare and select suitable advanced finishing processes based on material properties, geometry, and precision requirements.
5.	Evaluate process parameters affecting accuracy, surface integrity, material behavior, and productivity in micro/nano machining operations.
6.	Analyze different AM technologies and select suitable processes for engineering applications.

Section1	**Topics/Contents**

Unit I: Advanced Machining Processes

Abrasive water-jet machining, Electrochemical discharge Machining, Ultrasonic assisted EDM, Rotary EDM, Wire electric discharge machining (Wire EDM), Electrochemical grinding, Shaped tube electrolytic machining (STEM), laser beam machining (LBM). Electron Beam Machining, EBM Principle and process characteristics

Unit II: Advanced Forming Processes

Principle, process variables, characteristics, advantages, limitations and applications of high energy rate forming, high velocity forming, explosive forming, magnetic pulse forming, electro hydraulic forming, metal spinning, flow forming, stretch forming, incremental sheet metal forming

Unit III: Advanced Welding Processes

Friction stir welding, electron beam welding, laser beam welding, ultrasonic welding, under water welding, weld metallurgy, welding of plastics and composites, Weld defects, Welding automation, Processes required for joining miniature and electronic components

Section2	**Topics/Contents**

Unit IV: Advanced Finishing Processes

Significance of surface finish, Limitations of conventional processes, Need for advanced finishing, Abrasive flow finishing, Magnetic abrasive finishing, Magnetorheological finishing, Magnetorheological abrasive flow finishing, Industrial applications

Unit V: Micro- and Nanomachining Processes

Need of micro and nano machining, machine/setup, process parameters, mechanism of material removal, applications, advances of the diamond turn machining, ultrasonic micromachining, focused ion beam Machining, lithography, photochemical machining

Unit VI: Advanced Additive Manufacturing Processes

Principle, process, advantages and applications of Stereolithography Apparatus (SLA), Fused Deposition Modeling, Selective Laser Sintering, Laser Engineered Net Shaping (LENS), DfAM concepts for optimized component design, defects in AM parts, heat treatment and post-processing techniques

Text Books: ***(As per IEEE format)***

1	Manufacturing Processes for Engineering Materials, S. Kalpakjian and S. R. Schmid, 7th ed. Boston, MA, USA: Pearson, 2021.
2	A. Ghosh and A. K. Mallik, Manufacturing Science. New Delhi, India: East-West Press Pvt. Ltd.
3	Manufacturing Technology, P. N. Rao, Vol. 1, 5th ed. New Delhi, India: McGraw Hill Education, 2018.
4	M. P. Groover, *Fundamentals of Modern Manufacturing: Materials, Processes, and Systems*, 6th ed. Hoboken, NJ, USA: Wiley, 2015.
5	V. K. Jain, Advanced Machining Processes. New Delhi, India: Allied Publishers Pvt. Ltd.
6	S. Bandyopadhyay and S. Bose, Additive Manufacturing, Boca Raton, FL, USA: CRC Press, 2019.

Reference Books: ***(As per IEEE format)***

1	ASM International, ASM Handbook, Volume 6: Welding, Brazing, and Soldering. Materials Park, OH, USA: ASM International.
2	V. K. Jain, Micro Manufacturing Processes. Boca Raton, FL, USA: CRC Press.
3	ASM International, ASM Handbook, Volume 14: Forming and Forging. Materials Park, OH, USA: ASM International.
4	I. Gibson, D. Rosen, and B. Stucker, Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, 2nd ed. New York, NY, USA: Springer, 2015.

List of tutorials (Any five):

- Investigate challenges in forming Titanium alloys, Magnesium alloys, Advanced high-strength steels, and Composite laminates under HERF conditions.
- Prepare manufacturing plan for flow-formed rocket motor casing.
- Compare LBW, EBW, and TIG welding for aerospace titanium alloy joining.
- Discuss: Recast layer, heat affected zone, and micro-crack formation in Wire EDM of hardened steels.
- Develop a strategy for compensating tool wear during cavity machining in Electrical Discharge Machining.
- Critically review one recent journal paper and prepare a report on: Nano machining, MEMS fabrication, Ultra-precision machining, which include Objectives, Methodology, Results, Research gaps and Future scope
- Study industrial applications of AM in: Aerospace, Automotive, Medical, and Construction

List of Project areas: (Contents beyond syllabus)

- Experimental investigation of EDM parameters on mild steel: Optimization of EDM parameters for maximum MRR, Comparative study of copper and graphite electrodes, Surface roughness analysis in EDM, Fabrication of micro-features using EDM, Powder-mixed dielectric experimental study, Electrode wear analysis.
- Comparative study of laser cutting parameters on different materials, Investigation of kerf width and Heat Affected Zone (HAZ), Experimental analysis of laser engraving quality, Surface morphology after laser machining, Laser marking optimization, Laser welding quality assessment.
- Optimization of FDM printing parameters, Mechanical characterization of 3D printed PLA components. Comparison of infill patterns on mechanical properties.
- Propose machine learning-based adaptive control for Wire EDM, AWJM, and AFF using sensor feedback.
- Design a process chain for manufacturing a MEMS pressure sensor.
- Develop a hybrid nano-fabrication strategy for biomedical implants.

- Propose AI-driven adaptive control for micro machining systems.

Students may prepare a comprehensive review paper (20–30 pages) on any one of the following:

- Recent Advances in Electrical Discharge Machining.
- Sustainable EDM Technologies.
- Artificial Intelligence Applications in EDM.
- Hybrid EDM Processes.
- Recent Developments in Laser Beam Machining.
- Laser Processing of Aerospace Materials.
- Additive Manufacturing: Current Trends and Future Directions.
- Process Optimization Techniques in Advanced Manufacturing.
- AI-driven weld quality monitoring system.
- A review on functionally graded composite fabrication via stir casting.

For MOOCs and other learning Resources

11. Fundamentals of Additive Manufacturing Technologies (IIT Guwahati)
https://nptel.ac.in/courses/112103306

12. Advanced Manufacturing and Process Modelling (IISc/IIT system)
https://nptel.ac.in/courses/113108631

13. Advanced Machining Processes (IIT Kanpur / IIT Roorkee)
https://nptel.ac.in/courses/112104425

CO – PO / PSO Articulation Matrix

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	Program Outcome (PO)											PSO		
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PS O1	PS O2	PS O3
CO1														
3	3	2	3	2	1	1	1	1	1	2	3	3	2	
3	3	2	2	1	1	1	1	1	1	2	3	3	2	
3	3	2	3	2	1	1	1	1	1	2	3	3	2	
3	3	3	3	3	1	1	1	1	2	2	3	2	3	
3	3	2	3	3	1	1	1	1	1	3	2	3	3	
3	3	3	3	3	1	1	1	1	2	3	3	3	3	

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1			✓	✓		✓			
CO2			✓	✓		✓			
CO3			✓	✓	✓	✓			
CO4			✓	✓	✓	✓	✓		
CO5			✓	✓	✓	✓	✓	✓	
CO6			✓	✓		✓	✓	✓	

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓		✓				
CO2	✓						
CO3	✓	✓	✓				
CO4	✓	✓	✓				
CO5	✓	✓	✓				✓
CO6	✓	✓	✓			✓	✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1		✓		✓	
CO2		✓		✓	
CO3		✓	✓	✓	
CO4		✓	✓	✓	
CO5	✓	✓	✓	✓	✓
CO6	✓	✓	✓	✓	✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	9, 12	The course directly addresses advanced manufacturing

CO	SDG(s) Addressed	Justification / Linkage
		processes (SDG 9) to promote material efficiency, near-net-shape production, reduced waste, resource optimization, and improved process efficiency (SDG 12).
CO2	9, 12	The course directly addresses advanced manufacturing processes (SDG 9) to promote material efficiency, near-net-shape production, reduced waste, resource optimization, and improved process efficiency (SDG 12).
CO3	9, 12	The course directly addresses advanced manufacturing processes (SDG 9) to promote material efficiency, near-net-shape production, reduced waste, resource optimization, and improved process efficiency (SDG 12).
CO4	9, 12, 13	The course directly addresses advanced manufacturing processes (SDG 9) to promote material efficiency, near-net-shape production, reduced waste, resource optimization, and improved process efficiency (SDG 12) considering energy consumption and environmentally friendly manufacturing (SDG 13).
CO5	9, 12, 13	The course directly addresses advanced manufacturing processes (SDG 9) to promote material efficiency, near-net-shape production, reduced waste, resource optimization, and improved process efficiency (SDG 12) considering energy consumption and environmentally friendly manufacturing (SDG 13).
CO6	9, 12, 13	The course directly addresses advanced manufacturing processes (SDG 9) to promote material efficiency, near-net-shape production, reduced waste, resource optimization, and improved process efficiency (SDG 12) considering energy consumption and environmentally friendly manufacturing (SDG 13).

Syllabus Template **FF No.: 654-A**

ME1501C: IC Engine and Alternative fuels

Teaching Scheme	**Examination Scheme**
Credits : 3	ESE (W): 40 Marks
Lectures : 2 Hrs/week	GD/PPT: 20 Marks
Practical :	HA: 10 Marks
Tutorial :1 Hrs/week	CP : 30 Marks

Prerequisites:	
•	Students should have a basic understanding of Basic mechanical Engineering Thermodynamics, Fluid Engineering, Engineering Graphics, and Machine Drawing
Course Objectives:	The student will be able to understand
•	SI Engine combustion steps
•	CI Engine combustion steps
•	Various Engine emissions and its controls
•	Various Engine characteristics
•	Various liquid bio fuels
•	Various gaseous fuels
Course Outcomes:	
	After completion of the course, student will be able to
1.	Demonstrate the SI engine combustion steps and different combustion chambers used
2.	Demonstrate the CI engine combustion steps and different combustion chambers used

3.	Demonstrate various engine emissions, their formation mechanisms and parameters affecting these emissions, engine emission control techniques and various after treatment systems
4.	Analyze various performance, combustion and emission characteristics
5.	Compare various liquid alternative biofuels used for engines
6.	Compare various gaseous alternative fuels used for engines

Section1:	**Topics/Contents**

Unit 1: Combustion in SI engines (5 Hours)

Basics of SI Engine and its systems, Mixture formation, Ignition limits, SI engine Combustion stages and flame propagation, Rate of pressure rise and phases of combustion, Effect of operating variables on: process of combustion, flame propagation, ignition lag, Auto ignition and chemical reaction, Detonation: phenomenon, knocking, effect of engine variables on detonation, SI Engine Combustion chamber and its types.

Unit 2: Combustion in CI Engine (5 Hours)

Basics of CI Engine and its systems, Direct and indirect combustion chamber, Importance of air motion swirl, squish and turbulence-swirl ratio, Fuel air mixing, Stages of combustion, Delay period and operating variables affecting delay period, Detonation: phenomenon, knocking, effect of engine variables, Factors governing combustion, Combustion chamber design

Unit 3: Engine Emissionsand its control (5 Hours)

Carbon Monoxide (CO) Formation mechanism. Unburned Hydrocarbons (HC) Sources and formation HC emission control methods. Nitrogen Oxides (NOx) Formation of NO and NO_2 Factors influencing, NOx formation, Particulate Matter (PM), Soot formation in diesel engines, Particle size distribution,

Engine-Based Emission Control Techniques: Optimization of combustion process, Electronic Fuel Injection (EFI), Common Rail Direct Injection (CRDI), Exhaust Gas Recirculation (EGR), Variable Valve Timing (VVT), Lean-burn combustion, Engine calibration and electronic engine management systems

Exhaust Gas After-Treatment Systems: *Need for after-treatment technologies, Principles and operation of Oxidation Catalyst (DOC), Three-Way Catalytic Converter (TWC), Lean NOx Trap (LNT), Selective Catalytic Reduction (SCR), Diesel Particulate Filter (DPF), Gasoline Particulate Filter (GPF), Catalyst materials and their functions*

Section2:	**Topics/Contents**

Unit 4: Engine Performance, combustion and emission Characteristics (5 Hours)
Various performance parameters for IC Engine - Indicated power, brake power, friction power, SFC, A/F ratio etc. Methods to determine various performance parameters, characteristic curves, Heat balance sheet. Engine testing and calculations, P-θ diagram and heat release diagrams, variation of emissions with speed and load etc.

Unit 5: Liquid alternative fuels for Engine (5 Hours)
Properties of Liquid Alternative Fuels: Physical and chemical properties, Calorific value, Density and viscosity, Flash point and fire point, Cetane number and octane number, Volatility characteristics

Alcohol-Based Fuels: Methanol and ethanol Fuel properties and combustion characteristics, Blending with gasoline (E10, E20, E85), Advantages and limitations, Engine modifications and performance analysis, Emission characteristics

Biodiesel: Feedstocks for biodiesel production: Vegetable oils, Waste cooking oils, Animal fats,Algal oils,Biodiesel production by transesterification, Biodiesel blends (B5, B20, B100),Fuel properties and standards Performance, combustion, and emission characteristics, Advantages and challenges, Isobutanol blended diesel

Unit 6: Gaseous alternative fuels for Engine (5 Hours)
Classification of gaseous fuels: Natural Gas, Compressed Natural Gas (CNG), Liquefied Natural Gas (LNG), Liquefied Petroleum Gas (LPG), Hydrogen, Biogas. Performance testing for the SI/CI Engine

Textbooks: ***(As per IEEE format)***

1	Internal Combustion Engines Authors: V. Ganesan Publisher: McGraw-Hill Education India
2	Internal Combustion Engine Fundamentals by Author: John B. Heywood Publisher: McGraw-Hill Edition: 2nd Edition (2021)
3	Combustion and Emissions in SI and CI Engines Author: B.P. Pundir Publisher: Narosa Publishing
4	**Alternative Fuels Guidebook** Author: Richard L. Bechtold

Reference Books: ***(As per IEEE format)***

1	Emissions from Combustion Engines and Their Control Author: Donald L. Wise Publisher: CRC Press

2	Engine Emissions: Pollutant Formation and Advances in Control Technology Author: B. B. Kuo Publisher: CRC Press ISBN: 9780367431587
3	Combustion Engines Development: Mixture Formation, Combustion, Emissions and Simulation Editor: Helmut Eichlseder, Jörg Seume Publisher: Springer
4	Alternative Fuels and Advanced Vehicle Technologies for Improved Environmental Performance by Richard Folkson

List of Tutorials

Combustion Analysis

Abnormal Combustion

Combustion chambers design and development

Emission Measurement Techniques

Emission Control Techniques

After-Treatment Systems

Green hydrogen

Hydrogen storage

Fuel cell

Combustion analysis using cylinder pressure data.

Emission measurement using 5-gas analyzer.

EGR effect on engine performance and emissions.

Smoke measurement in diesel engines.

Performance and emission testing with biodiesel blends.

Catalytic converter efficiency evaluation.

List of Project areas:

Combustion Analysis Projects

Investigation of combustion characteristics of SI engines using ethanol-gasoline blends.

Effect of ignition timing on engine performance and emissions.

Combustion analysis using in-cylinder pressure measurement.

Study of knock characteristics in spark ignition engines.

Optimization of diesel combustion through fuel injection timing.

Alternative Fuel Combustion

Performance and emission analysis of biodiesel-diesel blends.

Combustion and emission characteristics of CNG-fueled engines.

Hydrogen enrichment in SI engines.

Waste cooking oil biodiesel production and engine testing.

Comparative study of ethanol, methanol, and gasoline fuels.

Engine Emission Reduction

Experimental investigation of Exhaust Gas Recirculation (EGR) on NOx reduction.

Optimization of air-fuel ratio for minimum emissions.

Study of water injection techniques for NOx control.

Effect of nano-additives on diesel engine emissions.

Low-temperature combustion strategies for diesel engines.

After-Treatment Systems

Design and testing of a low-cost diesel particulate filter (DPF).

Performance evaluation of Selective Catalytic Reduction (SCR) systems.

Catalytic converter efficiency analysis under varying operating conditions.

Regeneration techniques for diesel particulate filters.

Development of emission monitoring systems for after-treatment devices.

Computational and Simulation Projects

CFD analysis of combustion chamber geometry.

Simulation of spray combustion in diesel engines.

Modeling NOx formation using CFD tools.

Engine combustion simulation using GT-Power or AVL BOOST.

AI-based prediction of engine emissions.

Hybrid and Advanced Combustion Technologies

Homogeneous Charge Compression Ignition (HCCI) engine studies.

Reactivity Controlled Compression Ignition (RCCI) combustion analysis.

Premixed Charge Compression Ignition (PCCI) investigation.

Hybrid engine emission assessment.

Hydrogen-assisted advanced combustion systems.

Real-Time Emission Monitoring

IoT-based vehicle emission monitoring system.

Portable exhaust gas analyzer development.

Remote sensing of vehicle emissions.

On-board emission diagnostics using machine learning.

Predictive maintenance based on emission trends.

Industry-Oriented Projects

Bharat Stage VI emission compliance analysis.

Cold-start emission reduction techniques.

Real Driving Emissions (RDE) measurement and analysis.

Effect of fuel quality on engine emissions.

Lifecycle assessment of alternative fuels.

CO-PO Mapping

CO	Program Outcomes (PO)												PSO		
CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	1	0	0	0	0	0	0	1	1	0	1	1	2	1
CO2	1	0	0	0	0	0	0	0	1	1	0	1	1	2	1
CO3	1	0	0	0	0	1	0	0	1	1	0	1	1	2	2
CO4	3	0	3	3	1	1	1	0	1	1	0	1	1	3	1
CO5	2	0	2	0	2	1	1	1	1	1	1	1	1	3	2
CO6	2	0	2	1	2	1	1	1	1	1	1	1	1	3	2
Average	2	0	2	1	1	1	0	0	1	1	1	1	1	3	2

CO – PO / PSO Articulation Matrix

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	Program Outcome (PO)											PSO		
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO1	PSO2	PSO3
CO1														
3	1	0	0	0	0	0	0	1	1	0	1	1	2	1
1	0	0	0	0	0	0	0	1	1	0	1	1	2	1
1	0	0	0	0	1	0	0	1	1	0	1	1	2	2
3	0	3	3	1	1	1	0	1	1	0	1	1	3	1
2	0	2	0	2	1	1	1	1	1	1	1	1	3	2
2	0	2	1	2	1	1	1	1	1	1	1	1	3	2
2	0	2	1	1	1	0	0	1	1	1	1	1	3	2

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1			✓	✓				✓	
CO2		✓		✓	✓	✓			
CO3		✓		✓		✓		✓	
CO4		✓		✓		✓			
CO5				✓		✓		✓	
CO6				✓	✓	✓		✓	

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓						
CO2	✓		✓				
CO3	✓		✓				
CO4	✓	✓	✓				
CO5	✓	✓	✓				
CO6	✓		✓				✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓				
CO2	✓		✓		
CO3	✓		✓		
CO4	✓		✓		
CO5	✓		✓		
CO6	✓		✓	✓	✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	4, 9	Builds the analytical foundation (SDG 4) that drives data-led innovation (SDG 9).
CO2	9	Supervised models power industrial and predictive

CO	SDG(s) Addressed	Justification / Linkage
		applications (SDG 9).
CO3	3, 9	Statistical learning supports health diagnostics (SDG 3) and broader innovation (SDG 9).
CO4	8, 9	Classifiers enable fraud detection and economic applications (SDG 8, 9).
CO5	9	Decision-tree and ensemble models support data-driven industry solutions (SDG 9).
CO6	9, 11	Clustering / RL enable smart-city and resource applications (SDG 9, 11).

FFNo.:_654

MM: Product Life cycle Management (PLM) Team center Development

Teaching Scheme	**Examination Scheme**
Credits:	CVV: 20 Marks
Lectures:2Hrs/week	GD/PPT: 20 Marks
Practical:-2Hrs/week	HA: 20 Marks
Tutorial:1Hr/week	CP : 40 Marks

Prerequisites:	
	Fundamentals of Object-Oriented Programming(C++/Java)
Course Objectives:	
	To introduce Product Lifecycle Management(PLM) concepts and their industrial applications.
	To develop proficiency in using Siemens Team center for product data and process management.
	To understand Team center architecture, administration, and business data modelling.
	To develop Team center customization skills using ITK, SOA, Java, and ActiveWorkspace
	To prepare students for real-world PLM implementation and enterprise customizationprojects.
Course Outcomes:	
	After completion of the course, student will be able to
CO1	Explain Product Lifecycle Management concepts and efficiently use Team center for product data and work flow management.

CO2	Configure and administer Team center by implementing business objects, Access management, workflows, and data models.
CO3	Develop and customize Team center server-side solutions using ITK, User Exits,WorkflowHandlers,andSOAservices.
CO4	DesignanddevelopTeamcenterclient-sidecustomizationsusingJava,XML, Team center Services, and Active Workspace.

Unit 1:	**PLM Concepts and Team center Functional**
Introduction to Product Lifecycle Management (PLM), including digital product development, product data management, engineering change management, and business benefits. Fundamentals of Siemens Teamcenter, including architecture, Active Workspace, object types, item and revision management, dataset management, search, and query operations. Product Structure Management covering Product Structure, Bill of Materials (BOM), assembly structures, revision rules, and configuration. Workflow and Change Management, including workflow concepts, templates, change objects, approval processes, and release management. Project and Classification Management, including project organization, security, classification, and data organization.	
Unit 2:	**Team center Architecture and Installation**
Teamcenter architecture, server and database installation, license and corporate server configuration, BMIDE deployment, web tier setup, Teamcenter directories, performance tuning, backup and recovery, and system troubleshooting. Active Workspace (AWC) Installation and Configuration, covering microservices, server and client extensions, Active Workspace deployment, indexing and SOLR configuration, patching and upgrades, and Teamcenter integration with NX for enterprise PLM environments.	
Unit 3:	**Business Modeler IDE (BMIDE)**

Business Data Modeling using BMIDE, including business objects, classes, properties, templates, project management, deployment, UML modeling, and data model reporting. Configuration of Active Workspace (AWC) through custom objects, properties, constants, List of Values (LOVs), ID generation, and search filters. Creation and management of form types, item types, dataset types, product structure types, and status types. Business modeling concepts, including naming rules, deep copy rules, action and extension rules, GRM rules, condition engine, condition definitions, and business object customization for enterprise PLM applications.

