ANNA UNIVERSITY, CHENNAI

UNDERGRADUATE CURRICULUM (UNIVERSITY DEPARTMENTS)

Campus: College of Engineering Guindy, Anna University

Department: Manufacturing Engineering

Programme: B.E. Manufacturing Engineering

Regulations: 2023 (Revised 2024), with effect from the AY 2024 – 25 to all the students of UG Programme.

OVERVIEW OF CREDITS

SEM	PCC	PEC	ESC	HSMC	ETC	OEC	SDC	UC	SLC	TOTAL
I	-	-	4	11	-	-	7	3	-	**25**
II	2	-	7	11	-	-	-	1	-	**21**
III	14	-	8	-	-	-	2	-	-	**24**
IV	22	-	-	-	-	-		-	1	**23**
V	11	-	-	-	4	3	5	3	-	**26**
VI	-	15	-	-	-	-	3	-	-	**18**
VII	7	3	-	-	3	3	3	4	-	**23**
VIII	-	-	-	-	-	-	8	-	-	**8**
Total	56	18	19	22	7	6	25	9	1	**168**
% of Category	**33.3**	**10.7**	**11.3**	**13.1**	**4.2**	**3.6**	**16.7**	**6.5**	**0.6**	**100**

CATEGORY OF COURSES

PCC – Professional Core Course
ESC – Engineering Science Course
PEC– Professional Elective Course
HSMC – Humanities Science and Management Course
ETC – Emerging Technology Course
SDC – Skill Development Course
OEC – Open Elective Course
UC – University Course
SLC – Self Learning Course

For Honours & Minor Degree, please refer the Regulations 2023 (Revised 2024).

SEMESTER I

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS PER WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1.	EN23C01	Foundation English	LIT	2-0-2	4	3	HSMC
2.	MA23C01	Matrices and Calculus	T	3-1-0	4	4	HSMC
3.	CY23C01	Engineering Chemistry	LIT	3-0-2	5	4	HSMC
4.	ME23C01	Engineering Drawing and 3D Modelling	LIT	2-0-4	6	4	SDC
5.	CS23C02	Computer Programming in Python	LIT	3-0-2	5	4	ESC
6.	ME23C04	Makerspace	LIT	1-0-4	5	3	SDC
7.	UC23H01	*தமிழர் மரபு* / Heritage of Tamils	T	1-0-0	1	1	UC
8.	-	NCC / NSS / NSO / YRC		0-0-2	2	0	UC
9.	-	Audit Course – I	T	2-0-0	2	0	UC
10.	UC23U01	Universal Human Values	T	1-0-2	3	2	UC
TOTAL CREDITS						**25**	

SEMESTER II

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS PER WEEK		CREDITS	CATEGORY
				L-T-P	TCP		
1.	EN23C02	Professional Communication	LIT	2-0-2	4	3	HSMC
2.	MA23C02	Ordinary Differential Equations and Transform Techniques	T	3-1-0	4	4	HSMC
3.	PH23C01	Engineering Physics	LIT	3-0-2	5	4	HSMC
4.	EE23C03	Basics of Electrical and Electronics Engineering	LIT	2-0-2	4	3	ESC
5.	MF23201	Evolution of Manufacturing Engineering	T	2-0-0	2	2	PCC
6.	ME23C03	Engineering Mechanics	T	4-0-0	4	4	ESC
7.	UC23H02	தமிழர்களும் தொழில்நுட்பமும் /Tamils and Technology	T	1-0-0	1	1	UC
TOTAL CREDITS						**21**	

SEMESTER III

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS PER WEEK		CREDITS	CATEGORY
				L-T-P	TCP		
1.	MF23301	Thermodynamics and Heat Transfer	T	4-0-0	4	4	PCC
2.	MF23302	Casting and Welding Technology	T	3-0-0	3	3	PCC
3.	MF23303	Forming Technology	T	3-0-0	3	3	PCC
4.	MF23304	Engineering Materials and Metallurgy	LIT	3-0-2	5	4	PCC
5.	CE23C01	Mechanics of Materials	LIT	3-0-2	5	4	ESC
6.	CE23C02	Fluid Mechanics and Machinery	LIT	3-0-2	5	4	ESC
7.	-	Skill Development - I	LIT	1-0-2	3	2	SDC
8.	-	Audit Course – II	T	2-0-0	1	0	UC
TOTAL CREDITS						**24**	

SEMESTER IV

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE	PERIODS PER WEEK		CREDITS	CATEGORY
				L-T-P	TCP		
1.	MF23401	Machining Technology	LIT	3-0-2	5	4	PCC
2.	ME23C15	Design of Machine Elements	T	3-0-0	3	3	PCC
3.	ME23C11	Kinematics and Dynamics of Machinery	LIT	3-0-2	5	4	PCC
4.	MF23402	Fluid Power Systems	T	3-0-0	3	3	PCC
5.	MF23403	Computer Aided Design	LIT	3-0-2	5	4	PCC
6.	MF23C01	Additive Manufacturing	LIT	3-0-2	5	4	PCC
7.	MF23L01	Self-Learning Course (Minimum Duration 15 h)	T	1-0-0	0	1	SLC
TOTAL CREDITS						**23**	

SEMESTER V

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS PER WEEK		CREDITS	CATEGORY
				L-T-P	TCP		
1.	MF23501	CNC Machine Tools	LIT	3-0-2	5	4	PCC
2.	MF23C02	Non-Traditional Machining Processes	T	3-0-0	3	3	PCC
3.	MF23502	Metrology and Computer Aided Inspection	LIT	3-0-2	5	4	PCC
4.		Emerging Technology Course 1	LIT	3-0-2	5	4	ETC 1
5.		Open Elective – I	T	3-0-0	3	3	OEC
6.	MF23U02	Perspectives of Sustainable Development in Manufacturing Engineering	T	3-0-0	3	3	UC
7.		Skill Development Course -II	L	1-0-2	3	2	SDC
8.		Industry Oriented Course – I	-	-	-	1	SDC
9.		Summer Internship	IPW			2	SDC
TOTAL CREDITS						**26**	
Courses for Honours Degree							
1.	MF23D01	Capstone Design Project – Level I	CDP	0-0-12	12	6	SDC
OR							
1.	-	Honours Elective – I	T	3-0-0	3	3	PEC
2.	-	Honours Elective – II	T	3-0-0	3	3	PEC
Courses for Minor Degree							
1.	-	Minor Elective – I	T	3-0-0	3	3	PEC
2.	-	Minor Elective – II	T	3-0-0	3	3	PEC

$\$\$$Open Elective I shall be chosen from the Multidisciplinary courses.

$\#\#$4 weeks for two credit. Internship during IVth Semester Summer Vacation

SEMESTER VI (PREFERENCE FOR FOREIGN EXCHANGE)

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS PER WEEK		CREDITS	CATEGORY
				L-T-P	TCP		
1.	-	Professional Elective I	T	3-0-0	3	3	PEC
2.	-	Professional Elective II	T	3-0-0	3	3	PEC
3.	-	Professional Elective III	T	3-0-0	3	3	PEC
4.	-	Professional Elective IV	T	3-0-0	3	3	PEC
5.	-	Professional Elective V	T	3-0-0	3	3	PEC