Unit 4:	**Application Administration**
Teamcenter Application Data Modeling, including organization management, users, groups, roles, license management, and volume administration. Query and Report Management, covering query creation, report generation, revision rules, and data retrieval. Access and Project Management, including Access Manager, rule-based security, project creation, access control, and project administration. Workflow and Change Management, including workflow process modeling, workflow templates, task management, Workflow Designer, and change management. Classification Administration, covering classification hierarchy, classes, views, key-LOVs, attribute dictionaries, and classification data management.	

Unit 5:	**Team center Server Development**
Teamcenter Server Customization using the Integration Toolkit (ITK), including Teamcenter architecture, ITK APIs, environment setup, data model integration, error handling, debugging, memory management, and standalone application development. Customization techniques covering user exits, message methods, custom exits, property methods, workflow customization, and user services. SOA-based customization, including SOA framework, service development, API utilization, and integration of custom server-side functionalities for enterprise PLM applications.	
Unit 6:	**Team center Client Development**

Teamcenter Client Development,includingXMLstylesheetcustomization,Java-basedUIformdevelopment,KernelAPIs,TeamcenterServicesframework,sessionmanagement,fileoperations,servicecreation,andservicecustomization.ActiveWorkspace(AWC)Customization,declarativeframework,developmentenvironment,commandandpanelcustomization,customdataproviders,SOAintegration,anddeploymentofclient-sideextensions.

Text Books:

1	Sven Herbst and Alexander Hoffmann, Product Lifecycle Management (PLM) mit Siemens Team center.
2	Michael Grieves, *Product Lifecycle Management: Driving the Next Generation of Lean Thinking*, McGraw-Hill.
3	John Stark, Product Lifecycle Management (Volume 1): 21st Century Paradigm for Product Realisation, Springer.
4	Siemens Digital Industries Software, *Teamcenter Administration Guide*.
5	Siemens Digital Industries Software, Teamcenter Active Workspace User Guide.

Reference Books: (As per IEEE format)
J. Stark, Product Lifecycle Management: Volume 2, Springer.
M. Grieves, Product Lifecycle Management, McGraw-Hill.
Siemens Digital Industries Software, Teamcenter ITK Programmer's Guide.
Siemens Digital Industries Software, Teamcenter Services Guide.
Siemens Digital Industries Software, Active Workspace Configuration Guide.

List of Tutorial's:

Introduction to PLM and Teamcenter Environment

Product Structure and BOM Management

Workflow Creation and Change Management

Teamcenter Search, Query and Reports

Teamcenter Installation Overview

BMIDE Data Model Configuration

User, Group and Role Administration

Access Manager and Workflow Configuration

ITK Programming Fundamentals

Workflow Handler Development

SOA Service Development

Active Workspace Customization XML Rendering Style Sheet

C **CO – PO / PSO Articulation Matrix**

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	**Program Outcome (PO)**											**PSO**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PS O1**	**PS O2**	**PS O3**
CO 1	2	1	1	2	1	1	0	1	2	1	2	1	1	2
CO 2	2	1	2	1	1	1	1	2	1	2	2	1	1	1
CO 3	1	2	2	1	2	1	1	1	1	1	1	1	1	1
CO 4	2	1	1	2	1	1	0	1	2	1	2	1	1	2
CO 5	1	1	1	1	1	1	1	1	1	2	2	1	1	1
CO 6	1	1	1	0	1	1	0	0	1	1	1	1	1	0
Avg														

CO – WK Mapping (Knowledge & Attitude Profiles) Sample Table

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1			✓	✓				✓	
CO2		✓		✓	✓	✓			
CO3		✓		✓		✓		✓	
CO4		✓		✓		✓			
CO5				✓		✓		✓	
CO6				✓	✓	✓		✓	

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓						
CO2	✓		✓				
CO3	✓		✓				
CO4	✓	✓	✓				
CO5	✓	✓	✓				
CO6	✓		✓				✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓				
CO2	✓		✓		
CO3	✓		✓		
CO4	✓		✓		
CO5	✓		✓		
CO6	✓		✓	✓	✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	4, 9	Builds the analytical foundation (SDG 4) that drives data-led innovation (SDG 9).

CO	SDG(s) Addressed	Justification / Linkage
CO2	9	Supervised models power industrial and predictive applications (SDG 9).
CO3	3, 9	Statistical learning supports health diagnostics (SDG 3) and broader innovation (SDG 9).
CO4	8, 9	Classifiers enable fraud detection and economic applications (SDG 8, 9).
CO5	9	Decision-tree and ensemble models support data-driven industry solutions (SDG 9).
CO6	9, 11	Clustering / RL enable smart-city and resource applications (SDG 9, 11).

Syllabus Template **FF No.: 654-A**

ME3211: Hybrid and Electric vehicles

Teaching Scheme	**Examination Scheme**
Credits : 3	CVV: 20 Marks
Lectures : 2 Hrs/week	GD/PPT: 20 Marks
Practical :2Hrs/week	HA: 20 Marks
Tutorial :	CP : 40 Marks

Prerequisites:	
•	Students should have a basic understanding of Basic mechanical Engineering Thermodynamics, Fluid Engineering Materials, Engineering Graphics, and Machine Drawing
Course Objectives:	The student will be able to
•	To do mathematical analysis of engine cycles for air standard, fuel-air and real conditions.
•	To gain knowledge of Engine systems and modern trends
•	To demonstrate and analyse electric vehicle and hybrid electric vehicle configurations.
•	To do experimentation for Engine performance and its mathematical analysis.
•	To gain knowledge about energy storage systems of the Electric and Hybrid Electric Vehicles
•	To gain knowledge about electric propulsion systems and motors
Course Outcomes:	
	After completion of the course, student will be able to
1.	Do analysis of engine cycles for air standard, fuel-air and real conditions.

2.	Demonstrate and compare engine systems and modern trends in the engines.
3.	Demonstrate and analyze vehicle dynamics and architectures of Hybrid And Electric vehicles
4.	Do analysis of engine performance parameters.
5.	Demonstrate and analyze Energy storage systems of Hybrid and Electric vehicles
6.	Demonstrate and analyze electric propulsion systems and motors

Section1:	**Topics/Contents**

Unit 1: Hybrid Electric Vehicles Engine Fundamentals :(7 hours)

Engine components, Basic engine nomenclature, Engine classification, working of four

stroke and two stroke engines.Air standard cycles, Fuel air cycles and Actual cycles of the Engine

Unit 2: Engine Systems and latest trends: (6 hours)

Fuel Supply Systems for S. I. Engines, Fuel Supply Systems for C. I. Engines, Lubrication system, Cooling systems, Ignition systems, Exhaust systems, latest trends in engine systems

Unit 3: Vehicle dynamics, EV and HEV power train analysis (8 hours)

Conventional Vehicles fundamentals, Vehicle dynamics, Configurations of Electric Vehicles, Performance of Electric Vehicles, Traction Motor Characteristics and comparison with engines performance characteristics, Tractive Effort and Transmission Requirement, Vehicle Performance, Tractive Effort in Normal Driving and Energy consumption.

Concept of Hybrid Electric Drive Trains, Architectures of Hybrid Electric Drive Trains,

Series Hybrid Electric Drive Trains, Parallel Hybrid Electric Drive Trains, Torque-

Coupling Parallel Hybrid Electric Drive Trains, Speed-Coupling Parallel Hybrid

Electric

Drive Trains, Torque-Coupling and Speed-Coupling Parallel Hybrid Electric Drive Trains

Section2:	**Topics/Contents**

Unit 4: Performance of I. C. Engine (9 hours)

Determination of fuel consumption, air consumption, air-fuel ratio, Determination of brake power, indicated power, friction power. Determination of thermal efficiency, mechanical efficiency, volumetric efficiency, Determination of mean effective pressure, Energy Balance, Performance Characteristics

Supercharging: Objectives of supercharging, Supercharging of S.I. Engines and C.I. Engines and its limitations, effects of supercharging on performance of engine. Turbo charging- Methods, Limitations.

Unit 5: Hybrid Electric Vehicles batteries and Battery Packs (6 hours)

Battery specifications like specific energy, specific power, SOC, SOH, DOD, C rating Lithium-ion battery working, Lithium-ion battery types,

Battery Pack, Battery pack design, cell arrangements and cell balancing, BMS and Battery Thermal Management

Unit 6: Hybrid and Electric vehicles Motors (6 hours)

Motors used for EVs and HEVS. Motor basics, Speed-torque characteristics

PMSM motors: PMSM architecture, reluctance torque, total torque, Phase advance angle and MTPA, BEMF and high speed of the PMSM motors, flux weakening, motor controller basics and logic

Text Books: ***(As per IEEE format)***

1	V. Ganesan, “Internal Combustion Engines”, Tata McGraw-Hill Publishing Company Ltd

2	M. L. Mathur and R. P. Sharma, "A Course in Internal Combustion Engines", Dhanpat Rai and Co. Pvt. Ltd.
3	"Electric and Hybrid Vehicles Design Fundamentals" (2nd Edition), by Iqbal Husain
Reference Books: ***(As per IEEE format)***	
1	Srinivasan, "Automotive Engines", Tata McGraw-Hill Publishing Company Ltd.
2	Modern Electric, Hybrid Electric and Fuel Cell Vehicles Fundamentals, Theory and Design By Mehrdad Ehsani, Yimin Gao and Ali Emadi
3	Hybrid Electrical Vehicle Principles and Application with Practical Perspectives by Chris MI, M. Abul and David WenzhongGao
4	Propulsion System for Hybrid Vehicle 2nd Edition by John M. Miller

List of Practical's:

- Study and Demonstration of conventional diesel fuel injection system Distributor type injection system and common rail diesel injection system.
- Study and demonstration of Carburetors, GDI and MPFI systems.
- Trial on motor for torque and power performance.
- Trial on diesel engine to determine variable load performance and energy balance.
- Trial on multi-cylinder petrol/CNG engine – Morse Test.
- Variable speed trial on petrol engine.
- Variable speed trial on CNG engine.
- Trial on variable compression ratio engine.
- Trial on diesel/petrol engine to plot Pressure-Crank angle diagram.
- Trial on exhaust gas analyser and smoke meter for emission analysis at variable load.
- Trial on cell testing machine to plot the cell characteristics
- Study and Demonstration of the Electric Car/ Electric two-wheeler/Electric Bus

- Industry visit

List of Project areas: (Contents beyond syllabus)

1. Gasoline Engine simulation, optimization, and realization
2. Diesel Engine simulation, optimization, and realization
3. CNG Engine simulation, optimization, and realization
4. Engine after treatment systems
5. Alternative fuels for Engines
6. Brushless DC Motor simulation using Simulink or Ansys Maxwell
7. Induction Motor simulation using Simulink or Ansys Maxwell
8. SRM Motor simulation using Simulink or Ansys Maxwell
9. PMSM Motor simulation using Simulink or Ansys Maxwell
10. Engine testing performance and comparison
11. Motor testing performance and its comparison
12. Battery testing
13. BMS and BTMS
14. Prototype building of electric two-wheeler, three-wheeler, and four-wheeler
15. EV simulation with MATLAB Simulink and Simspace

CO – PO / PSO Articulation Matrix

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	Program Outcome (PO)											PSO		
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PS O1	PS O2	PS O3
CO1														
3	1	0	0	0	0	0	0	1	1	0	1	1	3	0
1	0	0	0	0	0	0	0	1	1	0	1	1	3	1
1	0	0	0	0	0	0	0	1	1	0	1	1	3	2
3	0	3	3	1	0	0	0	1	1	0	1	1	3	1
2	0	2	0	2	0	0	0	1	1	1	1	1	3	2
2	0	2	1	2	0	0	0	1	1	1	1	1	3	2
2	0	2	1	1	0	0	0	1	1	1	1	1	3	2

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1			✓	✓				✓	
CO2		✓		✓	✓	✓			
CO3		✓		✓		✓		✓	
CO4		✓		✓		✓			
CO5				✓		✓		✓	
CO6				✓	✓	✓		✓	

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓						
CO2	✓		✓				
CO3	✓		✓				
CO4	✓	✓	✓				
CO5	✓	✓	✓				
CO6	✓		✓				✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓				
CO2	✓		✓		
CO3	✓		✓		
CO4	✓		✓		
CO5	✓		✓		
CO6	✓		✓	✓	✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	4, 9	Builds the analytical foundation (SDG 4) that drives data-led innovation (SDG 9).
CO2	9	Supervised models power industrial and predictive

CO	SDG(s) Addressed	Justification / Linkage
		applications (SDG 9).
CO3	3, 9	Statistical learning supports health diagnostics (SDG 3) and broader innovation (SDG 9).
CO4	8, 9	Classifiers enable fraud detection and economic applications (SDG 8, 9).
CO5	9	Decision-tree and ensemble models support data-driven industry solutions (SDG 9).
CO6	9, 11	Clustering / RL enable smart-city and resource applications (SDG 9, 11).

Syllabus Template **FF No.: 654-A**

ME3211: HYDRAULIC MACHINES AND FLUID POWER

Teaching Scheme	**Examination Scheme**
Credits: 3	CVV: 20 Marks
Lectures: 2 Hrs/week	GD/PPT: 20 Marks
Practical: 2Hrs/week	HA: 20 Marks
Tutorial:	CP: 40 Marks

Prerequisites:	
•	Fluids Engineering/Fluid Mechanics
Course Objectives:	The student will be able to
•	Understand the application of impulse momentum principle
•	Understand the working of hydraulic turbines
•	Understand the working of hydraulic pump
•	Understand the application of Pascal Law
•	Understand the hydraulic systems
•	Design and analyze the fluid power systems
Course Outcomes:	
	After completion of the course, student will be able to
1.	Understand the principle, operation and design of impulse turbine.
2.	Understand the principle, operation and design of reaction turbines.
3.	Understand the principle, operation and design of centrifugal pump.
4.	Understand the functions of fluid power components.
5.	Understand the functions of hydraulic pumps and control valves.
6.	Analyze industrial fluid power systems and circuits

Section1:	**Topics/Contents**

Unit 1 Impulse Turbine
Introduction, Pelton turbine, Work done and Efficiencies of Pelton Turbines, Velocity Triangles and their analysis, Governing, Main and Operating Characteristics, Governing Mechanisms, Unit Quantities.

Unit 2 Reaction Turbine
Introduction, Francis turbine, Work done and Efficiencies of Reaction Turbines, Velocity Triangles and their analysis, Kaplan Turbine, Governing, Main and Operating Characteristics, Governing Mechanisms, Draft Tube.

Unit 3 Centrifugal Pump
Introduction, Classification, construction, working, various heads, velocity triangle, losses and efficiencies, specific speed, net positive suction head (NPSH), Main and Operating Characteristics, Pumps in series and parallel, Priming.

Section2:	**Topics/Contents**

Unit 4 Introduction to Fluid Power
Introduction, Source of Power and Fluid Power Control, Fluid Power Systems, advantages, Applications, Principle of working, Reservoir assembly, Filters, Accumulators.

Unit 5 Hydraulic Pumps and Control Valves
Introduction ,Construction of Gear Pumps, Vane Pumps, Necessity of Fluid control, Pressure Control Valves, Flow Control Valves, and Direction Control Valves, Symbols for hydraulic systems and pneumatic systems.

Unit 6 Hydraulic Actuators and Hydraulic Circuits
Industrial Circuits and Systems, Actuators types, Types of Cylinders,
hydraulic Circuits (Regeneration, Speed Control, Sequencing, Synchronizing, fail safe, pump unloading, actuator locking circuit).

Text Books: ***(As per IEEE format)***

1	R.K.Rajput, "Hydraulic Machines", S.Chand Publications, New Delhi
2	Esposito A., "Fluid Power with application", Prentice Hall

Reference Books: ***(As per IEEE format)***

1	Modi and Seth, "Hydraulics, Fluid Mechanics and Machinery", Standard Book House, NewDelhi
2	Vasandani V. P., "Theory of Hydraulic Machinery", Khanna Publishers, Delhi
3	Vickers Manual on Industrial Hydraulics
4	Lal J., "Hydraulic Machines", Metropolitan Book Co., Delhi
5	Karassic, "Hand Book of Pumps", Tata McGraw Hill Ltd. Delhi
6	Majumdar, "Oil Hydraulics-Principle and Maintenance", Tata McGraw Hill
7	Pipenger J. J., "Industrial Hydraulics", McGraw Hill

List of Practical's:

1. Trial on Pelton Turbine
2. Trial on Francis Turbine
3. Trial on Centrifugal Pump
4. Trial on Gear Pump
5. Trial on Vane Pump
6. Demonstration of working of Pressure/Direction/ Flow control valves
7. Demonstration of Compressed air generation and distribution systems
8.Demonstration of shuttle valve/quick exhaust valve/twin pressure valve/pneumatic clamp.
9. Study of hydro power plant.
10.Demonstration of hydraulic components

List of Project areas: (IoT based approach can be studied and applied)

- Design and analysis of Turgo turbine
- Design and analysis of Pelton turbine
- Design and analysis of Francis turbine
- Design and analysis of Kaplan turbine
- Design and analysis of Centrifugal pump
- Design and analysis of accumulators
- Design and analysis of hydraulic pumps
- Design and analysis of hydraulic valves
- Design and analysis of hydraulic actuators
- Design and analysis of hydraulic & Pneumatic circuits

CO – PO / PSO Articulation Matrix

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	**Program Outcome (PO)**											**PSO**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PS O1**	**PS O2**	**PS O3**
CO1	3	2	3	3	2	3	3	1	1	1	1	1	3	1
CO2	3	2	3	3	2	3	3	1	1	1	1	1	3	1
CO3	3	2	3	3	2	3	3	1	1	1	1	1	3	1

CO	Program Outcome (PO)											PSO		
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PS O1	PS O2	PS O3
CO4	3	2	3	3	2	3	3	1	1	1	1	1	3	1
CO5	3	2	3	3	2	3	3	1	1	1	1	1	3	1
CO6	3	2	3	3	2	3	3	1	1	1	1	1	3	1
Avg	3	2	3	3	2	3	3	1	1	1	1	1	3	1

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1			✓	✓				✓	
CO2		✓		✓	✓	✓			
CO3		✓		✓		✓		✓	
CO4		✓		✓		✓			
CO5				✓		✓		✓	
CO6				✓	✓	✓		✓	

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓						
CO2	✓		✓				

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO3	✓		✓				
CO4	✓	✓	✓				
CO5	✓	✓	✓				
CO6	✓		✓				✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓				
CO2	✓		✓		
CO3	✓		✓		
CO4	✓		✓		
CO5	✓		✓		
CO6	✓		✓	✓	✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	**4, 9**	Builds the analytical foundation (SDG 4) that drives data-led innovation (SDG 9).
CO2	**9**	Supervised models power industrial and predictive applications (SDG 9).

CO	SDG(s) Addressed	Justification / Linkage
CO3	**3, 9**	Statistical learning supports health diagnostics (SDG 3) and broader innovation (SDG 9).
CO4	**8, 9**	Classifiers enable fraud detection and economic applications (SDG 8, 9).
CO5	**9**	Decision-tree and ensemble models support data-driven industry solutions (SDG 9).
CO6	**9, 11**	Clustering / RL enable smart-city and resource applications (SDG 9, 11).

Syllabus Template **FF No.: 654-A**

ME3211: Finite Element Analysis

Teaching Scheme	**Examination Scheme**
Credits : 4	CVV: 20 Marks
Lectures : 3 Hrs/week	GD/PPT: 20 Marks
Practical : 2 Hrs/week	HA: 20 Marks
Tutorial : - Hr/week	CP : 40 Marks

Prerequisites:	
•	Students should have a basic understanding of Manufacturing Processes, Engineering Materials, Engineering Graphics, and Machine Drawing
Course Objectives:	The student will be able to
•	Understand the fundamentals and applications of Finite Element Method (FEM).
•	Develop finite element formulations for structural problems
•	Analyze truss, beam, and 2D elements using FEM.
•	Apply FEM techniques to heat transfer and vibration problems.
•	Use FEM software tools for engineering analysis and simulations.
•	Interpret and validate FEM results for practical engineering problems.
Course Outcomes:	
After completion of the course, student will be able to	
1.	Apply Principal of Minimum Potential Energy (PMPE) to derive finite element equations in 1D
2.	Analyze truss, beam, and frame elements to determine nodal displacements, strains, and stresses under static loading

3.	Model 2D plane stress/strain problems using CST and LSR elements to compute displacement and stress fields
4.	Apply iso-parametric formulation with natural coordinates and Gauss Quadrature numerical integration for analysis using higher-order 2D elements
5.	Solve 1D heat transfer problem using FEM
6.	Solve eigenvalue problems involving vibration analysis of 1D element using FEM techniques

Section1:	**Topics/Contents**

Unit-1: Fundamentals Concepts of FEA

Introduction to FEA, Applications of FEA in various fields , General Procedure for Finite Element Analysis, Types of Analysis.

Finite element formulation of 1D linear bar element using Principal of Minimum Potential Energy (PMPE), shape functions, element stiffness matrix, force terms, assembly of global stiffness matrix and load vector, treatment of boundary conditions, calculation of nodal displacement, strain and element stresses, properties of stiffness matrix.

Unit-2: Plane Truss and Beam Elements

Analysis of Truss Element: Formulation of Element Matrices, Direction cosine, assembly of global stiffness matrix, element strains and stresses, Numerical Examples:

Analysis of Beam Element: Hermite Shape function (Derivation), element stiffness matrix, element load vector, Numerical Examples , Plane Frame Element: Introduction to element stiffness matrix.

Unit-3: 2D Elements

Two-Dimensional Stress Analysis: Plane Stress/Strain problems in 2D elasticity, constitutive relations. Constant Strain Triangle (CST), Liner Strain Rectangle (LSR), Displacement function, Pascal‘s triangle, compatibility and completeness requirement, geometric isotropy, Convergence requirements, strain filed, stress filed, Assembly of global stiffness matrix and load vector, Boundary conditions, solving for primary variables (displacement), stress calculations.

Section2:	**Topics/Contents**

Unit 4: Isoparametric Elements & Numerical Integration

Coordinate mapping - Natural coordinates, higher order triangular and quadrilateral

elements (Lagrangean and serendipity elements), mesh refinement- p vs h refinements, Uniqueness of mapping - Jacobian matrix.

Numerical integration –Gauss Quadrature in 1 & 2 dimension, Order of Gauss integration.

Unit 5: 1D Steady State Heat Transfer Problems

Introduction to Galerkin weighted residual method, One dimensional steady-state heat transfer problem- Governing differential equation, Finite Element formulation using Galerkin's approach for composite wall and thin Fin, Elimination approach to treat boundary conditions and solving for temperature distribution.

Unit 6: Dynamic Analysis

Types of dynamic analysis, General dynamic equation of motion, lumped and consistent mass, Mass matrices formulation of bar, truss and beam element.

Undamped-free vibration- Eigenvalue problem, Evaluation of eigenvalues and eigenvectors (characteristic polynomial technique)

Text Books: ***(As per IEEE format)***

1	*Chandrupatla T. R. and Belegunda A. D., Introduction to Finite Elements in Engineering, Prentice Hall India, 2002*
2	*P. Seshu, Text book of Finite Element Analysis, PHI Learning Private Ltd., New Delhi,* *2010.*
3	*G Lakshmi Narasaiah , Finite Element Analysis, , B S Publications, 2008*

Reference Books: ***(As per IEEE format)***

1	*R. D. Cook, Concepts and Applications of Finite Element Analysis, Wiley, India*
2	*Bathe K. J., Finite Element Procedures, Prentice-Hall of India (P) Ltd., New Delhi*
3	*Daryl L. Logan, A First Course in the Finite Element Method, , 2007.*

List of Practical's:

- Finite element simulation of 1D linear stepped bar under static load with parametric design automation
- Finite element simulation of plane truss under static load with parametric design automation
- Modal analysis of a beam: Study the effect of material properties on natural frequency for constant cross-sectional area and span length for cantilever beam, simply supported beam, and fixed-fixed beam.
- Static structural analysis of a plate with a hole subjected to static load (use shell elements). Estimate stress concentration factor for varying mesh size and hole diameter and compare with analytical results.
- Heat conduction analysis of composite wall using FEA software
- Fatigue analysis with S-N curve as input
- Coupled Thermo-Mechanical Analysis
- Analysis of any Machine Component and Assembly using 3D Elements. Use appropriate contact definition for connected parts.
- Computer program for stress analysis of 1D bar using linear elements.
- Computer program for stress analysis of 2D truss subjected to plane forces

For assignments 1 to 8, preferably use ANSYS Workbench software for FEA simulation. For programming assignments 9 and 10, students can write the program in any of the programming languages such as MATLAB, Python etc.

List of Project areas: (Contents beyond syllabus)

1. FEA simulation Crash analysis
2. FEA simulation for Fatigue analysis
3. Buckling analysis
4. Harmonics Analysis of any rotating machine using FEA software
5. Composite Material simulation
6. ANSYS Automation using Python scripting
7. Solar Panel Frame Analysis for different wind speed, tilt angle etc

8. Hip Implant simulation

CO – PO / PSO Articulation Matrix

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	Program Outcome (PO)											PSO		
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	1	2	2							1	2	2
CO2	3	3	2	2	2							2	3	2
CO3	3	3	2	3	2							2	3	2
CO4	3	3	2	3	3							2	3	3
CO5	3	2	1	2	3		1					1	3	3
CO6	3	3	2	3	3							1	3	3
Avg	3	2.83	1.67	2.5	2.5		1					1.5	2.83	2.5

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓	✓					
CO2		✓	✓	✓	✓	✓			
CO3		✓		✓	✓	✓			
CO4		✓	✓	✓		✓			
CO5	✓	✓	✓	✓		✓			
CO6	✓	✓	✓	✓	✓	✓			

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓		✓				

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO2	✓		✓				
CO3	✓		✓				
CO4	✓		✓				
CO5	✓		✓				
CO6	✓		✓				✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓				✓
CO2	✓		✓		✓
CO3	✓		✓		✓
CO4	✓		✓		✓
CO5	✓		✓		✓
CO6	✓		✓		✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	4, 9	Builds the analytical foundation (SDG 4) that drives data-led innovation (SDG 9).
CO2	4,9	Supervised models power industrial and predictive applications (SDG 9).
CO3	4, 9	Statistical learning supports health diagnostics (SDG 3) and broader innovation (SDG 9).
CO4	4, 9	Classifiers enable fraud detection and economic applications (SDG 8, 9).
CO5	4,9	Decision-tree and ensemble models support data-driven industry solutions (SDG 9).
CO6	4,9	Clustering / RL enable smart-city and resource applications (SDG 9, 11).

Syllabus Template **FF No.: 654-A**

ME3205: Heat Transfer

Teaching Scheme	**Examination Scheme**
Credits : 3	CVV: 20 Marks
Lectures : 2 Hrs/week	GD/PPT/HA: Marks
Practical : - Hrs/week	ESE (W/O): 40 Marks
Tutorial : 1 Hr/week	ESE (P/O): 40 Marks

Prerequisites:	
•	Students should have a basic understanding PDE, Thermodynamics
Course Objectives:	The student will be able to
•	1) Understand the modes of heat transfer
•	2) Concepts of steady and unsteady cases in heat transfer
•	3) Extended surfaces
•	4) Free and Forced Convection
•	5) Analysis and Design of Heat Exchangers
•	6) Modelling Radiative heat transfer

Course Outcomes:	
	After completion of the course, student will be able to
1.	Students will be able to mathematically formulate and analyse heat transfer system by Conduction mode
2.	Students will be able to apply the conduction heat transfer knowledge for composite systems with heat generation
3.	Students will be able to apply the knowledge of fluid flow and free convection heat transfer to analyze the thermal system
4.	Students will be able to apply the knowledge of fluid flow and forced convection heat transfer to analyze the thermal system
5.	Students will be able to perform thermal design of various heat exchangers
6.	Students will be able to analyze radiative heat transfer system

Section1:	**Topics/Contents**

Unit 1. Introduction

Applications of heat transfer in engineering field. Modes of heat transfer. Thermal conductivity, its significance, its variation in solids, liquids and gases. Formulation for temperature distribution and heat transfer rate for one dimensional steady state heat conduction in a plane wall, cylinder and sphere with and without heat generation.

Unit 2: Conduction

General heat conduction equation in Cartesian coordinate system and its applications to simple thermal systems. General heat conduction equation in cylindrical and spherical co-ordinates. Electrical analogy and its use in analyzing composite systems. Overall heat transfer coefficient. Critical radius of insulation.

Unit 3: Fins and Transient Conduction

Extended surfaces (fins): Introduction, Significance and Classification. Fin analysis with different boundary conditions. Performance evaluation of fins. Temperature measurement error with thermo-well.

Introduction to unsteady state heat conduction and Lumped analysis.

Section2:	**Topics/Contents**

Unit 4: Forced and Free Convection

Mechanism of convection, Introduction to hydrodynamic and thermal boundary layer.

Laminar and turbulent flow over and inside a surface.

Energy equation (2D/3D) in cartesian coordinate system

Dimensional analysis of free and forced convection. Physical significance of the

dimensionless Numbers; Nu, Re, Pr, Gr, Ri, St, Ra.

Forced convection: Empirical correlation's for heat transfer in laminar and turbulent flow over a flat plate and in a circular pipe. Concept of hydraulic diameter.

Natural convection: Physical mechanism, Empirical correlations for free convection heat transfer over horizontal plate, vertical plate and cylinder.

Unit 5: Radiation

Heat exchange by radiation between two finite black surfaces. Radiation shape factor.

Irradiation, radiosity, electrical network method of solving problems. Heat exchange

between non-black bodies and Heat exchange between two infinitely parallel planes,

cylinders and spheres. Radiation shields.

Unit 6: Heat Exchangers

Heat Exchangers: Meaning, Significance, Classification. Performance evaluation methods (LMTD and Effectiveness-NTU). Condensers and Evaporators

Introduction to Heat Pipes.

Text Books: ***(As per IEEE format)***

1. "Fundamentals of Engineering Heat and Mass Transfer", Sachdeva R. C., Wiley Eastern

Limited, 3rd Edition 1988.

2. "A text book on Heat Transfer" Sukhatme S. P., Orient Longmans Ltd., New Delhi, 3rd

Edition, 1989.

3. “Heat Transfer- A Basic Approach”, Ozisik M. N., McGraw Hill, I edition, 1985.

Reference Books: ***(As per IEEE format)***

1. “Fundamentals of Heat Transfer”, Frank P. Incropera and David P. De Witt, Wiley, Eastern Limited

2.“Heat Transfer”, J. P. Holman, McGraw Hill, 9th edition, 2004.

3. “Engineering Heat Transfer”, Gupta and Prakash, Nemchand and Brothers.

List of Practical’s: **(**All lab equipment must be utilized-Mandatory)

1. Determination of Thermal Conductivity of Insulating Powder
2. Determination of Thermal Conductivity of Composite Wall
3. Free Convection
4. Temperature distribution over length of fin
5. Forced Convection heat transfer
6. Stefan-Boltzmann constant
7. Emissivity determination
8. Tube in tube heat exchanger
9. Heat Pipe
10. Critical Heat Flux

List of Project areas: (Contents beyond syllabus)

1.Thermal management of battery

2. Refrigeration and Air conditioning

3. IC Engine

4. Electronics cooling

CO – PO / PSO Articulation Matrix

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	Program Outcome (PO)											PSO		
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PS O1	PS O2	PS O3
CO1	3	3	2	2	2	1	1	2	2	2	1	1	3	2
CO2	3	3	2	2	2	1	1	2	2	2	1	1	3	2
CO3	3	3	2	2	2	1	1	2	2	2	1	1	3	2
CO4	3	3	2	2	2	1	1	2	2	2	1	1	3	2
CO5	3	3	2	2	2	1	1	2	2	2	1	1	3	2
CO6	3	3	2	2	2	1	1	2	2	2	1	1	3	2
Avg														

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	✓	✓	✓	✓	✓			✓	✓
CO2		✓	✓		✓	✓		✓	✓
CO3		✓		✓		✓		✓	✓
CO4		✓		✓		✓	✓	✓	✓
CO5		✓		✓		✓	✓	✓	✓
CO6		✓		✓	✓	✓	✓	✓	✓

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓						
CO2	✓		✓				
CO3	✓		✓				
CO4	✓	✓	✓				
CO5	✓	✓	✓				

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO6	✓		✓				✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓				
CO2	✓		✓		
CO3	✓		✓		
CO4	✓		✓		
CO5	✓		✓		
CO6	✓		✓	✓	✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	4, 9	Builds the analytical foundation (SDG 4) that drives data-led innovation (SDG 9).
CO2	9	Supervised models power industrial and predictive applications (SDG 9).
CO3	3, 9	Statistical learning supports health diagnostics (SDG 3) and broader innovation (SDG 9).
CO4	8, 9	Classifiers enable fraud detection and economic applications (SDG 8, 9).
CO5	9	Decision-tree and ensemble models support data-driven industry solutions (SDG 9).
CO6	9, 11	Clustering / RL enable smart-city and resource applications (SDG 9, 11).

FF No.: 654-A

ME1501: Mechanical System Design

Teaching Scheme	**Examination Scheme**
Credits : 3	CP : 30 Marks
Lectures : 2 Hrs/week	LAB: 10 Marks
Practical : 2 Hrs/week	CVV : 20 Marks
Tutorial : - Hr/week	ESE (W/O): 40 Marks

Prerequisites:	
	Students should have a basic understanding of Strength of Materials, Machine Design, Engineering Materials, Engineering Graphics, and Machine Drawing
Course Objectives:	The student will be able to
	Introduce the fundamentals of mechanical system design
	Develop understanding of gear drives and machine tool gearbox design..
	Study the design procedures for cylinders and pressure vessels
	Introduce aesthetic and ergonomic considerations in product design.
	Develop practical design skills using engineering design methodology and CAD tools
Course Outcomes:	
After completion of the course, student will be able to	
1.	Apply Principal of Bevel and Worm gear design for industrial applications
2.	Design machine tool gearboxes using speed and ray diagrams.
3.	Analyze and design thin and thick cylinders
4.	Design pressure vessels using standard design codes.
5.	Design material handling system like belt conveyor
6.	Apply DFX principles in engineering product design.

Section1	**Topics/Contents**

Unit-I: Design of Bevel Gears

Types of Bevel Gears, Terminology, Force Analysis, Beam Strength of Bevel Gears, Wear Strength of Bevel Gears, Effective Load on Gear Tooth

Unit-2: Design of Worm Gears

Terminology of Worm Gears, Force Analysis, Friction in Worm gears, Selection of Materials, Strength and Wear Rating of Worm Gears, Thermal Considerations

Unit-3: Design of Machine Tool Gearbox

Introduction to machine tool gearboxes, design and its applications, Geometric progression, determination of variable speed range, graphical representation of speed

and structure diagram, ray diagram, selection of optimum ray diagram

Section 2	**Topics/Contents**

Unit-4: Design of Pressure Vessels

Thin and Thick Cylinders, Lame's Equation, Clavarino's and Bernie's Equations, Autofrettage, Modes of Failures in Pressure Vessels, Unfired Pressure Vessels, Classification of Pressure Vessels as Per I. S. 2825, Stresses Induced in Pressure Vessels, Materials for Pressure Vessel, Thickness of Cylindrical and Spherical Shells, End Closures, Openings in Pressure Vessels

Unit-5: Design of Belt conveyer system for material handling

System concept, basic principles, objectives of material handling system, unit load and containerization. Belt conveyors, Flat belt and troughed belt conveyors, capacity of conveyor, rubber covered and fabric ply belts, belt tensions, conveyor pulleys, belt idlers, tension take-up systems, power requirement of horizontal belt conveyors for frictional resistance of idler and pulleys

Unit-6: DFMA and Statistical Considerations in Design

Design for Manufacture, Assembly and Safety: General principles of design for manufacture and assembly (DFM and DMFA), principles of design of castings and forgings, design for machining, design for safety

Statistical Considerations in Design: Introduction, Normal distribution, Frequency distribution

Text Books: (As per IEEE format)

1	*Bhandari V.B. - "Design of Machine Elements", McGraw Hill Education (India) Ltd.*
2	*Shigley J.E. and Mischke C.R."Mechanical Engineering Design" McGraw Hill Publ. Co.Ltd.*
3	*M. V. Joshi and V. V. Mahajani, Process equipment design*
4	*George E. Dieter and Linda C. Schmidt, Engineering Design, 4th Ed., McGraw Hill Higher Education, 2000*

Reference Books: (As per IEEE format)

1	*Spotts M.F. -"Design of Machine Elements", Prentice HallInternational*
2	*Black P.H. and O. Eugene Adams - "Machine Design" - McGraw Hill BookCo.Ltd.*

3	*"Design Data" - P.S.G. College of Technology,Coimbatore*
4	*IS-2825-1969 Code for unfired pressure vessels.*
5	*John F Harvey, "Theory and Design of Pressure vessels", CBS publishers & distributors, Delhi*

List of Practical's:

Depending upon the type of mechanical system undertaken for project work, students have to design related and requisite machine elements from the following list as practical activity.

- Design of bevel gears for a specified application as per design requirements
- Design of Worm and Worm Wheel Gear Drive for a Specified Application
- Design of Gearbox Housing/Casing
- Construction of Structural Diagram and Ray Diagram for Gearbox Design
- Selection and Optimization of Ray Diagram for Gearbox Design
- Design of Cylinders and Pressure Vessels for a Specified Application
- Design of belt conveyor for specified mechanical system
- Design of pulley for specified mechanical system
- Selection of Electric drive for a given mechanical system
- Develop ergonomically improved product/component considering safety and user comfort.
- Aesthetic design consideration for any Mechanical Product/ Component

Note: AI techniques such as machine learning, generative design, optimization algorithms, predictive analysis, and simulation tools can be integrated into Assignments/Projects to improve design accuracy, performance, efficiency, reliability, and decision-making in mechanical engineering applications.

List of Project areas: (Contents beyond syllabus)

A detail design report, CAD model and working drawing of details and assembly of the following

- Multi-Speed and Multi Stage Gearbox Design:
  Machine tool gear box (three stage, 12 speed gear box)/ Automobile gear box/ differential gear box / Wind Mill Gear Box etc.

- Mechanical System for Material Handling
- Pressure vessel design
- Design of Reciprocating Compressor
- Design of Concrete Mixer
- Design of Sugar Cane Crusher
- Design of I. C. Engine Component
- Any other Similar

CO – PO / PSO Articulation Matrix

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	Program Outcome (PO)											PSO		
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PSO1	PSO2	PSO3
CO1	3	3	3	2	2							3	3	1
CO2	3	3	3	2	2							3	3	2
CO3	3	3	3	3	2	1						2	3	1
CO4	3	3	3	3	2	2						2	3	2
CO5	3	3	3	2	3	1	1					3	3	2
CO6	2	3	3	2	3	2	2	2	1			3	3	3
Avg	2.83	3	3	2.5	2.33	1.17	0.5	0.33	0.17			2.67	3	1.83

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓	✓	✓	✓			
CO2		✓	✓	✓	✓	✓			
CO3		✓	✓	✓	✓	✓			
CO4		✓	✓	✓	✓	✓	✓		
CO5		✓	✓	✓	✓	✓			
CO6		✓	✓	✓	✓	✓	✓		

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓		✓				✓
CO2	✓	✓	✓				✓
CO3	✓	✓	✓				✓
CO4	✓	✓	✓		✓		✓
CO5	✓	✓	✓			✓	✓
CO6	✓	✓	✓	✓		✓	✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓				✓
CO2	✓	✓			✓
CO3	✓				✓
CO4	✓	✓			✓
CO5	✓	✓			✓
CO6	✓	✓	✓		✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	4, 9	Builds the analytical foundation (SDG 4) that drives data-led innovation (SDG 9).
CO2	4, 9	Supervised models power industrial and predictive applications (SDG 9).

CO	SDG(s) Addressed	Justification / Linkage
CO3	4,9,12	Statistical learning supports health diagnostics (SDG 3) and broader innovation (SDG 9).
CO4	4,9,12	Classifiers enable fraud detection and economic applications (SDG 8, 9).
CO5	4,9,12	Decision-tree and ensemble models support data-driven industry solutions (SDG 9).
CO6	4,9,12	Clustering / RL enable smart-city and resource applications (SDG 9, 11).

FF No.: 654

ME1501: DATA SCIENCE

Teaching Scheme	**Examination Scheme**
Credits : 3	ESE (W): 40 Marks
Lectures: 2 Hrs/week	GD/PPT: 20 Marks
Practical: -	HA: 10 Marks
Tutorial: 1 Hrs/week	CP : 30 Marks

Prerequisites:	
•	-
Course Objectives:	
•	To develop proficiency in acquiring, managing, analyzing, and visualizing data using modern data science tools.
•	To apply statistical and computational techniques for extracting insights from structured datasets.
•	To develop predictive models using machine learning algorithms and evaluate their performance.
•	To communicate analytical results through dashboards and data-driven storytelling.
Course Outcomes:	
	After completion of the course, student will be able to
CO1.	Acquire, manage, and process data using Python, SQL, and data science libraries.
CO2.	Perform exploratory data analysis and statistical inference to derive meaningful insights from engineering datasets.
CO3.	Create visualizations, dashboards, and reports for effective communication of analytical findings.
CO4.	Develop, evaluate, and optimize regression-based predictive models for engineering applications.

Unit 1:	**Data Engineering and SQL**
Introduction to Data Science and Engineering Data: Data science lifecycle, structured and unstructured data, engineering and industrial applications of data science. Database Fundamentals: Relational databases, entities, attributes, keys, tables, relationships among tables. Basic SQL Operations: SELECT, INSERT, UPDATE, DELETE statements. Advanced SQL Querying: WHERE clause, LIKE operator, ORDER BY, GROUP BY, HAVING clause, aggregate functions. Complex SQL Queries: Joins, subqueries, querying multiple tables, data summarization and reporting.	

Unit 2:	**Python Programming and Data Acquisition**
Python Fundamentals; Object-Oriented Programming Working with Files: Reading and writing text files, CSV files, JSON files using Open() and Python libraries. Numerical Computing with NumPy: Arrays, vectorized operations, indexing, mathematical computations. Data Manipulation using Pandas: DataFrames, importing datasets, filtering, sorting, aggregation, data transformation. Data Acquisition: Introduction to APIs, REST APIs, data extraction from web services, web scraping using BeautifulSoup.	
Unit 3:	**Data Analysis and Statistical Inference**
Data Wrangling: Handling missing values, duplicate records, outlier treatment, data transformation and normalization. Exploratory Data Analysis (EDA): Data profiling, descriptive statistics, distribution analysis, groupby operations for categorical analysis. Correlation Analysis: Covariance, Pearson correlation coefficient, Spearman correlation coefficient, interpretation of relationships among variables. Hypothesis Testing: Null and alternative hypotheses, significance level, p-value, confidence intervals, decision making based on statistical tests. Chi-Square Testing: Goodness-of-fit test, test of independence, applications in quality control and engineering experiments. Feature Relationships and Statistical Interpretation: Scatter matrices, correlation heatmaps, statistical interpretation of engineering datasets.	
Unit 4:	**Data Visualization, Dashboards and Predictive Modeling**
Visualization Fundamentals: Principles of effective visualization, chart selection, visual perception, data storytelling. Visualization using Matplotlib and Seaborn: Line charts, bar charts, pie charts, histograms, scatter plots, box plots, heatmaps. Interactive Visualization: Interactive charts and dashboards using Plotly and Dash. Business Intelligence and Dashboard Design: KPI identification, dashboard design principles, interactive reporting using Google Looker Studio. Regression Modeling: Simple linear regression, multiple linear regression, polynomial regression, model development for predictive analytics. Model Evaluation and Optimization: R^2 score, Mean Squared Error (MSE), Root Mean Squared Error (RMSE), residual plots, KDE plots, overfitting, underfitting, ridge regression, hyperparameter tuning using grid search.	
Text Books:	
1	**McKinney, W.** (2022). *Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Jupyter* (3rd ed.). O'Reilly Media.
2	**VanderPlas, J.** (2016). *Python Data Science Handbook: Essential Tools for Working with Data*. O'Reilly Media.
3	**Beaulieu, A.** (2020). *Learning SQL: Generate, Manipulate, and Retrieve Data* (3rd ed.). O'Reilly Media.
Reference Books: ***(As per IEEE format)***	
1	**Géron, A.** (2022). *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow* (3rd ed.). O'Reilly Media.
2	**James, G., Witten, D., Hastie, T., Tibshirani, R., & Taylor, J.** (2023). *An Introduction to Statistical Learning with Applications in Python*. Springer.

3	**Nussbaumer Knaflic, C.** (2015). *Storytelling with Data: A Data Visualization Guide for Business Professionals*. Wiley.
4	**Han, J., Kamber, M., & Pei, J.** (2022). *Data Mining: Concepts and Techniques* (4th ed.). Morgan Kaufmann
5	**Downey, A.** (2024). *Think Stats: Exploratory Data Analysis in Python* (3rd ed.). O'Reilly Media.
6	**Provost, F., & Fawcett, T.** (2013). *Data Science for Business*. O'Reilly Media.

List of Tutorial's:

- SQL database design and implementation for engineering applications.
- SQL querying, joins, aggregation, and reporting.
- Pivot tables, pivot charts, and spreadsheet dashboard development.
- Python programming fundamentals and object-oriented programming.
- Data handling and analysis using NumPy and Pandas.
- Data acquisition using APIs and web scraping.
- Data cleaning and wrangling using Pandas.
- Exploratory data analysis and statistical summarization.
- Correlation analysis, hypothesis testing, and chi-square testing.
- Data visualization using Matplotlib and Seaborn.
- Interactive dashboards using Plotly, Dash, and Google Looker Studio.
- Regression modeling, model evaluation, ridge regression, and grid search.

CO – PO / PSO Articulation Matrix

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	Program Outcome (PO)											PSO		
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PS O1	PS O2	PS O3
CO1														
3	1										1			
3	3	1	1											
3	3	3	1	3										
3	3	3	3	3							1			
3.0	2.5	2.3	1.7	3.0							1.0			
Avg														

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1			✓	✓				✓	
CO2		✓		✓	✓	✓			
CO3		✓		✓		✓		✓	
CO4		✓		✓		✓			
CO5				✓		✓		✓	
CO6				✓	✓	✓		✓	

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓						
CO2	✓		✓				
CO3	✓		✓				
CO4	✓	✓	✓				
CO5	✓	✓	✓				
CO6	✓		✓				✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓				
CO2	✓		✓		
CO3	✓		✓		
CO4	✓		✓		
CO5	✓		✓		
CO6	✓		✓	✓	✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	4, 9	Builds the analytical foundation (SDG 4) that drives data-led innovation (SDG 9).
CO2	9	Supervised models power industrial and predictive applications (SDG 9).
CO3	3, 9	Statistical learning supports health diagnostics (SDG 3) and broader innovation (SDG 9).
CO4	8, 9	Classifiers enable fraud detection and economic applications (SDG 8, 9).
CO5	9	Decision-tree and ensemble models support data-driven industry solutions (SDG 9).
CO6	9, 11	Clustering / RL enable smart-city and resource applications (SDG 9, 11).

Syllabus Template **FF No.: 654-A**

INDUSTRIAL ENGINEERING

Teaching Scheme	**Examination Scheme**
Credits : 3	ESE (W): 40 Marks
Lectures : 2Hrs/week	GD/PPT: 20 Marks
Practical : Hrs/week	HA: 10 Marks
Tutorial : Hrs/week	CP : 30 Marks

Prerequisites:	NIL
Course Objectives:	
•	To introduce the concepts, principles and framework of contents of Industrial Engineering.
•	To acquaint the students with various productivity enhancement techniques.
•	To acquaint the students with different aspects of Production Planning and Control and Facility Design.
•	To introduce the concepts of various cost accounting and financial management practices as applied in industries
•	To acquaint the students with different aspects of Human Resource activities and Industrial Safety rules.
•	To acquaint students with different aspect of simulation modeling for various industrial engineering\applications.
Course Outcomes:	
	After completion of the course, student will be able to
1.	Explain the fundamental concepts of Industrial Engineering, productivity improvement, work study, and method study for enhancing organizational efficiency.
2.	Apply work measurement techniques, including time study, work sampling, PMTS, MTM, and MOST, to establish standard times and improve work

	systems.
3.	Analyze Production Planning and Control (PPC) systems, forecasting methods, ERP, MRP, and Supply Chain Management concepts for effective production planning and decision-making.
4.	Evaluate facility design, inventory management, engineering economy, human resource management, and industrial safety practices to improve productivity, optimize resources, and support industrial decision-making.

Section1:	**Topics/Contents**

Unit I: Introduction to Industrial Engineering and Productivity

Industrial Engineering, productivity improvement, work study, and method study, including production systems, productivity measurement, work analysis, process and motion study techniques, and the application of Value Engineering and Value Analysis to enhance productivity and operational efficiency.

Unit II: Work Measurement and Work System Design

Work measurement and Work system design, work sampling, time study, performance rating, allowances, and standard time determination. Predetermined Motion Time Systems (PMTS), including MTM and MOST, applications in designing efficient work systems and improving productivity.

Section2:	**Topics/Contents**

Unit III: Production Planning and Control

Production Planning and Control (PPC), production planning, capacity planning, ERP, MPS, MRP, and MRP-II. Forecasting techniques, demand control strategies (MTO, MTA, and MTS), and the basic concepts of Supply Chain Management for effective production and resource planning.

Unit IV: Facility Design, Inventory, Engineering Economy, HR and Safety

Facility design, plant location, plant layout, assembly line balancing, and material handling systems. Inventory management and Inventory control techniques, engineering economy concepts such as costing and break-even analysis, financial statements, capital investment evaluation, and the principles of Human Resource Development and Industrial Safety for effective industrial management.

Text Books: ***(As per IEEE format)***	
1	M Mahajan, Industrial Engineering and Production Management, Dhanpat Rai and Co.
2	O. P. Khanna, Industrial engineering and management, Dhanpat Rai publication.
3	Martend Telsang, Industrial Engineering, S. Chand Publication.
4	Banga and Sharma, Industrial Organization& Engineering Economics, Khanna publication.
Reference Books: ***(As per IEEE format)***	
1	Introduction to Work Study by ILO, ISBN 988-81-204-1818-2, Oxford & IBH Publishing
2	.H. B. Maynard, K Jell, Maynard ‘s Industrial Engineering Hand Book, McGraw Hill Education.
3	Askin, Design and Analysis of Lean Production System, Wiley,
4	Zandin K.B., Most Work Measurement Systems, ISBN 0824809535, CRCPress,2002
5	Martin Murry, SAP ERP: Functionality and Technical Configuration, SAP Press; 3rdNew edition (2010).
6	Barnes, Motion and time Study design and Measurement of Work, Wiley India
7	Raid Al-Aomar, Adwerd J Williams, Onur M. Uigen ‘Process Simulation using WITNESS’, Wiley

CO – PO / PSO Articulation Matrix

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO	**Program Outcome (PO)**											**PSO**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PS O1**	**PS O2**	**PS O3**
CO 1	3	2	1	–	1	–	1	–	1	1	1	2	3	2
CO 2	3	3	2	1	2	–	1	1	2	2	1	2	3	3
CO 3	3	3	2	1	2	1	2	1	2	2	3	2	3	3
CO 4	3	3	2	1	2	2	2	2	2	3	3	2	3	3

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1		✓	✓	✓		✓	✓		
CO2		✓	✓	✓	✓	✓			
CO3		✓	✓	✓	✓	✓	✓		
CO4		✓	✓	✓	✓	✓	✓		

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓		✓				
CO2	✓	✓	✓	✓			
CO3	✓	✓	✓	✓	✓		
CO4	✓	✓	✓	✓	✓	✓	✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓				

CO	EA1	EA2	EA3	EA4	EA5
CO2	✓	✓	✓		
CO3	✓	✓	✓	✓	
CO4	✓	✓	✓	✓	✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	**8, 9**	Productivity improvement, work study and method study support efficient work systems, improved productivity and effective industrial operations.
CO2	**8, 9**	Work measurement and work-system design support productive work practices, efficient utilization of human resources and improvement of industrial processes.
CO3	**8, 9, 12**	PPC, forecasting, ERP, MPS, MRP, MRP-II and SCM support efficient production planning, resource optimization and responsible utilization of materials.
CO4	**8, 9, 12**	Facility design, inventory management, engineering economy, HR and industrial safety support productive, safe and resource-efficient industrial systems.

Syllabus Template **FF No.: 654-A**

ME1501: Robotics and Automation

Teaching Scheme	**Examination Scheme**
Credits : 4	ESE (W): 40 Marks
Lectures : 3 Hrs/week	GD/PPT: 20 Marks
Practical : 2 Hrs/week	HA: 10 Marks
Tutorial : Hr/week	CP : 30 Marks

Prerequisites:	
•	Electronics and Electrical Engineering. Applied electromechanics.
Course Objectives:	The student will be able to
•	Learn the industrial Robots
•	Explain pneumatic and hydraulic application circuits
•	Identify different kinematics of robots
•	Describe the use of robot control system
•	The robots in manufacturing automation
•	Design the robot for specific application
Course Outcomes:	
	After completion of the course, student will be able to
1.	Understand the application of robots in industry.
2.	Develop application based pneumatic and Hydraulic circuits
3.	Explain the kinematics of robots
4.	Understand the applications of robot control system

5.	Understand the robot application in manufacturing
6.	Design the robot for specific application

Section1:	**Topics/Contents**
	Introduction to Industrial Robots : Laws of Robotics, Robot Anatomy, Robot classification and its types, Robot joints, Robot Performance- Resolution, Accuracy, Repeatability, Dexterity, Industrial Applications of robot, Selection parameters and Robot Specification **Hydraulic and Pneumatic systems**- Generalized Hydraulic and Pneumatic systems, Control Valves, Application Circuits-fall same, Pick and Place, Quick return, Synchronization, sequential circuits. **Manipulator Kinematics and Dynamics** -Introduction, Direct Kinematics, Inverse kinematics, Differential kinematics, Trajectory planning**, Dynamics:-**Introduction, Lagrange's equation kinetic and potential energy. Link inertia Tensor, link Jacobian Manipulator inertia tensor. Gravity, Generalized forces, Lagrange-Euler Dynamic model, Dynamic model of a Two-axis planar robot, Newton Euler formulation, Lagrange Euler formulation, problems Basic fluid power principles, Pneumatic components and circuits, Hydraulic components and circuits, Electro-pneumatic and electro-hydraulic systems, Industrial applications
Section2:	**Topics/Contents**
	Control Flow of Industrial Robot : - Control design basics, Cruise-Controllers, Performance Objectives. Simple robot – State space model, Linearization, LTI system, stability. PID control, basic control algorithms **Robots in Manufacturing**- Spot welding, Spray painting, Plastic moulding, forging. Micro/Nanofabrication techniques- Photo Lithography, Electron beam, X-Ray, Ion beam Lithography- LIGA process- Micro Stereo lithography Micro/Nano Assembly - Self-Assembly, human machine Interfacing -Biomimetics and Design Strategy - Kinematics and Dynamics of Robot- Teleportation Based, Task Based and Automatic Control Approaches. **Robot Design:-** Linkages, Types, Transmission elements Flexible connectors, pulley-and-Belt drives, variable speed transmission. Design of Robot for particular applications – A case study, Robot language classification - programming methods - off and on line programming - Lead through method - Teach pendent method - VAL systems and language,

simple Programs	
Text Books: ***(As per IEEE format)***	
1	Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta,
2	“Industrial Robotics, Technology programming and Applications", McGraw Hill, 2012.
3	S.R. Deb, “Robotics Technology and flexible automation”, Tata McGraw-Hill Education., 2009.
4	P.A. Janaki Raman, "Robotics and Image Processing an Introduction", Tata McGraw Hill Publishing company Ltd., 1995.
Reference Books: ***(As per IEEE format)***	
1	Richard D. Klafter, Thomas .A, ChriElewski, Michael Negin, "Robotics Engineering an Integrated Approach", PHI Learning., 2009.
2	Francis N. Nagy, Andras Siegler, "Engineering foundation of Robotics", Prentice Hall Inc., 1987.
3	Fu. K. S., Gonzalez. R. C. & Lee C.S.G., “Robotics control, sensing, vision and intelligence”, McGraw Hill Book co, 1987
4	Ray Asfahl. C., “Robots and Manufacturing Automation”, John Wiley & Sons Inc.,1985

List of Practical’s: **(**All lab equipments must be utilised-Mandatory)

Study of robot anatomy and classification (Cartesian, SCARA, articulated, etc.)

Identification of robot components: sensors, actuators, controller

Study of degrees of freedom (DOF) using simple robotic arms

Forward kinematics of a 2-link robotic arm

Inverse kinematics of a simple robotic manipulator

Path planning using interpolation techniques

Simulation of pick-and-place robot operation

Trajectory planning of robotic arm

Simulation of welding robot operation

Simulation of spray painting robot

Pick-and-place industrial application using robotic arm

Conveyor belt automation using sensors and actuators

List of Project areas: (Contents beyond syllabus)

Line follower robot (IR sensor-based)

Obstacle avoiding robot (ultrasonic sensor)

Bluetooth-controlled robot using Arduino Bluetooth Controller

Remote-controlled robot (RF module)

Light-following robot

Pick-and-place robotic arm using servo motors

Color sorting robot using sensors

Automated conveyor belt system

Robotic arm controlled by joystick

Gesture-controlled robot using accelerometer

CO – PO / PSO Articulation Matrix

CO	Program Outcome (PO)											PSO		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PS O1**	**PS O2**	**PS O3**
CO1	3											3	1	
CO2	3	3	2	1	1							3	1	
CO3	3	2	2	1	1							3	1	
CO4	3	3	2									3	1	

CO5	3		2	1	1							3	1	
CO6	3											3	1	
Avg	3	2.5	2	1	1									

Correlation: 1 = Low (Slight), 2 = Medium (Moderate), 3 = High (Substantial), '-' = no correlation.

CO – WK Mapping (Knowledge & Attitude Profiles)

'✓' indicates the knowledge profile drawn upon by the CO.

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1			✓	✓				✓	
CO2		✓		✓	✓	✓			
CO3		✓		✓		✓		✓	
CO4		✓		✓		✓			
CO5				✓		✓		✓	
CO6				✓	✓	✓		✓	

CO – WP Mapping (Complex Engineering Problems)

CO	WP1	WP2	WP3	WP4	WP5	WP6	WP7
CO1	✓						
CO2	✓		✓				
CO3	✓		✓				
CO4	✓	✓	✓				
CO5	✓	✓	✓				
CO6	✓		✓				✓

CO – EA Mapping (Complex Engineering Activities)

'✓' indicates the activity attribute addressed by the CO

CO	EA1	EA2	EA3	EA4	EA5
CO1	✓				
CO2	✓		✓		

CO	EA1	EA2	EA3	EA4	EA5
CO3	✓		✓		
CO4	✓		✓		
CO5	✓		✓		
CO6	✓		✓	✓	✓

CO – SDG Mapping (Sustainable Development Goals)

CO	SDG(s) Addressed	Justification / Linkage
CO1	4, 9	Builds the analytical foundation (SDG 4) that drives data-led innovation (SDG 9).
CO2	9	Supervised models power industrial and predictive applications (SDG 9).
CO3	3, 9	Statistical learning supports health diagnostics (SDG 3) and broader innovation (SDG 9).
CO4	8, 9	Classifiers enable fraud detection and economic applications (SDG 8, 9).
CO5	9	Decision-tree and ensemble models support data-driven industry solutions (SDG 9).
CO6	9, 11	Clustering / RL enable smart-city and resource applications (SDG 9, 11).

Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Technology

(An Autonomous Institute affiliated to Savitribai Phule Pune University formerly University of Pune)

Structure & Syllabus of

B.Tech. Final Mechanical Engineering

Final Year Mechanical Engineering Applicable for A.Y. 2026 - 27

Prepared by:

Board of Studies in Mechanical Engineering

Approved by:

Academic Board, Vishwakarma Institute of Technology, Pune

Vision:

To be recognized as one of the pre-eminent Mechanical Engineering Programs

Mission:

- To prepare students competent to make their careers in Mechanical Engineering
- To provide value education to students to make them responsible citizen
- To strengthen collaborations with Industries, Academia and Research Organizations to enrich learning environment and to enhance Research Culture
- To be recognized as a leading Mechanical Engineering Department in the field of knowledge, skill and research

Program Educational Objectives

- To work independently as well as in team to formulate, design, execute solutions for engineering problems and also analyze, synthesize technical data for application to product, process, system design & development
- To understand & contribute towards social and environmental issues, following professional ethics and codes of conduct and embrace lifelong learning for continuous improvement
- To develop expertise towards use of modern engineering tools, instruments, programming languages and software's
- To acquire and develop careers in industries, Research organizations, academia and demonstrate entrepreneurial skill

Program Outcomes and Program Specific Outcomes (POs & PSOs)

PO1:-Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2:-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.

PO3:-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.

PO4:-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.

PO5:-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.

PO6:-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.

PO7:-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.

PO8:-Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9:-Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10:-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 receiving clear instructions.

PO11:-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.

PO12:-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 (PSO) Mechanical Engineering

Mechanical Engineering Graduates will be able to:

PSO1:- Demonstrate knowledge and understanding about machine drawing and modelling of mechanical engineering components & systems and selection of appropriate materials and manufacturing processes for their production.

PSO2:- Understand the working of mechanical engineering components & systems and thereby design, analyse and conduct experiments for enhancement of performance.

PSO3:- Ability to apply multidisciplinary approach and usage of modern hardware & software tools for the development of smart mechanical engineering components & systems

Course Structure-FF: 653_A

B.Tech. MECH. MODULE-VII AY: 2026-27

Sub. No.	Sub. Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination scheme						Total	Credits
			Th.	Lab	Tut	CA			MSE	ESA			
						HA				ESE	CVV		
S1	-	Open Elective-I	2							100		100	2
S2	-	Open Elective-II	2			10			30	30	30	100	2
S3	-	Open Elective-III	2			10			30	30	30	100	2
S4	ME4255	Major Project		18					30	70		100	9
	ME4256**	Major Project		20					30	70		100	10
S5	ME4381*	Design Thinking-7		2						100		100	1
Total			**6**	**20**									**16**

*Irrespective of module course in Sem-1 **Irrespective of module course in Sem-2

Course Structure-FF: 653_A

B.Tech. MECH. MODULE-VIII AY: 2026 - 27

Sub. No.	Sub. Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination scheme						Total	Credits
			Th	Lab	Tut	CA			MSE	ESA			
										ESE			
S1	-	Internship*		30					30	70		100	15
	-	Internship**		32					30	70		100	16
S2	ME4381*	Design Thinking-7		2								100	1
Total				**32**									**16**

***Internship code sem-1**

ME4276	INDUSTRY INTERNSHIP	ME4275	PROJECT INTERNSHIP
ME4273	RESEARCH INTERNSHIP	ME4277	INTERNATIONAL INTERNSHIP

****Internship code sem-2**

ME4293	INDUSTRY INTERNSHIP	ME4296	PROJECT INTERNSHIP
ME4295	RESEARCH INTERNSHIP	ME4294	INTERNATIONAL INTERNSHIP

Electives

	Subject Head	Course	Credits
Elective -1 A	s01	MD4274: Large Language Models Skill Development	1
	s01	MD4275: Mastering Microsoft Power BI	1
	s01	MD4276: Generative AI Skills for Developers	1
	s01	MD4277: Career in Data Analysis	1
	s01	MD4278: Concepts of Data Visualization and Storytelling	1
	s01	MD4279: AWS Certified Solutions Architect	1
	s01	MD4280: IT Security Specialist	1
	s01	MD4281: Technical Program Management	1
Elective -1 B	s02	MD4282: Natural Language Processing Skill Development	1
	s02	MD4283: Prompt Engineering Skills	1
	s02	MD4284: Essentials in Generative AI	1
	s02	MD4285: Python in Finance	1
	s02	MD4286: Understanding Quantum Computing	1
	s02	MD4287: Foundational Maths for Machine Learning	1
	s03	ME4251: CAD/CAM/CAE	2

Elective -2	s03	ME4254: REFRIGERATION AND AIR CONDITIONING	2
	s03	ME4261: POWER PLANT ENGINEERING	2
Elective -3	s04	ME4311: APPLIED COMPUTATIONAL FLUID DYNAMICS	2
	s04	ME4315: Fundamentals of Electric Vehicle Powertrain Design	2
	s04	ME4316: Fundamentals of Electric Vehicle Battery Pack Design	2

Asst. Head

MECHANICAL ENGINEERING DEPARTMENT ★ विश्वकर्मा इंस्टिट्यूट पुणे-३७.

Dr. S. S. Kore
HOD, Mech

ME4251: CAD/CAM/CAE

Syllabus Template

ME 4251CAD/CAM/CAE

Credits: 02 **Teaching Scheme**

Lab: 12 Hours/Week

Course Prerequisites: 1.Mathematics Engineering Mechanics; Mathematics course related

to: Ordinary Differential Equation, Matrices,

Course Outcomes:

The student will be able to –

1. Use the underlying algorithms, mathematical concepts, supporting computer graphics. These include but are not limited to: Composite2D & 3D homogeneous matrices for translation, rotation, and scaling transformations.

2. Use and demonstrate fundamental knowledge of CAD/CAM.

3. Understand the basic theory behind the finite element method.

4. Use the finite element method for the solution of practical engineering problems.

5. Create the G-code program (with a standard computer post processor) of a work- piece on a standard numerically controlled machine tool with CNC

6. Understand Rapid prototyping Technique

Section I

Computer Graphics Introduction to Basic Transformations - Translation, Rotation, Scaling, Reflection, Homogenous Coordinate system , Concatenated Transformation, Mapping of Geometric Models, Inverse Transformations.

Geometric Modelling Curves Introduction to Parametric representation of curves and its advantages. Analytic Curves- Line, Circle, Parabolas, Hyperbolas, Ellipses, Conics. Synthetic Curves- Hermite Cubic Spline, Bezier Curve, Surfaces Introduction to Parametric representation of Surfaces. Analytic Surfaces-Plane, Ruled, Tabulated, Revolved surfaces. Synthetic Surfaces- Bezier Surface, Solids

Introduction, Geometry and Topology, Solid Representation, Boundary Representation, Euler's equation, Constructive Solid Geometry, Boolean operation for CSG, Hybrid Modelling, Feature Based Modelling,

Computer Aided Manufacturing Introduction, Integrating CAD, NC and CAM, Preparing CAD data for NC, The Basic components of NC System, Machine Axes and Coordinate system, Positioning System, NC Motion Control System, Point-to-Point and Continuous Path Machining, The NC Procedure, Machine Zero, Job Zero, Manual part Programming (G and M code),

Section II

Finite Element Analysis Types of 1D element. Displacement function, Global and local coordinate systems, Order of element, primary and secondary variables, shape functions and its properties. Formulation of elemental stiffness matrix and load vector for spring, bar, beam, truss and Plane frame. Transformation matrix for truss and plane frame, Assembly of global stiffness matrix and load vector, Properties of stiffness matrix, half bandwidth, Boundary conditions elimination method and penalty approach, Symmetric boundary conditions, Stress calculations. Two Dimensional Finite Element

Analysis Types of 2D elements, Formulation of elemental stiffness matrix and load vector for Plane stress/strain such as Linear Strain Rectangle (LSR), Constant Strain Triangles (CST), primary and secondary variables, properties of shape functions. Assembly of global stiffness matrix and load vector, Boundary conditions, solving for primary variables (displacement)

Rapid Prototyping Introduction to Rapid Prototyping, classification of RP Processes, Working principle, models & specification process, application, advantages & disadvantages

Home Assignment:

List of Home Assignments: Design:

1. Design and Analysis a beam for a given application

2. Design and analysis of Shaft

4. Design and analysis of connecting rod Case Study:

1. Effect Mesh size

2. Effect of material on Model

3. Effect of variation of thermal conductivity in a nonlinear conduction problem

5. Good and Bad FEA model Blog:

1. Principles and Tips for Improving Engineering Analysis

2. Automotive Applications of FEA

3. Finite element for nonlinear problems

4. Recent areas of Application for FEA

5. Recent areas of application for CFD Surveys:

1. Novel application of FEA

2. Novel application of CFD

Text Books:

1. Ibrahim Zeid, “Mastering CAD/CAM”, Tata McGraw Hill

2. Groover M. P., “Automation, production systems and computer integrated manufacturing” Prentice Hall of India.

3. Chandrupatla T. R. and Belegunda A. D., “Introduction to finite elements in engineering”, Prentice Hall of India

4. P.N. Rao -CAD/CAM, Principles & Applications-Tata McGraw Hill

Reference Books:

1. Ibrahim Zeid, “CAD/CAM - theory and practice”, Tata McGraw Hill.

2. Segerling L. J., “Applied finite elements analysis”, John Wiley and Sons.

3. Gebhardt A., “Rapid Prototyping”, Hanser Publisher.

4. David F. Rogers, J. Alan Adams, Mathematical Elements for Computer Graphics, Tata McGraw-Hill Publishing Company Ltd., New Delhi-8.

CO-PO Mapping

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	1	1	1	0	0	0	0	0	0	0	0	3	1	0
CO 2	0	0	1	0	0	1	0	0	0	0	0	0	3	2	0
CO 3	0	1	0	0	0	0	0	2	0	0	0	0	3	3	2
CO 4	0	0	2	3	0	0	0	2	0	0	0	0	3	3	2
CO 5	0	0	2	3	0	0	0	1	0	0	0	0	3	2	0
CO 6	0	0	1	3	0	0	0	0	0	0	0	0	3	3	1

ME4280: COMPUTATIONAL FLUID DYNAMICS

Syllabus Template

ME 4280 Computational Fluid Dynamics

Prerequisites: Knowledge of Fluid Mechanics, Heat Transfer and Numerical Methods

Course Objectives:

1. To teach the basics of numerical methods to solve flow/thermal energy equations
2. To understand and learn Finite volume method
3. To learn modelling of industrial flow problems
4. To understand choosing the most appropriate boundary conditions
5. To know the basics of turbulence modelling
6. To know the basics of Compressible flow and its formulations

Credits: 02 **Teaching Scheme: Theory: 2 Hours/Week**

Course Relevance:

1. The course exposes the students to algorithms used in flow solvers.
2. Students learn how to model and simulate industrial flow problems
3. With the knowledge gained by this course, students can model, simulate as well as design components like blower, turbine, heat exchanger etc.

Section I

Unit 1

Review of fluid mechanics & heat transfer, Principles of Conservation: Continuity Equation, Navier Stokes Equation, Energy Equation and General Structure of Conservation Equations (Reynolds transport theorem)

Unit 2

Classification of Partial Differential Equations and Physical Behaviour, Approximate Solutions of Differential Equations: Error Minimization Principles, Variational Principles and Weighted Residual Approach, Finite Volume Method: Some Conceptual Basics and Illustrations through 1-D & 2D Steady and unsteady State Diffusion Problems

Unit 3

Boundary Conditions, Stability Analysis: Consistency, Stability and Convergence; Meshing technique, Unstructured & structured Grid Formulation, Grid independent and time

independent study

Section II

Unit 4

Discretization of Navier Stokes Equations: Stream Function- Vorticity approach and Primitive variable approach; Differencing scheme: central, upwind, higher order differencing, explicit and Implicit scheme; Solution Algorithms for Pressure -Velocity coupling: (SIMPLE, SIMPLEC, PISO Algorithm)

Unit 5

Turbulence Modeling: Introduction, Statistical representation of turbulent flows: General Properties of turbulent quantities, Closure problem: Necessity of turbulence modeling, Reynolds average Navier stokes (RANS) equation, Different types of turbulence model, near wall behavior

Unit 6

Compressible Flow: solution of compressible N-S equation, finite volume formulations, geometric flexibility

List of Tutorials: (Write any 3)

1. Discretization of compressible N-S equation
2. Energy conservation equation for steady/unsteady state & compressible/incompressible flow
3. Analytical solution for Unsteady Heat Conduction in 1-d
4. Analytical solution for Unsteady heat Conduction in 2 d
5. Analytical solution for Unsteady heat Conduction in 3 d
6. Write a code of laminar flow through a pipe (Python, FORTRAN, MATLAB)
7. Write a code of parabolic inlet velocity profile (Python, FORTRAN, MATLAB)
8. Analytical solution of drag force, for a laminar flow over a flat plate
9. Analytical solution of constant heat flux on wall boundary
10. Analytical solution for Blasius Equation

List of Practical's: (Any Six)

1. Laminar/turbulent flow through a pipe/channel
2. Flow through a pipe bend
3. Flow through a 2D square lid driven cavity
4. Flow through a Converging-Diverging Nozzle
5. External flow analysis: Flat plate/Circular Cylinder/Aerofoil
6. Natural Convection with a Vertical Plate
7. Flow through a pipe with constant temperature/heat flux wall condition
8. Conduction through a slabs/walls/bricks
9. Flow through a tube-in-tube heat exchanger
10. Effect of Diffuser angle on aerodynamic characteristics

PR4203: DIE AND MOLD DESIGN

Syllabus Template

PR4203::DIE & MOLD DESIGN

Course Prerequisites: Manufacturing Technology,Forming Technologies & Tool

Technology

Course Objectives:

1. To learn sheet metal working operations and equipments

2. To design Simple blanking and progressive die design 3.To learn design of deep drawing dies and Bending dies 4.To learn design of pattern, core box and gating system of sand cast and diecast components

5. To understand principle of injection mould design for plastic components

Credits:2 **Teaching Scheme Theory: 2 Hours/Week**

Course Relevance: This course explores the design of dies for sheet metal shearing and

forming operations .It also focus on design of casting manufacturing tools such patterns, corebox, gating system, die casting dies, injection molding dies for plastic components. This will enhance skills and methods of Die, Molds and Tools design for engineering applications. Scope of course is in core engineering design as well as consulting and service industries for new product design and developments from sheet metal, forged and injection molded plastic components.

SECTION-1

1) Introduction to Press Working :Press working terminology, Basic operations, types of presses-mechanical, hydraulic, pneumatic and their mechanisms, elements of die sets, types of die sets, types of dies - simple, compound, progressive, combination and inverted dies, types of punches Methods of reduction of shear force, types of strip layouts, types of strippers, types of pilots, types of stoppers.

2) Design of Blanking & Progressive dies: Shearing force, press capacity, clearances, die & punch size types of strippers, types of pilots, types of stoppers, selection of dowel pins &allen screws., center of pressure of progressive die. Problems on progressive and blanking die design

3) Design of Deep Drawing & Bending Dies:Formability of sheet metals,Forming Limit diagram, Anisotropy of sheet metals,Deep drawing mechanism, Design of deep drawing die: blank size, no of draws, drawing punch and die size, drawing force, press capacity and ironing,Types of Bending dies, developed length calculation, bending force, spring back & methods used to overcome it, press brake.

SECTION-1I

4) Forging Die Design :

(A) Closed die Forging : Single impression and Multi impression dies.Stock size calculation, Machined component part print to Forged component part design.Forging process plan. Edging impression design, Blocking, Fullering and Finishing impression die design.Forging Die material, Die manufacturing and heat treatment of dies.

(B) Upset Forging Die Design: Rules of Upset forging,Stock size estimation. Process sequence. Die and punch sets for psetting. Equipment and applications of Upset forged.

5) Polymer materials &Processing: Classification of polymer materials, property and applications.

Processing polymers: Injection Moulding, Compression Moulding, Blow Moulding,Rotational Moulding, Thermoforming, Calendering and Extrusion processes.

6)Injection Mould Design :Injection moulding: Types of machines and equipment,Selection of plastic material for various parts, Design of mould elements: Cavity & Core Two plate injection mould system, three plate injection mould system,,parting lines, split molds, molds for threaded components. Feed system: Designs of various types of runners, gates, balancing of runners, positioning of gates, mould filling patterns etc. Ejection system: Pin ejection, stripper plates, valve ejection, blade ejection, air ejection, etc. Cooling & heating

arrangements: Design of cooling channels, layouts etc,runner less molds.

List of Home Assignments: Design:

1. Blanking die design of simple blank

2. Deep drawing die design for cup shape forming

3. Bending die design of bend component 4.Closed Forging Die design 5.Upset Forging Die design

Design Case Study of Industry base components:

1. Die design for Cup shape components.

2. Die design for connecting rod 3 Die design for axle flange 4.Die design for Bottle Cap

5. Die design for sheet metal components

Text Books: (As per IEEE format)

1.Donaldson, Lecain and Goold, Tool Design, Tata McGraw Hill, ISBN 0 07 099274

2. J R Paquin, Die design Fundamentals, Industrial Press Inc., ISBN 0 8311 1172 0.

3. P. N. Rao, Manufacturing Technology- Foundry, Forming & Welding, Tata McGraw Hill

4. R. G. W. Pye, Injection Mould Design (Design manual for plastic industry), EWP

Reference Books: (As per IEEE format)

1. P. H. Joshi, Press Tools Design & Construction, Wheeler Pub

2. P. C. Sharma, Production Engineering, S. Chand

3. Dr. Surender Kumar, Production Engg. Design (Tool Design), Satya Prakashan

4. R. G. W. Pye, Injection Mould Design (Design manual for plastic industry), EWP

5. A. S. Athalye, Plastics Materials handbook, Multitech Pub. Co., ISBN 81 7671 007

6. Denton and Glanvil Injection mould design fundamentals, Industrial Press, Inc.

Moocs Links and additional reading material: www.nptelvideos.in

Course Outcomes:

Student will be able to

1. Select and design appropriate die set and equipment for shearing operations of sheet metal.

2. Understand principles of deep drawing operations.

3. Design bending die design and selection of press capacity

4. Scope of polymeric materials and applications

5. Understand the principles of polymer processing techniques

6. Design elements of injection molding dies and understand the working of injection machines.

CO PO Map

CO attainment levels

Future Courses Mapping:

For Higher studies in Tool and Die Design,Plastic Engineering, MTech Manufacturing Engineering, MTech Design

Job Mapping:

Die designer in Sheet metal industry, Forging Industry, Plastic component manufacturing as well as casting manufacturers.Die shop ,Toolroom, Job as Engineering design department. Procurement of sheet metal components,plastic components, forged components and castings

ME4253: VIBRATION ANALYSIS

Syllabus Template

ME4253:Vibration Analysis

Course Prerequisites:

Engineering Mechanics; Theory of Machines, Mathematics course related to: Ordinary Differential Equation, Matrices, Transforms: Fourier and Laplace

Course objectives:

Students will be able to-

1. To understand the fundamentals of Vibration Theory
2. To be able to mathematically model real-world mechanical vibration problems
3. To use computer software programs to investigate and understand vibration problems.

Credits: 02 **Teaching Scheme: Theory: 2 Hours/Week**

Course Relevance:

Vibration is a common phenomenon occurring in a mechanical system. For example, vibration of a rotor due to unbalanced mass, vibration of a vehicle engine at varying speed. The study of a dedicated course is required to understand the fundamental concepts of mechanical vibrations for engineers and designers.

SECTION—I

Introduction: Concept of linear and non-linear systems, various mathematical models of vibration system, damping models, free vibration analysis.

Forced vibration analysis (under harmonic excitation) of single degree freedom system, force and displacement transmissibility, Numerical simulations.

Multi degree freedom systems: Introduction, Formulation of equations of motion, elastic and inertial couplings, Free vibration analysis (un-damped and damped): natural frequencies and mode shapes, orthogonality of mode shapes, principal coordinates, modal analysis, Numerical simulations.

SECTION—II

Multi degree freedom systems: Forced vibration analysis (under harmonic excitation) , Numerical simulation.

Rotor system dynamics, Principles of vibration Control.

Vibration Measurements: Measurement of displacement, velocity, acceleration, frequency and damping. Vibration testing equipment's: signal generation, measurement and analysis, conditioning monitoring of pumps, gear box, e.t.c..

List of Home Assignments:

Design:

1. 1-DOF system free vibration
2. 1-DOF system forced vibration
3. 2-DOF system free vibration
4. 2-DOF system forced vibration
5. Vibration instruments –design considerations Case Study:

1. Vibration conditioning monitoring of centrifugal pumps

2. Vibration conditioning monitoring of gear box

3. Vibration analysis of washing machine

4. Vibration absorbers-application like high tension cables

5. Fault diagnosis using vibration measurements Blog

1. Various damping models

2. Linearization of non-linear system- Demonstration using Simple pendulum problem

3. Displacement transmissibility of shock absorbers subjected to shock loading

4. Vibration isolators

5. Forced vibration analysis under periodic (non-harmonic) excitation Surveys

1. Vibration measuring instruments

2. Acceptable Levels of Vibration-different standards 3.Source of vibration in steam turbines

4. Sources of vibration in a car

5. vibration isolation systems

Text Books: (As per IEEE format)

1. L. Meirovitch, Fundamental of Vibrations, Mc-Graw Hill Inc., 2001 2.Grover G. K., Mechanical Vibrations ,Nem Chand and Bros (2009)

3. , S. S. Rao, Mechanical Vibrations, Pearson Education Inc. (4th Ed.), 2007.

4. Ghosh and Malik, Theory of Mechanism and Machines , East West Pvt. Ltd

Reference Books: (As per IEEE format)

1.Thomas Bevan, Theory of Machines, CBS Publications.

2. B. Balachandran, E. B. Magrab, 2009, Vibrations, Cengage learning: Second edition

3. D. J. Inman, Engineering Vibration, 4th Edition, Prentice-Hall, 2013

4. S. Graham Kelly, Fundamentals of Mechanical Vibrations, Mc-Graw Hill, 2000. Second edition

Course Outcomes: Students will be able to

1. Develop the mathematical model of a single degree freedom vibration system and perform free vibration analysis.

2. Perform force vibration analysis of a single degree freedom system.

3. Develop the mathematical model of a multi degree freedom vibration system and perform free vibration analysis.

4. Perform forced vibration analysis of a multi degree freedom system.

5. Perform and verify computer simulations employing time integration and modal analysis of discrete vibrating systems.

6. Select the instruments for a vibration measurement and analyze the measured data.

ME4254: REFRIGERATION AND AIR CONDITIONING

Syllabus Template

ME4254: REFRIGERATION AND AIR CONDITIONING

Course prerequisite-Thermodynamics and Heat Transfer

Course Objectives:

1. Students should be able to analyze vapour compression refrigeration cycle and find cop of the cycle.

2. Students will be able to compare two vapour compression cycles and select the efficient one.

3. Students will be able to understand various psychometric processes involved in air conditioning systems.

4. Students will be able to find important factors which affect the load on the air conditioner.

Credits: 2 **Teaching Scheme Theory: 2 Hours/Week**

Course Relevance:

Refrigeration is the need of an hour. Refrigeration cycles are used in cold storages, transport of perishable food, blood banks, ice plants, dairies and few process industries. Air conditioning has become a necessity to cope up with the extreme atmospheric conditions. It is necessary for comfort in malls, auditoriums, theaters, hospitals, hotels, buses, railways, aeroplanes as well as in some process industries. VCS and VAS both are widely used in comfort and process air conditioning. Mechanical engineers, having knowledge of refrigeration and air conditioning may get various job opportunities in the above and other related industries.

SECTION-1

Unit 1 :Vapour Compression Cycle (VCC)

Introduction of Refrigeration, Ideal vapour compression cycle (VCC), effect of operating parameters on VCC, use of p-h charts, actual vapour compression cycle, method to improve COP of VCC, Introduction to multistage systems. (CO1)

Unit 2: Refrigerants

Classification of refrigerants, Desirable properties of refrigerants, Designation of refrigerants, Ozone depletion potential (ODP) Global warming potential (GWP), Montreal protocol, Kyoto protocol, Alternative Refrigerants, Total equivalent warming impact

(TEWI). (CO2)

Unit 3: Components of VCC and Vapour Absorption Cycle

Types of Compressor, Condenser, Evaporator, Expansion Device. Introduction to vapour absorption system (VAS), COP of simple vapour absorption system, lithium bromide system, Comparison between VCS and VAS. (CO3)

SECTION-1I

Unit 4: Psychrometry

Introduction to Psychrometry, Psychrometric properties, Use of Psychrometric chart. (CO4)

Unit 5: Psychrometirc Processes

Psychrometric processes, Sensible heat Factor (SHF), Application of psychrometric processes in Air-conditioning equipment - Apparatus Dew Point (ADP), Bypass factor of coil, Air Washer, Evaporative cooling. (CO5)

Unit 6: Comfort Conditions and Types of AC Systems

Human comfort, factors influencing comfort, Concept of effective temperature, Air conditioning Systems - Unitary, Zoned and Central; Summer, Winter and Year round. Applications of Air conditioning in Industry and Transport. Introduction to duct system. (CO6)

List of Home Assignments: Design: 1.Food preservation system

2. Alternative refrigerants

3. Air refrigeration cycles

4. Cryogenic refrigeration

5. Multi compression multi evaporator VCS Case Study:

1. Case study of an auditorium air conditioning plant

2. Case study of a window air conditioner

3. Case study of air conditioning systems of railway coach

4. Case study of winter air conditioning systems

5. Case study of evaporator types Blog

1. ECO friendly Refrigerants

2. Rotary compressors in RAC applications

3. Latest trends in condenser

4. Latest trends in duct design

5. Latest trends in domestic refrigerator Surveys

1. Survey of different compressors used in RAC applications

2. Survey of different types of room air conditioners available in market

3. Survey of different types of expansion devices

4. Survey of food preservation systems

5. Survey and comparison of household split air conditioners

Suggest an assessment Scheme: Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Blooms Taxonomy.

1. MSE

2. HA

4. CVV

5. ESE

Text Books: (As per IEEE format)

1. Khurmi R.S., Gupta J. K.,―Refrigeration and Air conditioning, S. Chand Publication (Fifth edition).

2. Arora C. P., ―Refrigeration and Air conditioning, Tata McGraw Hill Co., New Delhi.

3. Dossat Ray J, ―Refrigeration and Air conditioning, Wiley Eastern Limited

Reference Books: (As per IEEE format)

1. Arora S. C. and Domkundwar S., ―Refrigeration and Air conditioning, Dhanpatrai and Sons, New Delhi.

2. Manohar Prasad, ―Refrigeration and Air conditioning, Wiley Eastern Limited.

3. Anantnarayanan ―Refrigeration and Air conditioning, Tata McGraw Hills Co., New Delhi.

Moocs Links and additional reading material: www.nptelvideos.in

Course Outcomes:

The students will be able to – 1.Analyze vapour compression and vapour absorption refrigeration system

2. Select suitable components for vapor compression system application and compatible ecofriendly refrigerant based on international protocols

3. Various methods to improve COP of VCS and VAS

4. Analyze psychrometric processes and use those in air conditioning methods

5. Understand different types of air conditioning systems applied for human comfort and for industrial applications

6. Understanding various factors contributing in the air conditioning load

CO PO Map

PO 2 3 4 5 6 7 8 9 10 11 12 PS 2 3 CO 1 O1

1 3 2 3 3 2 3 3 1 1 1 1 1 1 3 1

2 3 2 3 3 2 3 3 1 1 1 1 1 1 3 1

3 3 2 3 3 2 3 3 1 1 1 1 1 1 3 1

4 3 2 3 3 2 3 3 1 1 1 1 1 1 3 1

5 3 2 3 3 2 3 3 1 1 1 1 1 1 3 1

6 3 2 3 3 2 3 3 1 1 1 1 1 1 3 1

CO attainment levels

CO Number Level

1 3

2 5

3 4

4 3

5 4

6 5

Future Courses Mapping: Mention other courses that can be taken after completion of this course Advanced refrigeration and air conditioning, Advanced applied thermal engineering

Job Mapping:

What are the Job opportunities that one can get after learning this course Work in cold storages, blood banks, malls, auditoriums, hotels, hospitals, theaters, sugar mills, pulp and paper mills etc as RAC engineer. This knowledge will be useful to study advanced RAC and then design, erection and commissioning of the system can be done.

ME4261: POWER PLANT ENGINEERING

Syllabus Template

ME4261: Power Plant Engineering

Credits: 02 **Teaching Scheme Theory: 02 Hours/Week**

Course Prerequisites:

1. Thermodynamics

2. Applied Thermal Engineering

3. Heat Transfer

4. Fluid Mechanics & Hydraulic Machines Power Plant Engineering is a vast field of Engineering that mainly focuses on power generation and the principles involved in real-world applications. More specifically this course is focused on application of energy principles and power generation cycles.

Course Objectives:

1) To study the power generation scenario, the components of thermal power plant, improved Rankin cycle, Cogeneration cycle. 2) To understand details of steam condensing plant, analysis of condenser, the environmental impacts of thermal power plant, and methods to reduce various pollution from thermal power plant. 3) To study layout, component details of hydroelectric power plant, hydrology and elements, types of nuclear power plant. 4) To understand components; layout of diesel power plant, components; different cycles; methods to improve thermal efficiency of gas power plant. 5) To study the working principle, construction of power generation from non-conventional sources of energy. 6) Providing an overview of Power Plants and detailing the role of Mechanical Engineers in their operation and maintenance.

Course Outcomes: On completion of the course, students will be able to –

1) Describe and analyze different types of sources and mathematical expressions related to thermodynamics and various terms and factors involved with power plant operation. 2) Describe the power generation scenario, the layout components of thermal power plant and analyze the improved Rankin cycle, Cogeneration cycle.

3) Analyze the steam condensers, recognize the environmental impacts of thermal power plant and methods to control the same. 4) Recognize the layout, component details of hydroelectric power plant and nuclear power plant. 5) Realize the details of diesel power plant, gas power plant and analyze gas turbine power cycle. 6) Emphasize the fundamentals of non-conventional power plants.

Section I

Introduction to Power plant: Power and energy, sources of energy, review of thermodynamic cycles related to power plants - Rankine cycle, Indian Energy scenario, Conventional& Non-Conventional sources of energy and their availability in India, different types of Power Plants, Power Plants in India, Location of power plant.

Thermal power plant: Role of thermal power plant in current power generation scenario, Selection site for thermal power plant, General lay out of a thermal power plant, Fuels used in thermal power plant- Fuel handling layout and its methods, stages in coal handling storage, Fuel burning-Stoker firing, Pulverized fuel burning- Pulverization of coal, Ash handling system- Gravity system, pneumatic or vacuum system. Ash disposal management and its utilization, Feed water treatment- Mechanical, thermal methods.

Hydroelectric power plant: Introduction to Hydroelectric power plant, Rainfall, Runoff and its measurement, Hydrograph, flow duration curve, Selection of sites for hydroelectric power plant, General layout of Hydroelectric power plant and its working, Classification of the plant-Run off river plant, storage river plant, pumped storage plant, Advantages and disadvantages of hydroelectric power plant

Section II

Diesel and Gas turbine plant: The layout of diesel power plant, Components and the working of diesel power plant, Advantages and disadvantages of diesel power plant, Gas turbine power plant-Schematic diagram, components and its working, Combined cycle power generation- Combined gas and steam turbine power plant operation (only flow diagram).

Nuclear power plant: Introduction, Nuclear power-Radio activity-Radioactive charge-types of reactions, Working of a nuclear power plant, Thermal fission Reactors- PWR, BWR and gas cooled reactors, Advantages and Disadvantages of Nuclear power plant.

Power from Renewable Energy: Principle, Construction and working of Wind, Tidal, Solar Photovoltaic (SPV), Solar Thermal, Geothermal and Fuel Cell power systems.

Power Plant Economics and Environmental impact of Power plant: Social and economical issues of power plant, greenhouse effect, Acid precipitation-Acid rain, Acid snow, Dry deposition, Acid fog, Air, water, Thermal pollution from power plants, Radiations from nuclear power plant effluents. Energy, Economic and Environmental issues of Power plants.

List of Tutorials: (Any Three)

1) Analysis of Rankine cycle 2) Analysis of Rankine cycle with reheat 3) Analysis of Rankine cycle with regeneration 4) Analysis of Rankine cycle with reheat and regeneration 5) Analysis of nozzle 6) Analysis of jet condenser 7) Analysis of surface condenser 8) Analysis of cooling towers and cooling ponds 9) Power plants load 10) Power plant economics

List of Practical's: (Any Six)

1. Trial on diesel power plant
2. Trial on steam power plant
3. Industrial visit to power plant
4. Trial and demonstration of a boiler feed water treatment
5. Study and demonstration of power plant instrumentation
6. Study and demonstration of High pressure boiler
7. Study and demonstration of FBCB boiler
8. Study and demonstration ESP system
9. Demonstration and trial on Surface Condenser
10. Demonstration and trial on Steam Nozzles List of Course Seminar Topics:

1. Thermal power plant
2. Hydraulic power plant
3. Nuclear power plant
4. Wind power plant
5. Diesel power plant
6. Solar power plant

7. Gas power plant
8. DM Plant and Water Treatment
9. Ash handling and dust collection
11. Cooling towers and cooling ponds Indian Energy Scenario and World Energy resources
12. Clean Coal Technology
13. Combined cycle Gas Turbine for efficient Energy Production
14. Supercharging and Turbocharging for Diesel Power Plant
15. Optimization of Solar Power Plant
16. Safety in Nuclear Power Plants
17. Design of Wind Power Turbines
18. Economics and Environmental issues of Power Plants

List of Course Group Discussion Topics:

1. Selection of sight of Nuclear Power Plant
2. Selection of sight of Hydro Power Plant
3. Environmental impact of Thermal Power Plant
4. Waste Disposal of Nuclear Power Plants
5. Cooling water requirements for power plant and water pollution
6. Load shedding between power stations,
7. Cost analysis
8. Solar energy as a clean energy source
9. Biogas
10. Tidal energy List of Home Assignments: Design:

1. Design of jet condenser
2. Design of surface condenser
3. Design of nozzle of a power plant
4. Wind turbine design for wind power plants
5. Steam turbine design Case Study:

1. Case study of thermal power plant with coal as a fuel
2. Case study of thermal power plant with gas as a fuel
3. Case study of sugar factory cogeneration power plant
4. Case study of a nuclear power plant
5. Case study of DM plant in a sugar factory cogeneration power plant
6. Case study on combined cycle power plant with cogeneration
7. Study and Analysis of Small Hydro Projects
8. Case studies on Interconnection Barriers for Distributed Renewable Power Projects
9. Case Studies on Renewable Energy sources Blog:

1. Power generation scenario in India

2. Power generation scenario of world

3. Solar power generation

4. Pollution due to thermal power plant

5. Coal reserves of India and coal imports Surveys:

1. Survey for power plant types and its capacity in India

2. Survey for Nuclear power plant types and its capacity in World

3. Survey for Wind power plant types and its capacity in World

4. Diesel power plants

5. Gas power plants

Moocs Links and additional reading material: www.nptelvideos.in

1. http://nptel.ac.in/courses/108105058/8

2. http://nptel.ac.in/courses/108105058/9

3. http://nptel.ac.in/courses/108105058/10

Text Books:

1. Domkundwar& Arora, Power Plant Engineering, Dhanpat Rai & Sons, New Delhi

2. Domkundwar&Domkundwar- Solar Energy and Non-Conventional Sources of Energy, Dhanpat Rai& Sons, New Delhi.

3. R.K.Rajput, Power Plant Engineering‖, Laxmi Publications New Delhi.

4. D.K.Chavan&G.K.Phatak, Power Plant Engineering‖, Standard Book House, New Delhi.

References Books:

1. E.I.Wakil, Power Plant Engineering‖, McGraw Hill Publications New Delhi

2. P.K.Nag, Power Plant Engineering‖, McGraw Hill Publications New Delhi.

3. R.Yadav , Steam and Gas Turbines‖ ,Central Publishing House, Allahabad.

4. G.D.Rai, Non-Conventional Energy Sources, Khanna Publishers,Delhi

5. S.P.Sukhatme, Solar Energy‖ Tata McGraw-Hill Publications, New Delhi

6. G R Nagpal Power Plant Engineering , Khanna Publication

7. Gas Turbines by V.Ganeshan, McGraw Hill Education

8. Steam Turbine Theory and Practice, William J. Kearton, CBS Publication

9. Power plant Engg / Elanchezhian/ I.K. International Pub Future Courses Mapping: There is a great and vast career scope in Power Plant Engineering and also a power plant engineer career can be very well established. Although thermal power is an obsolete source of energy requirements in India, which is fulfilled by many plants in India. Power Plant Engineering will be leading the world in energy requirements for 3-4 decades. You can also do a Postgraduate while working in the industry. Thus a career in Power Plant Engineering is not limited and has great opportunities in India as well as abroad.

Job Mapping:

Work in different power plants such as thermal, hydro, nuclear, gas as an engineer. This knowledge will be useful to study power station economics in detail. Defense and railways also are beneficial areas for them as these departments require thermal engineers to assist in the maintenance and design of their machinery. Spraying and Maintenance Services Milling Companies Steam Pipelines

Fabrication Services Boiler Maintenance and Cleaning Services Educational Institutes Power Plant Engineering NPTEL Dams Hydro-companies Power Houses Electricity Departments

CO PO Map:

P P P P P P P P P PO PO PO1 PSO PSO PSO O1 O2 O3 O4 O5 O6 O7 O8 O9 10 11 2 1 2 3

CO 3 3 3 3 3 2 1 1 1 2 1 1 1 3 1

CO 3 3 3 3 3 2 1 1 1 2 1 1 1 3 1

CO 3 3 3 3 3 2 1 1 1 2 1 1 1 3 1

CO 3 3 3 3 3 2 1 1 1 2 1 1 1 3 1

CO 3 3 3 3 3 2 1 1 1 2 1 1 1 3 1

CO 2 2 3 3 3 3 1 1 1 2 1 1 1 3 1

CO attainment levels:

CO Number Level 1 4 2 5 3 4 4 3 5 4 6 3

Suggest an assessment Scheme:

Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree

assessment and check if it covers all aspects of Blooms Taxonomy.

MCQ Exam – Section I (30 Marks converted to 30 equivalent Marks)

Home Assignment 100 (Marks converted to 10 equivalent Marks)

MCQ Exam – Section II (30 Marks converted to 30 equivalent Marks)

Comprehensive Viva Voce (100 Marks converted to 30 equivalent Marks)

CO-PO Mapping

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 3	3	3	3	3	2	1	1	1	2	1	1	1	3	1	
CO 3	3	3	3	3	2	1	1	1	2	1	1	1	3	1	
CO 3	3	3	3	3	2	1	1	1	2	1	1	1	3	1	
CO 3	3	3	3	3	2	1	1	1	2	1	1	1	3	1	
CO 3	3	3	3	3	2	1	1	1	2	1	1	1	3	1	
CO 2	2	3	3	3	3	1	1	1	2	1	1	1	3	1	

MD4206: MARKETING MANAGEMENT

Syllabus Template

IE4206:MARKETING MANAGEMENT

Course Prerequisites: None

Course Objectives:

1. To provide basic understanding of marketing management concepts and their relevance to business development

2. To make students aware of the questionnaire for market research

3. To provide understanding of consumer & industrial buying decision process & motives. 4.To provide understanding of the concept of product management and branding in context of consumer and industrial products

5. To develop knowledge for optimizing marketing mix to get competitive advantage

Credits:2 **Teaching Scheme: Theory: 2 Hours/Week**

Course Relevance: This course will provide basic knowledge of Marketing for working

in a business environment.

SECTION-1

1. Concepts of Marketing Definition of Marketing, Core marketing concepts, Marketing Management philosophies, Micro and Macro Environment, Characteristics affecting Consumer behavior, Types of buying decisions, buying decision process, Classification of consumer products, Market Segmentation

2. Marketing Information Systems And Research Components of marketing information system– benefits & uses marketing research system, marketing research procedure, Demand Estimation research, Test marketing, Segmentation Research - Cluster analysis, Discriminant analysis. Sales forecasting: objective and subjective methods

3. Marketing of Industrial Goods Nature and importance of the Industrial market, classification of industrial products, participants in the industrial buying process, major factors influencing industrial buying behavior, characteristics of industrial market demand. Determinants of industrial market demand Buying power of Industrial users, buying motives of Industrials users, the industrial buying process, buying patterns of industrial users.

SECTION-1I

1. Product Management The concept of a product, features of a product, classification of products, product policies – product planning and development, product line, product mix – factors influencing change in product mix, product mix strategies, meaning of "New – product; major stages in new – product development product life cycle.

2. Branding Reasons for branding, functions of branding features of types of brands, kinds of brand name.

3. Pricing Policies Importance of Price, pricing objectives, factors affecting pricing decisions, procedure for price determination, kinds of pricing, pricing strategies and decisions

4. Advertising and Sales Promotion (Digital marketing) Objectives of advertisement function of advertising, classification of advertisement copy, advertisement media – kinds of media, advantages of advertising. Objectives of sales promotion, advantages sales promotion,

5. Packaging Meaning, growth of packaging, function of packaging, kinds of packaging.

List of Tutorials: (Any Three)

List of Practicals: (Any Six) NA

List of Projects: NA

List of Course Seminar Topics: NA

List of Course Group Discussion Topics: NA

List of Home Assignments: Design:

1. Consumer Analysis for a firm
2. Market segmentation plan
3. Business market stakeholder analysis
4. Product line analysis
5. Pricing strategy for the product/service Case Study:

1. How Social Media Insights Marketing
2. Impact of E-Commerce on marketing
3. Case study on societal Marketing
4. Product Development analysis
5. Personal Selling Blog

1. Marketing through social Media
2. Changing buying motives for the consumer
3. Ethics in marketing
4. Marketing & Distribution
5. Industrial engineering tools for marketing Surveys

1. Consumer Analysis
2. Market analysis for particular Product or Service
3. Factors influencing industrial buying
4. Impact of promotion
5. Impact on advertisement on the consumer preferences.

Assessment scheme Sr. Type of Assessment Conduction Marks No 30 Marks converted to 30 equivalent 1 MCQ Exam – Section I Mid Semester Marks 100 Marks converted to 10 2 Home Assignment End of Semester equivalent Marks 30 Marks converted to 30 equivalent 3 MCQ Exam – Section II End of Semester Marks 100 Marks converted to 30 4 Comprehensive Viva Voce End of Semester equivalent Marks

Text Books: (As per IEEE format)

1. Philip Kotler, Principles of Marketing Prentice – Hall.
2. Philip Kotler, Marketing Management Prentice – Hall.

Reference Books: (As per IEEE format)

1. Wiliam J Stanton, Fundamentals of Marketing Mcgraw Hill
2. R.S.N. Pillai and Mrs. Bagavathi , Marketing S. Chand

Moocs Links and additional reading material: www.nptelvideos.in

Course Outcomes:

Students will be able to:

1. Understand basic marketing management concepts and their relevance to business development

2. Prepare a questionnaire to design marketing research plan for business organizations

3. Understand consumer & industrial buying decision process & motives.

4. Understand the concept of product management and branding in context of consumer and industrial products

5. Understand the pricing strategies in context of consumer and industrial products.

6. Optimize marketing mix to get competitive advantage

CO PO Map PO1 PO2 PO3 PO4 PO5 PO6 PO7 PO8 PO9 PO10 PO11 PO12 PSO1 PSO2 PSO3 CO1 1 2 0 2 0 3 1 1 1 2 3 1 1 0 1 CO2 1 3 3 3 2 2 0 1 2 3 3 1 0 0 2 CO3 0 2 0 1 0 2 1 1 3 3 2 0 1 0 0 CO4 0 2 2 1 0 2 1 0 0 3 2 1 2 2 0 CO5 1 3 3 3 1 1 0 1 2 2 2 1 1 1 2 CO6 2 3 2 2 2 2 1 1 2 1 2 1 0 1 1 Avg 1.25 2.5 2.5 2 1.66 2 1 1 2 2.33 2.33 1 1.25 1.33 1.5

CO attainment levels

CO 1 - 2 CO 2 - 3 CO 3 - 3 CO 4 - 3 CO 5 - 3 CO 6 - 4

Future Courses Mapping: Mention other courses that can be taken after completion of this course

Job Mapping:

Students can get Job opportunities in the area of Marketing

CO-PO Mapping

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	1	2	0	2	0	3	1	1	1	2	3	1	1	0	1
CO 2	1	3	3	3	2	2	0	1	2	3	3	1	0	0	2
CO 3	0	2	0	1	0	2	1	1	3	3	2	0	1	0	0
CO 4	0	2	2	1	0	2	1	0	0	3	2	1	2	2	0
CO 5	1	3	3	3	1	1	0	1	2	2	2	1	1	1	2
CO 6	2	3	2	2	2	2	1	1	2	1	2	1	0	1	1

PR4213: WORLD CLASS MANUFACTURING & INDUSTRY 4.0

Syllabus Template

PR4213::WORLD CLASS MANUFACTURING & INDUSTRY 4.0

Course Prerequisites:

Basics of How Factory works, Facility Planning, Manufacturing Systems and Strategy

Course Objectives:

1. Understand and Apply basic concepts and Principles of Lean Management
2. Understand Toyota Production System and apply it's principles
3. Acquire knowledge of Total Productive Maintenance Philosophy and
4. Understand and Apply Theory of Constraints to solve industry problems
5. Apply Lean, TPS, TPM and TOC in Service sector like Healthcare, Banking etc.

Credits: 2 **Teaching Scheme Theory: 02 Hours/Week**

Course Relevance:

Course helps to understand and implement Lean Principles, Toyota Production System, TPM and Theory of Constraints in Industries.

SECTION-1

Topics and Contents Lean Manufacturing – Definition & Concept. Characteristics of Lean Manufacturing. Concept of MUDA, MURA & MURI, Value Added and NVA activities Value Stream Mapping – VSM Symbols, Current State and Future State, Kaizen- Types, Format. Kaizen Development, Toyota Production System- Toyota's 14 Principles of Management, Problem Solving Approach, Design of JIT- Pull System, Kanban-Types, Calculations of Kanban, Concept of Standard Work – Standardization, Standard Operating Procedures Set-up Time Reduction: SMED Methodology for Set-up reduction, OTED (One Touch Exchange of Dies), Quick Attachment Devices. Group Technology Approaches, Characteristics of A Group/Cell Families of Parts, Group Technology – Codification & Classification Systems , Production Flow Analysis and Choice Of Family , Benefits and Applications Of Group Technology. Cellular Manufacturing: Work cell concepts and applications, Work cell design, work cell staffing and equipment issues.

SECTION-1I

Topics and Contents Japanese Lean Principles: Heijunka (Resource Leveling), Jidoka (Autonomation), Genechi Genbitsu (Go and See) Maintenance Management – Breakdown, Preventive, Predictive. Total Productive Maintenance (TPM): Concept & Origin, Outline of TPM – 8 Pillars, TPM Performance Measures – PQCDSM & OEE (Overall Equipment Effectiveness), Introduction to Autonomous Maintenance (Jishu Hozen) activities, Planned Maintenance, Small-Group activities of TPM. Visual Management System- , Introduction to 5S: Steps in 5S Methodology, Concept of 1S(Seiri), 2S(Seiton), 3S (Seiso), 4S (Shiketsu), 5S, (Shitsuke). Implementation of 1S & 2S, Visual Displays, Visual Controls Theory of Constraints: Introduction to TOC, Concept, Constraints – Types, Factory Physics Laws and Bottleneck Scheduling, Concept of Throughput, Inventory & Operating Expenses, Throughput Accounting, TOC Methodology, Numerical & Cases in TOC. Application of TOC in industry, Drum-Buffer-Rope Approach. Lean Applications in Service Sector - Logistics, Healthcare Industry 4.0: Introduction, Globalization and Emerging Issues, The Fourth Revolution, Smart Factories, Drivers and Enablers of Industry 4.0, Cyber Physical Systems, Industrial IoT (IIoT)

List of Tutorials: (Any Three) NA

List of Practicals: (Any Six) NA

List of Projects: NA

List of Course Seminar Topics: NA List of Course Group Discussion Topics: NA

List of Home Assignments: Design:

1. Design Kanban or JIT system for manufacturing / service organization
2. Design and Implement Single Piece Flow System
3. Design Cellular manufacturing systems by using Lean principles
4. Design TOC based manufacturing / service system
5. Design Industry 4.O and Lean based integrated system Case Study:

1. Case study based on Value Stream Mapping
2. Case study based on Kanban Simulation
3. Case study based on TPM Performance measures and OEE
4. Case study based on Theory of Constraints (TOC) methodology
5. Case study based on Integration of Lean and Industry 4.O Blog

1. Application of any lean technique for the hypothetical or simulated scenario
2. Implementation of any lean technique to solve industry problems (Manufacturing)
3. Understand and Implementation of any lean technique to solve industry problems (Service)
4. Apply Theory of Constraints methodology to solve industry problems
5. TPM benefits and abnormalities Surveys

1. Survey of Companies for Lean Implementation
2. Survey of MSME's to know challenges of Lean Implementation
3. Survey of Companies implemented TPM and its effect on Business
4. Survey of Lean Implementation methodologies in Domestic and MNCs
5. Survey of Critical Success and Failure Factors for Lean implementation

Assessment scheme Sr. Type of Assessment Conduction Marks No 30 Marks converted to 30 equivalent 1 MCQ Exam – Section I Mid Semester Marks 100 Marks converted to 10 2 Home Assignment End of Semester equivalent Marks 30 Marks converted to 30 equivalent 3 MCQ Exam – Section II End of Semester Marks 100 Marks converted to 30 4 Comprehensive Viva Voce End of Semester equivalent Marks

Text Books: (As per IEEE format)

1. B.S. Sahay, Saxena, World Class Manufacturing - A strategic perspective, Laxmi Publications Pvt Ltd, 1st Edition, 2018

2. Richard Schonberger, World Class Manufacturing – The Next Decade: Building Power, Strength, and Value, Free Press, 1996

3. Jeffrey Liker, The Toyota Way, McGraw Hill Publications, Indian Edition, 2017

Reference Books: (As per IEEE format)

1. Mishra R.C., Pathak K, Maintenance Engineering and Management, PHP Publications, 2nd Edition, 2016

2. James Womack & Daniel Jones, Learning to See, 1998

3. John Bicheno, Cause and Effect Lean – The essentials of Lean Manufacturing, 1994

4. Nakajima Seiichi, Introduction to TPM: Total Productive Maintenance, 1995

5. Terry Wireman, Total Productive Maintenance, Industrial Press, 2004

6. Kelley, M.J. Harris, Management of Industrial Maintenance, Newness Butterworths

Moocs Links and additional reading material: www.nptelvideos.in

https://nptel.ac.in/courses/110/107/110107130/ https://www.coursera.org/learn/lean-manufacturing-services

Course Outcomes:

1. Identify, eliminate and reduce the non-value added activities (wastes) in manufacturing organization

2. Apply the tools and techniques of lean manufacturing to improve productivity in manufacturing organizations

3. Understand the principles and benefits of Toyota Production System philosophy

4. Apply the concept, tools and techniques in TPM philosophy

5. Apply the tools and techniques of constraint management to improve productivity in manufacturing and service organizations

6. Apply the tools and techniques of lean manufacturing to improve productivity in service organizations

CO PO Map PO1 PO2 PO3 PO4 PO5 PO6 PO7 PO8 PO9 PO10 PO11 PO12 PSO1 PSO2 PSO3 CO1 2 1 0 1 0 1 1 1 0 1 0 0 0 1 0 CO2 2 1 0 1 0 1 1 0 0 1 0 0 1 1 1 CO3 2 1 0 1 0 1 1 0 0 1 0 0 0 1 0 CO4 1 1 0 2 0 1 1 1 0 1 0 0 0 1 1 CO5 2 1 0 3 0 0 0 0 1 1 0 0 2 1 1 CO6 1 1 0 2 0 1 1 0 2 0 0 0 1 1 0 Avg 1.67 1 0 1.67 0 0.83 0.83 0.33 0.5 0.83 0 0 0.67 1 0.5

CO attainment levels

CO1- 3 CO2- 3 CO3- 3 CO4- 2 CO5- 3 CO6- 3

Future Courses Mapping: Logistics & Supply Chain Management, Project Management, Design For X

Job Mapping:

Industrial Engineer TPM Facilitator Lean Implementor Service sector industries Health care

CO-PO Mapping

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	2	1	0	1	0	1	1	1	0	1	0	0	0	1	0
CO 2	2	1	0	1	0	1	1	0	0	1	0	0	1	1	1
CO 3	2	1	0	1	0	1	1	0	0	1	0	0	0	1	0
CO 4	1	1	0	2	0	1	1	1	0	1	0	0	0	1	1
CO 5	2	1	0	3	0	0	0	0	1	1	0	0	2	1	1
CO 6	1	1	0	2	0	1	1	0	2	0	0	0	1	1	0

IE4211: DESIGN FOR X AND PRODUCT LIFECYCLE MANAGEMENT

Syllabus Template

IE4211:DESIGN FOR X AND PRODUCT LIFECYCLE MANAGEMENT

Course Prerequisites:

Course Objectives:

1. Understand the significance of Product Life Cycle Management and its strategies
2. Understand the importance of Product Design and New Product Development
3. Understand & apply principles of Design for Manufacturing and Assembly
4. Apply techniques such as QFD, FMEA for existing/ new products in industries
5. Understand the importance of DFX viewpoint in Product Design and Business .

Credits: 2 **Teaching Scheme Theory: 2 Hours/Week**

Course Relevance: NA

SECTION-1

Product Life Cycle & Product Design Introduction to Product Life, Importance of Product Life Cycle, Technology / Development Cycle, PLC Strategies, New Product Design Process, Value Chain, Sequential Vs. Concurrent Design Approach. Competitive Advantage & Competitive Strategy, Economics of Process Selection – General Design Principles of Manufacturability, Material Selection – Strength and Mechanical Factors- Applications of Form Design, Selection of Shapes, Digital Manufacturing Design for Manufacture & Assembly Review of Manufacturing Processes, Selection of manufacturing Processes, Design for Casting, Design for Bulk Deformation Processes, Design for Sheet Metal Forming Processes, Design for Machining, Design for Plastic Processing, Injection Molding etc. Review of Assembly Processes, Design for Welding, Design for Brazing and Soldering, Design for Adhesive Bonding. Types of assembly, DFA, Evaluation of Assembly, Assembly Cost Reduction, Case Studies based on DFMA

SECTION-1I

Design for Quality, Reliability and Maintainability Design for Quality, House of quality for QFD process, Human Engineering Considerations in Product Design, Identification of controls, Design for Optimization, Design for Reliability, Approach to Robust Design, Failure Mode and Effect Analysis. Design for Maintainability - MTTF, MTTR, MTBF, FIT Design for X (Specific Purpose) Design for Safety- Safety aspects in Manufacturing Environment, Design for Safety

Application for Products and Equipments, Design for Additive Manufacturing, Design for Logistics, Design for Delayed differentiation, Design for ergonomics, Design for Environment, Design for recycling, Case studies based on above DFX concepts,

List of Tutorials: (Any Three) NA

List of Practical's: (Any Six) NA

List of Projects: NA

List of Course Seminar Topics: NA List of Course Group Discussion Topics: NA

List of Home Assignments: Design:

1. Product Design and Material Selection

2. Design for Manufacturing and Assembly of new product of your choice

3. Design of a QFD for existing or new product of your choice

4. Develop FMEA for existing or new product of your choice

5. Design product from DFX point of view Case Study:

1. Case study based on Material and Shape Selection

2. Case study based on Product Design and NPD

3. Case study based on Design for Manufacturing and Assembly

4. Case study based on Design for Quality and Reliability

5. Case study based on Maintenance & Safety

6. Case study based on Quality Function Deployment

7. Case study based on Failure Modes and Effects Analysis

8. Case study based on Design for Sustainability (Recycling, Logistics etc.) Blog

1. Detailed design process

2. Product Life Cycle of products around us

3. Prepare QFD of products around us

4. Prepare FMEA of products around us

5. Process and Assembly method selection Surveys

1. Survey based on Product Life Cycle strategies across various industries

2. Survey based on Product Design & NPD Processes within the same industry of your choice

3. Survey based on usability of DFMA principles in practice

4. Survey based on usability of QFD / FMEA techniques in practice

5. Survey based on Safety and Maintenance aspects for product / equipment

6. Survey based on Design for Sustainability, Recycling, Logistics etc.

Assessment Scheme: Mid semester - 30 End semester - 30

Home assignment - 10 marks

CVV - 30 marks

Text Books: (As per IEEE format)

1. Dieter George E, Engineering Design, 3rd Edition Mc Graw Hills Publications 2000.

2. G Boothroyd, P Dewhurst and W Knight, Product design for manufacture and assembly, John Wiley, NY: Marcel Dekkar, 1994.

Reference Books: (As per IEEE format)

1. K G Swift and J D Booker, Process selection: from design to manufacture, London: Arnold, 1997.

2. J G Bralla, Handbook for Product Design for Manufacture, McGraw Hill, NY, 1998.

3. ASTM Design handbook.

4. M Fashby and K Johnson, Materials and Design - the art and science of material selection in product design, Butterworth-Heinemann, 2003.

Moocs Links and additional reading material: www.nptelvideos.in

Course Outcomes:

1. Understand the role and impact of New Product Development and Product Life Cycle on any business

2. Utilize DFMA and Concurrent Engineering Principles on a "real life" project

3. Apply the concept of DFMA for Convential manufacturing and assembly processes 4.Apply the Quality and Reliability aspects of design for manufacture and assembly

5. Apply the Maintainability and Safety aspects of design for manufacture and assembly

6. Apply the concept of DFX for specific purpose such as recycling, delayed differentiation, logistics, ergonomics, sustainability

CO PO Map

CO attainment levels

CO-1 :4 CO-2 :4 CO-3 :4 CO-4 :4 CO-5 :4 CO-6 : 4

Future Courses Mapping: Industry Internship or Capstone Project

Job Mapping:

Design Engineer

IE4212: DATA ANALYTICS FOR ENGINEERS

Syllabus Template

IE4212: DATA ANALYTICS FOR ENGINEERS

Course Prerequisites: Nil

Course Objectives:

1. To help students learn, understand, and practice big data analytics and machine learning approaches, which include the study of modern computing, big data technologies and scaling up machine learning techniques focusing on industry applications.

2. To understand and learn the conceptualization and summarization of concepts like big data and machine learning, trivial data versus big data, big data computing technologies, machine learning techniques, and scaling up machine learning approaches.

3. To gain insight in basic techniques for processing large amounts of data in an efficient, reliable, and consistent way and develop skills in understanding, interpreting, and documenting data and information in the context of realistic scenarios.

4. To get understanding of the data life cycle and develop skills for structuring their solutions of practical problems along the phases of the data life cycle and apply data analytics techniques to realistic data-sets in which they can recognize the demands within their area of specialization.

5. To obtain basic knowledge of statistical concepts and techniques and develop skills to apply them in practice and learn to implement their solutions for data analytics problems in a programming language (Python), and apply a structured and systematic approach to data processing.

Credits: 02 **Teaching Scheme Theory: 02 Hours/Week**

Course Relevance: The course can help the students to prepare for data analytics related

tasks and jobs, needed in the various areas of knowledge, science and technology.

SECTION-1

Introduction to Data Science and Analytics Introduction to big data:– Challenges of Conventional Systems - Intelligent data analysis – Nature of Data - Analytic Processes and Tools - Analysis vs Reporting. Data in Engineering and Management Research, Types of data, Measures of Frequency Distribution, Big data Analytics (Apache Spark), Application Area: Finance, Time series Analysis, Advertisement, NLP, IOT. Introduction to Data Science in Python: Python Core Objects and built-in functions, Number Object and operations, String Object and Operations, List Object and Operations, Tuple Object and operations, Dictionary Object and operations, Set object and operations, Boolean Object and None Object, Different data Structures, data processing Conditional Statements and Loops, UDF Functions and Object Functions, File Handling with Python, Python Modules and Packages, Exceptional Handing and Object-Oriented Python, Python OOPS. Database System: Database interaction with Python Creating Database with MYSQL, CRUD

Operations, Creating a Database Object. Python MySQL / SQlite Database Access Disconnecting Database, Data Analytics Tool Spreadsheet, ML Tool, BI Tools

SECTION-1I

Machine Learning : Data Visualization - Matplotlib, Data Analysis Using Python Modules- Numpy, Pandas,Tableau Machine Learning Algorithms Supervised Learning Regression Linear Regression (Simple and Multiple) Logistic Regression. Machine Learning Algorithms Supervised Learning

Regression Linear Regression Multiple Linear Regression Bias-Variance Trade-Off Classification Modellin : Logistic Regression, K-Nearest Neighbors (KNN), Simple Vector Machine (SVM), Decision Trees o Ensemble Methods - Random Forest Unsupervised Learning Clustering: K-Means Clustering Hierarchical Clustering DBSCAN

List of Practicals: (Use of Excel / R / Python / Minitab / SAS / SPSS/Google Data Studio)

NA

List of Projects: NA

List of Course Seminar Topics: NA List of Course Group Discussion Topics: NA List of Home Assignments:

1. Bayesian Data Analysis
2. Educational data mining
3. Business intelligence predictive Analytics
4. Big data and Business Intelligence(BI) or Market Intelligence (Related: Big Data)
5. Open source Data Mining
6. Data Mining System
7. Data mining Trends
8. Health data mining
9. Web Analytics solution
10. Data Mining marketing
11. Data Mining in Search Engine Analytics (related SEO)
12. Tools for Data Cleaning and Munging
13. Text Classification
14. Evaluation Methods for Machine Learning
15. Integrating Big Data platforms with traditional DW/BI environments
16. Data visualization and in-memory data
17. NoSQL BI Tools and applications
18. Analyzing Big Data using Self-Service BI Tools,
19. Using Data virtualization to simplify access Big Data and traditional DW/BI systems
20. SQL connectivity initiatives to Big Data
21. Managing stream computing in a Big Data environment
22. MapReduce developer tools
23. Creating Sandboxes for Data Science projects
24. Tools for ETL processing
25. Creating a multi-platform analytical ecosystem
26. The role of Data Virtualization in a Big Data environment

Text Books: (As per IEEE format)

1. Chris Albon : Machine Learning with Python Cookbook , O‟Reilly Media Inc.2018 2 Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014 3 Jeffrey Stanton, An Introduction

to Data Science, 2012. 4 Tom M. Mitchell, Machine Learning, India Edition 2013, McGraw Hill Education

Reference Books: (As per IEEE format)

1. Wes McKinney , “Python for Data Analysis” ,OReilly Media Inc. 2013

2. Samir Madhavan, “Mastering Python for Data Science”, PACKT publishing, 2015

3. Jake Vanderplas, “Python Data-science Handbook” , OReilly Media Inc. 2017

4. Joel Grus, “Data science from Scratch , First Principles with Python” , OReilly Media Inc 2015

Moocs Links and additional reading material:

[1] Kevin Murphy, “Machine Learning: A Probabilistic Perspective” , MIT Press, 2012, https://www.cs.ubc.ca/~murphyk/MLbook/pml-intro-5nov11.pdf [2] Professor S. Sarkar IIT Kharagpur “Introduction to machine learning” , https://www.youtube.com/playlist?list=PLYihddLFCgYuWNL55Wg8ALkm6u8U7gps [3] Professor Carl Gustaf Jansson, KTH, Video Course on Machine Learning https://nptel.ac.in/noc/individual_course.php?id=noc19-cs35 [4].Tom Mitchell, “Machine Learning”, http://www.cs.cmu.edu/~tom/10701_sp11/lectures.shtml [5]. Charles Severance: University of Michigan, Python for Everybody [COURSERA]. Available: https://www.coursera.org/ [6]. Madhavan Mukund, (12, may, 2018). Programming, Data Structures & Algorithms using Python [NPTEL]. Available: http://nptel.ac.in/ [7]. Keith Galli Complete Python NumPy Tutorial (Creating Arrays, Indexing, Math, Statistics, Reshaping) Available: https://www.youtube.com/watch?v=GB9ByFAIAH4 [8]. Keith Galli Complete Python Pandas Data Science Tutorial! (Reading CSV/Excel files, Sorting, Filtering, Groupby) Available: https://www.youtube.com/watch?v=vmEHCJofslg [9]. CS Dojo, Intro to Data Analysis / Visualization with Python, Matplotlib and Pandas | Matplotlib Tutorial Available: https://www.youtube.com/watch?v=a9UrKTVEeZA

Assessment Scheme: Mid semester - 30 End semester - 30

Home assignment - 10 marks

CVV - 30 marks

Course Outcomes:

1. Ability to integrate machine learning libraries and mathematical and statistical tools with modern technologies and assess the appropriateness of different kinds of research designs and methodology.

2. Ability to identify the characteristics of datasets and compare the trivial data and big data for various applications.

3. Ability to select and implement machine learning techniques and computing environments that are suitable for the applications under consideration and also recognize and implement various ways of selecting suitable model parameters for different machine learning techniques.

4. Ability to solve problems associated with batch learning and online learning, and the big data characteristics such as high dimensionality, dynamically growing data and in particular scalability issues.

5. Ability to understand and apply scaling up machine learning techniques and associated computing techniques and technologies

MD4202: PROJECT MANAGEMENT

Syllabus Template

MD4202:: PROJECT MANAGEMENT

Course Prerequisites:

Course Objectives:

6. Understand the significance of Product Life Cycle Management and its strategies
7. Understand the importance of Product Design and New Product Development
8. Understand & apply principles of Design for Manufacturing and Assembly
9. Apply techniques such as QFD, FMEA for existing/ new products in industries
10. Understand the importance of DFX viewpoint in Product Design and Business.

Credits: 2 **Teaching Scheme Theory: 2 Hours/Week**

Course Relevance: NA

SECTION-1

Introduction: (6 Hours) Definition & Characteristics of Project, Performance Parameters: Time, Cost & Quality. Difference with respect to Standard Routine Production. Classification of Projects: Sector based, Investment based, Technology based, Causation based, Need based (BMERD) - Balancing, Modernization, Replacement, Expansion & Diversification Project Life Cycle Phases – Concept/Initiation Phase: Parameters Involved in Project Identification. Sources of New Project Ideas. Governmental Framework for Identification of Opportunities, Incentives from state & central govt.; Import-substitution projects Project Conceptualization & Feasibility Analysis (4 Hours) Project Definition Phase: Project Formulation & Feasibility. Types of Feasibility Studies – Pre-feasibility, Support/Functional, Feasibility Study. Preparation of Project Feasibility Report Project Planning, Implementation & Control (6 Hours) Planning & Organization Phase: Project Planning, Scheduling & Monitoring, Statement of Works, Project Specifications, Work Breakdown Structure, Network Analysis & Duration Estimating Network Diagrams – PERT/CPM, Estimate Activity Times, Milestone Scheduling. Project Crashing.

SECTION-1I

Project Human Resource (4 Hours) Project Organization & Management. Project Organization Structure, Role of Project Manager, Resource Levelling, Resource Smoothening,

Project Cost Management (4 Hours) Project Cost Estimation: Need, Causes of Cost & Time Overruns. Nature of Cost Estimates, Types of Project Cost Estimates Project Implementation & Control (4 Hours) Implementation Phase: Activities Involved: Erection & Commissioning, Installation, Trial Runs & Commencement of Commercial Production. Cleanup / Shutdown Phase

List of Home Assignments: Design / Case Study / Blog / Surveys

1. HA Based on Project Planning by using MS- Project
2. HA Based on CPM with or without using MS- Project (On actual projects)
3. HA Based on PERT with or without using MS- Project (On actual projects)
4. HA Based on Project Crashing (Cost Optimization)
5. HA Based on Resource Optimization - Resource Levelling and Smoothening
6. Survey based on PM Softwares and its applicability

7. Study based on Project Cost Management

8. Analysis based on Earned Value Management of any project

9. Blog based on Best practices in Project Management

10. Blog based on Project Management Softwares and its usage

11. Use of MS Project in Construction / IT/ Technology/ NPD Projects

12. Use of Project Management in Engg fields

13. Use of PM in Education (From student's perspective)

14. Feasibility study of any project or Business plan

15. Blog on Scope of Project Management domain in India

16. Blog on Challenges in Project Management for IT / Construction / Govt sector

17. Survey based on Project Manager's experience about Challenges/ Benefits in the PM domain

18. Study of Project Life Cycle Management

19. Study of Cost or Time or Quality aspects of Project Management

20. Study of Industry 4.O feasibility in Project Management

Assessment Scheme: Mid semester - 30 End semester - 30

Home assignment - 10 marks

CVV - 30 marks

Text Books: (As per IEEE format)

1. Harold Kerzner, “Project Management: A Systems Approach to Planning, Scheduling, and Controlling”

2. K. Nagarajan, “Project Management” Second Edition, New Age International, 2004

Reference Books: (As per IEEE format)

1. A Guide to Project Management Body of Knowledge (PMBOK guide) 6th Edition

Moocs Links and additional reading material:

https://onlinecourses.nptel.ac.in/noc19_mg30/preview

Course Outcomes:

1. Learn the basic concepts of project and project management

2. Ascertain the feasibility of small and medium projects with respect to managerial, marketing, operational, financial and socio-economic perspectives

3. Apply Plan and schedule small and medium projects to achieve the triple constraint of time, cost and quality using software package

4. Understand the concept of earned value management system and critical chain in managing projects

5. Understand the concepts of project risk management and critical chain project management

6. Monitor the progress of projects to determine variances and recommend corrective actions

CO PO Map

CO attainment levels

CO-1 :3 CO-2 :3 CO-3 :3 CO-4 :3 CO-5 :3 CO-6 :3

Future Courses Mapping: Industry Internship or Major Project

IE4214: OPERATION SCHEDULING

IE4005: Operations Scheduling

Course Prerequisites: None

Course Objectives:

1.To provide basic understanding of scheduling management concepts and their relevance to Production Planning & Control 2.To make students aware of the different techniques used for Single Machine Scheduling 3.To make students aware of the different techniques used for Parallel Machine Scheduling 4.To provide understanding of the concept of Flow shop model & its usage 5.To develop knowledge for optimizing scheduling values like Makes span, Machine Idle time

Credits:2 **Teaching Scheme: Theory: 2 Hours/Week**

Course Relevance: This course will provide basic knowledge of Marketing for working in a business environment.

SECTION-1

Unit I:

Single Machine Scheduling & Other Objectives in a single machine scheduling Basic theorems performance measures – mean flow time, mean tardiness etc. Hodgson's algorithm , method to minimize tardiness, Branch and Bound method, Commonly used heuristics like Cost over Time rule (COVERT), LPUL Rule, SWPT Rule, Largest Weight (WT) Rule and LPUL rule. Backward forward (BF) heuristic method, single machine scheduling problems with early and late penalties.

Unit II: Problems with early and late due dates, Minimize number of jobs delayed, problems of different types like maximizing the number of jobs completed when the available time is less, when the sequence dependent jobs, minimizing Variation of flow time, sequence dependent set up times, multiple criteria scheduling, Jobs arriving at different times.

Unit III: Parallel Processing & Batch Sequencing, Parallel machine models, Make span minimization of independent and dependent jobs – Mc Naughton's algorithms, Weighted mean flow time minimization, Parallel Processing- Job with equal weights,Job with due dates, Batch scheduling for a limited capacity, fixed-period process problem, baking problem-ovens in sequence. DSRO-Network Base scheduling of jobs on m machines, LCR method used for line balancing , mixed model assembly.

SECTION-1I

Unit IV: Flow shop models, Introduction of Flow shop model, objectives of flowshop model,

Use of Gantt chart –Minimize machine idle time method, Nawaz heuristic, Compbell Dudek method, Palmer's method.

Unit V: Job Shop Models, Minimize makes pan- SPT rule, Network approach to Job shop scheduling, Modified shifting bottleneck heuristic (MODSB), Two stage job shop scheduling heuristic, Job shop scheduling CEXSPT rule.

Unit VI: Graphical representation – Feasible, semi-activeand active schedules – Single pass

approach –Non-delay schedule generation. Heuristic schedule generation – Priority dispatching rules – Dynamic job shop simulation.

List of Home Assignments: Design:

1. Common Due Date single machine scheduling

2. Jobs arriving at different times system design

3. Dependant Jobs production system

4. System design for reducing Tardy jobs

Case Study:

1. Parallel processing of identical jobs

2. Makes span calculation for parallel machines

3. McNaughton's Algorithm application in Parallel machining

4. Batch Processing scheduling Blog

1. Flow shop Model & its Practical applications

2. CDS Model & its Practical applications

3. Minimize Machine Idle time Mechanism

4. Johnson's Algorithm for flow shop model Surveys

1 Job shop model & its Practical applications 2 CEXSpt model & its Practical applications 3 SPT in Job shop model & its Practical applications 4 MODSOB Method in Job shop model & its Practical applications

.

Assessment scheme Sr. Type of Assessment Conduction Marks No 100 Marks converted to 10 1 Home Assignment End of Semester equivalent Marks

30 Marks converted to 30 equivalent 2 MCQ Exam – Section I Mid Of Semester Marks 30 Marks converted to 30 equivalent 3 MCQ Exam – Section II End of Semester Marks 100 Marks converted to 30 4 Comprehensive Viva Voce End of Semester equivalent Marks

Text Books: (As per IEEE format)

1. Industrial Scheduling – Dileep R Sule, Ist edition, International Thomson Publishing Company,London 2.Kenneth R.Baker, "Introduction to sequencing and scheduling", Ist edition ,John Wiley and Sons, 2000

Reference Books: (As per IEEE format)

1. Michael Pinedo, "Scheduling: theory, algorithms and systems", Ist edition ,Prentice Hall of India, 1996.

2. King, J.R, "Production planning and control", Ist edition, Pergamum International Library, 1975

Moocs Links and additional reading material: www.nptelvideos.in

Course Outcomes:

Students will be able to:

1. Understanding of single machine scheduling , its other objectives etc.

2. Understanding of Parallel Processing & Batch Sequencing.

3. Analysis of Flow shop models & its implications

4. Analysis of Job shop models & its implications

CO PO Map PO1 PO2 PO3 PO4 PO5 PO6 PO7 PO8 PO9 PO10 PO11 PO12 PS13 PS14 PS15 CO1 3 2 1 2 2 CO2 3 2 1 2 2 CO3 3 2 1 2 2 CO4 3 2 1 2 2

CO attainment levels

CO 1 - 2 CO 2 - 3 CO 3 - 3 CO 4 - 3

Future Courses Mapping: Mention other courses that can be taken after completion of this course

Job Mapping:

Students can get Job opportunities in the area of scheduling of Process

ME4202: COMPUTER INTEGRATED MANUFACTURING

Syllabus Template

ME4202 : Computer Integrated Manufacturing

Course Prerequisites:

Manufacturing processes, Industrial management, CAD/CAM

Course objectives:

1. To acquaint the students with databases and numerical analysis related to CIM.

2. To introduce students with Computer Aided Process Planning Systems and Cellular Manufacturing Systems.

3. To study the role and components of different Automation strategies.

Credits: 02 **Teaching Scheme: Theory: 2 Hours/Week**

Course Relevance:

This course gives the integration of automated production processes by using computers and delivers a benefit of streamlining production processes with reduced costs and improved scheduling flexibility. Data storage and handling is also the need of contemporary manufacturing systems. This is also catered using software.

SECTION—I Introduction Introduction of CAD and CAM, Manufacturing planning and control, Concurrent Engineering, Concept and elements of CIM, Mathematical model of production performance, manufacturing control, elements of automated system, lean production and Just-in-Time production.

Production planning and control Process planning, Computer aided process planning and steps, Aggregate production planning and master production schedule, Material Requirement planning, capacity planning, control system, shop floor control, Inventory control, Manufacturing Resource planning (MRPII), Enterprise resource planning (ERP)

Cellular Manufacturing Group Technology, part families and part classification and coding, composite part concept, machine cell design and layout, Arranging machines in a GT cell, Production Flow Analysis (PFA)

SECTION—II

Flexible manufacturing System Automation, Introduction, Automation strategies, Types of Automation - Hard and Soft Automation, FMS, FMS components, Applications and benefits, FMS planning and control, quantitative analysis in FMS, Automated Guided vehicle systems, and AS/RS, Vehicle guidance technology, vehicle management and safety.

Manufacturing system control Computerized statistical process control, shop floor control, inventory control, pull system of production control, introduction to automated inspection devices: Coordinate Measuring Machine (CMM), Inspection probes etc.

Industrial Robotics Robot anatomy and related attributes, classification of robots, Robot control system, sensors in robotics, end effectors, accuracy and repeatability, Industrial robot applications, Robot part programming, simple problems.

List of Home Assignments:

Design:

1. Flexible manufacturing system

2. Machine cell

3. Material handling system

4. Mathematical model of production performance

5. Manufacturing Order Report

Case Study:

1. Available computer/automation hardware, and software.

2. Production Flow Analysis

3. Master Production Schedule

4. Aggregate production planning

5. Enterprise Resource planning in Manufacturing

Blog

1. Open CIM System Management Software

2. Real Time monitoring in CIM

3. Robot Control Programming

4. CNC Milling Station and Control software

5. Benefits of Computer Integrated Manufacturing

Surveys

1. Islands of automation and software

2. Product related activities of a company

3. Plant operations

4. Computer Managed Production planning

5. Product data management

Suggest an assessment Scheme: Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Blooms Taxonomy.

1. MSE

2. HA

3. CVV

4. ESE

Text Books: (As per IEEE format)

1. Groover M.P. “Automation, production systems and computer integrated manufacturing”, Prentice Hall of India

2. Deb S.R., “Robotics Technology and Flexible Automation”, Tata McGraw Hill

3. Radhakrishnan P. and Subramanyam S.,”CAD,CAM,CIM”, New Age International Pvt. Ltd.

4. John J.,Craig, “Introduction to Robotics”, Pearson Publication.

Reference Books: (As per IEEE format)

1. Eric Teicholz and Joel orr,Computer Integrated Manufacturing Handbook, McGraw Hill Book Co.

2. Yoram Coren, “Computer control and Manufacturing Systems”, McGraw Hill publication.

3. Paul G. Ranky, “Computer Integrated Manufacturing”, PHI.

4. Nanua Singh, John, “Systems Approach to Computer Integrated Design and Manufacturing”, Wiley publication

Moocs Links and additional reading material:

https://nptel.ac.in/courses/112/104/112104289/

Course Outcomes:

Students will be able to: 1) Apply knowledge about Computer Aided Quality control and Process Planning Control. 2) Design Flexible manufacturing cell after carrying out Group technology study and finally creating FMS 3) Analyze and Design appropriate automated assembly systems 4) Apply Computer aided process planning and MRP. 5) Distinguish various automated flow lines in high volume production systems. 6) Understand the robot systems and their applications in manufacturing industries.

ME4255: MAJOR PROJECT

Syllabus Template

ME4255: MAJOR PROJECT

Course Prerequisites:

All Engineering Courses Studied so far including Mathematics and Physics

Course Objectives:

1. To make students aware in the selection of domain, area and topic of their interest
2. To orient the students to identify the problem precisely, analyze the same and subsequently do the synthesis.
3. To orient the students to apply their knowledge preferably to real life engineering problem solving
4. To evolve students in conceptual, lateral, and out of box thinking
5. To provide an opportunity to them to acquire hands on experience of manufacturing processes
6. To provide platform to learn how to work in a group and gain basic management skills

Credits: 10 . Teaching Scheme:

Lab: 20 Hours/Week

Course Relevance: By this academic component students areexposed to the process of

selection of manufacturing methods, materials, fits and tolerances, assembling and disassembling of system, equations or correlations, boundary conditions, input parameters, dependent and independent variables, technical data, analysis techniques, data generation techniques etc. Also it gives an exposure to selection of Standards, Standard processes, Standard Techniques, Standard components, Standard Mechanisms, Standard measuring and regulating instruments etc. This lead to an overall growth of the student as professional Mechanical Engineer

SECTION-1

Design/Development/Retrofitting/Fabrication/Atomization/Optimization/Modeling/Coding /Simulations/Experimental-analysis/Computational-analysis/Mathematical-analysis/Use of analogies/Use of commercially available software/Use of available codes/Use of open source codes and software's/Performance improvements of Mechanism/Machine/Model /Prototype/System based on existing/new ideas/principle etc.

SECTION-1I

Energy audit /conservation/management, Use of renewable energy sources etc. Validation or Bench marking of the outcome/ results. Demonstration of Prototype or actual model. Results and Discussions. Concluding remarks.

INSTRUCTIONS

A report containing maximum 30 pages (printed on both sides excluding certificate, permission letter, and title pages) shall be submitted based on the background, motivation and scope of the project, project specifications, activities involved in the project and activity plan, literature review made, basic theory, details of methodology adopted and data reduction, results and discussions, conclusions extracted and proposed future work (if any) followed by referencing and appendices (if any).

GUIDELINES

● Report shall be typed and printed in standard format. ● Figures and tables shall be at appropriate positions, with numbers and captions. ● Project title and approval sheets shall be attached at the beginning of the report followed by Index and Abstract of the project. ● References shall be mentioned at the end followed by appendices (if any). ● When a group of students is doing a project, names of all the students with GR No and Roll No shall be included on every certified project report copy. ● Each group of students shall submit to the concerned the required number of copies of project reports as decided by the department and one copy shall be prepared for each individual student.

List of Tutorials: -NA-

List of Practical's: -NA-

List of Projects: -NA-

List of Course Seminar Topics: -NA-

List of Course Group Discussion Topics: -NA-

List of Home Assignments: -NA-

Suggest an assessment Scheme: Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Blooms Taxonomy.

1. MSE

2. ESE

Text Books: (As per IEEE format)

Any Book relevant to your Project Topic.

Reference Books: (As per IEEE format)

1.Reference Books, Text Books, Handbooks, PSG Data Book, Various Catalogues, Property Tables, Property Charts etc.

2. Cited Papers from Journals and Conferences

3. Literature available from open source

Course Outcomes:

After completing this academic activity, students will be able to;

1. Apply theoretical concepts for solving the project problem,

2. Define/Develop/Select methodology to execute the project work.

3. Decide and apply the manufacturing techniques and instrumentation

4. Develop the procurement skills

5. Assemble and demonstrate the working model

6. Develop skills of technical report/paper/patent writing and presentation

CO PO Map

CO/ P P P PO S S S PO: PO: PO: PO: PO: PO: PO: PO: PO: PO: PO: PO: O O O 1 2 3 4 5 6 7 8 9 10 11 12 : : : 1 2 3

CO:1 3 3 3 3 2 2 2 1 1 3 3 3 3 3 1

CO:2 3 3 3 3 3 2 2 1 1 3 3 3 3 3 1

CO:3 3 3 3 3 3 2 2 2 1 3 3 3 3 3 2

CO:4 1 1 1 1 1 1 1 3 1 3 2 2 1 1 1

CO:5 2 2 2 2 2 1 1 1 1 3 3 3 3 3 2

CO:6 1 1 1 1 1 1 1 3 2 3 3 3 1 1 1

CO attainment levels

CO Number Lev el

1. Apply theoretical concepts for solving the project problem, 1

2. Define/Develop/Select methodology to execute the project work. 2

3. Decide and apply the manufacturing techniques and instrumentation 2

4. Develop the procurement skills 3

5. Assemble and demonstrate the working model 4

6. Develop skills of technical report/paper/patent writing and presentation 4

Future Courses Mapping: Mention other courses that can be taken after completion of this course

-NA-

Job Mapping:

What are the Job opportunities that one can get after learning this course

For all kinds of Jobs this exposure will count.

B.TECH. MECHANICAL MODULE-VIII

B.Tech. MECH. MODULE-VIII AY: 2024 - 25

Sub. Sub. Subject Teaching Examination scheme Total Credits No. Code Name Scheme(Hrs/Week) Th Lab Tut CA MSE ESA ESE

* Internship 30 30 70 100 16 S1

Total 30 16

ME4276 INDUSTRY INTERNSHIP ME4275 PROJECT INTERNSHIP

ME4273 RESEARCH INTERNSHIP ME4277 INTERNATIONAL INTERNSHIP

CO-PO Mapping

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	2	2	2	1	1	3	3	3	3	3	1
CO 2	3	3	3	3	3	2	2	1	1	3	3	3	3	3	1
CO 3	3	3	3	3	3	2	2	2	1	3	3	3	3	3	2
CO 4	1	1	1	1	1	1	1	3	1	3	2	2	1	1	1
CO 5	2	2	2	2	2	1	1	1	1	3	3	3	3	3	2
CO 6	1	1	1	1	1	1	1	3	2	3	3	3	1	1	1

ME4273: RESEARCH INTERNSHIP

Syllabus Template

ME4273: RESEARCH INTERNSHIP

Credits: 16 **Teaching Scheme: …. Hours / Week**

[Semester long (minimum 4 and a half months) Research Assistantship under a Professor/Guide at a reputed research organization / Institute / University] A. Literature Review

Exhaustive literature review based on published literature in the research area

B. Project work

Prospective Project Areas:

Design / Development / Retrofitting / Fabrication / Atomization / Optimization / Modeling /Coding / Simulations / Experimental-analysis / Computational-analysis / Mathematical- analysis /Use of analogies / Use of commercially available software / Use of available codes / Use of open source codes and software's / Performance improvements of Mechanism / Machine / Model / Prototype / System based on existing / new ideas, principle / Energy audit / conservation/management / Use of renewable energy sources / Validation or Bench marking of the outcomes, results etc.

Project Execution Guidelines: • understand domain, area and topic of project • identify the problem precisely, analyze the same and subsequently carry out the synthesis • apply engineering concepts / knowledge to the real life engineering problem at hand • ensure conceptual, lateral, and out of box thinking • acquire hands on experience of manufacturing processes • learn to work in a group and gain basic management skills • understand process of selection of manufacturing methods, materials, fits and tolerances, assembling and disassembling of system, equations or correlations, boundary conditions, input parameters, dependent and independent variables, technical data, analysis techniques, data generation techniques etc. • selection of Standards, Standard processes, Standard Techniques, Standard components, Standard Mechanisms, Standard measuring and regulating instruments etc • organizing proper results and present relevant discussion from it • present relevant conclusions and future scope from the work carried out

C. Internship Report: A report containing maximum 60 pages (printed on both sides excluding certificate, permission letter, and title pages) should be submitted based on the industry in-plant training, the background,

motivation and scope of the project, project specifications, activities involved in the project and activity plan, literature review carried out, basic theory, details of methodology adopted and data reduction, results and discussions, conclusions extracted and proposed future work (if any) followed by referencing and appendices (if any).

Reference Books / Material:

1. Reference Books, Text Books, Handbooks, PSG Data Book, Various Catalogues, Property Tables, Property Charts etc.

2. Cited Papers from Journals and Conferences

3. Already available literature from open source

Course Outcomes:

The student will be able to –

1. correlate the theoretical and practical concepts (4)

2. understand working of organizations and management (3)

3. demonstrate verbal, written and graphical communication skills. (5)

4. undertake technical discussions. (4)

5. define / develop / select methodology for executing the project work (5)

6. apply theoretical concepts for solving the project problem (5)

CO PO Map PO 2 3 4 5 6 7 8 9 10 11 12 PS 2 3 CO 1 O1

1 3 2 3 3 2 3 3 2 3 2 3 2 3 3 3

2 3 2 3 3 2 3 3 3 2 3 2 3 2 3 2

3 3 2 3 3 2 3 3 2 3 2 3 2 3 3 3

4 3 2 3 3 2 3 3 3 2 3 2 3 2 3 2

5 3 2 3 3 2 3 3 2 3 2 3 2 3 3 3

6 3 2 3 3 2 3 3 3 2 3 2 3 2 3 2

CO attainment levels

CO Number Level

1 3

2 5

3 4

4 3

5 4

6 5

ME4275: PROJECT INTERNSHIP

Syllabus Template

ME4275: PROJECT INTERNSHIP

Credits: 16 **Teaching Scheme: …. Hours / Week**

[Semester long (minimum 4 and a half months) Research Assistantship under a Professor/Guide at a reputed research organization / Institute / University] A. Literature Review

Exhaustive literature review based on published literature in the research area

B. Project work

Prospective Project Areas:

Design / Development / Retrofitting / Fabrication / Atomization / Optimization / Modeling /Coding / Simulations / Experimental-analysis / Computational-analysis / Mathematical- analysis /Use of analogies / Use of commercially available software / Use of available codes / Use of open source codes and software's / Performance improvements of Mechanism / Machine / Model / Prototype / System based on existing / new ideas, principle / Energy audit / conservation/management / Use of renewable energy sources / Validation or Bench marking of the outcomes, results etc.

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CO PO Map PO 2 3 4 5 6 7 8 9 10 11 12 PS 2 3 CO 1 O1

1 3 2 3 3 2 3 3 2 3 2 3 2 3 3 3

2 3 2 3 3 2 3 3 3 2 3 2 3 2 3 2

3 3 2 3 3 2 3 3 2 3 2 3 2 3 3 3

4 3 2 3 3 2 3 3 3 2 3 2 3 2 3 2

5 3 2 3 3 2 3 3 2 3 2 3 2 3 3 3

6 3 2 3 3 2 3 3 3 2 3 2 3 2 3 2

CO attainment levels

CO Number Level

1 3

2 5

3 4

4 3

5 4

6 5

ME4276: INDUSTRY INTERNSHIP / (CAPSTONE PROJECT)

Syllabus Template

ME4276: Industry Internship / (CAPSTONE PROJECT)

Credits: 16 **Teaching Scheme: …. Hours / Week**

[Semester long (minimum 4 and a half months) internship in a Industry]

A. Industry in-plant training

Study of products, processes, structure, organization, strategies, technology of the industry

B. Project work

Prospective Project Areas:

Design / Development / Retrofitting / Fabrication / Atomization / Optimization / Modeling /Coding / Simulations / Experimental-analysis / Computational-analysis / Mathematical- analysis /Use of analogies / Use of commercially available software / Use of available codes / Use of open source codes and software's / Performance improvements of Mechanism / Machine / Model / Prototype / System based on existing / new ideas, principle / Energy audit / conservation/management / Use of renewable energy sources / Validation or Bench marking of the outcomes, results etc.

Project Execution Guidelines: • understand domain, area and topic of project • identify the problem precisely, analyze the same and subsequently carry out the synthesis • apply engineering concepts / knowledge to the real life engineering problem at hand • ensure conceptual, lateral, and out of box thinking • acquire hands on experience of manufacturing processes • learn to work in a group and gain basic management skills • understand process of selection of manufacturing methods, materials, fits and tolerances, assembling and disassembling of system, equations or correlations, boundary conditions, input parameters, dependent and independent variables, technical data, analysis techniques, data generation techniques etc. • selection of Standards, Standard processes, Standard Techniques, Standard components, Standard Mechanisms, Standard measuring and regulating instruments etc • organizing proper results and present relevant discussion from it • present relevant conclusions and future scope from the work carried out

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CO PO Map PO 2 3 4 5 6 7 8 9 10 11 12 PS 2 3 CO 1 O1

1 3 2 3 3 2 3 3 2 3 2 3 2 3 3 3

2 3 2 3 3 2 3 3 3 2 3 2 3 2 3 2

3 3 2 3 3 2 3 3 2 3 2 3 2 3 3 3

4 3 2 3 3 2 3 3 3 2 3 2 3 2 3 2

5 3 2 3 3 2 3 3 2 3 2 3 2 3 3 3

6 3 2 3 3 2 3 3 3 2 3 2 3 2 3 2

CO attainment levels

CO Number Level

1 3

2 5

3 4

4 3

5 4

6 5

ME4277: INTERNATIONAL INTERNSHIP

Syllabus Template

ME4277: INTERNATIONAL INTERNSHIP

Credits: 16 **Teaching Scheme: …. Hours / Week**

[Semester long (minimum 4 and a half months) 'Internship at a Mechanical Industry' OR 'Research Assistantship under a Professor at a reputed research organization / Institute /University'] A. 'Industry In-plant Training (for Industry Internship)' OR 'Literature Review (for Research Assistantship)'

Industry In-plant Training – Study of products, processes, structure, organization, strategies, technology of the industry OR

Literature Review –

Exhaustive literature review based on published literature in the research area

B. Project work

Prospective Project Areas:

Design / Development / Retrofitting / Fabrication / Atomization / Optimization / Modeling /Coding / Simulations / Experimental-analysis / Computational-analysis / Mathematical- analysis /Use of analogies / Use of commercially available software / Use of available codes / Use of open source codes and software's / Performance improvements of Mechanism / Machine / Model / Prototype / System based on existing / new ideas, principle / Energy audit / conservation/management / Use of renewable energy sources / Validation or Bench marking of the outcomes, results etc.

Project Execution Guidelines: • understand domain, area and topic of project • identify the problem precisely, analyze the same and subsequently carry out the synthesis • apply engineering concepts / knowledge to the real life engineering problem at hand • ensure conceptual, lateral, and out of box thinking • acquire hands on experience of manufacturing processes • learn to work in a group and gain basic management skills • understand process of selection of manufacturing methods, materials, fits and tolerances, assembling and disassembling of system, equations or correlations, boundary conditions, input parameters, dependent and independent variables, technical data, analysis techniques, data generation techniques etc. • selection of Standards, Standard processes, Standard Techniques, Standard components, Standard Mechanisms, Standard measuring and regulating instruments etc

• organizing proper results and present relevant discussion from it • present relevant conclusions and future scope from the work carried out

C. Internship Report: A report containing maximum 60 pages (printed on both sides excluding certificate, permission letter, and title pages) should be submitted based on the industry in-plant training, the background, motivation and scope of the project, project specifications, activities involved in the project and activity plan, literature review carried out, basic theory, details of methodology adopted and data reduction, results and discussions, conclusions extracted and proposed future work (if any) followed by referencing and appendices (if any).

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6. apply theoretical concepts for solving the project problem (5)

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1 3 2 3 3 2 3 3 2 3 2 3 2 3 3 3

2 3 2 3 3 2 3 3 3 2 3 2 3 2 3 2

3 3 2 3 3 2 3 3 2 3 2 3 2 3 3 3

4 3 2 3 3 2 3 3 3 2 3 2 3 2 3 2

5 3 2 3 3 2 3 3 2 3 2 3 2 3 3 3

6 3 2 3 3 2 3 3 3 2 3 2 3 2 3 2

CO attainment levels

CO Number Level

1 3

2 5

3 4

4 3

5 4

6 5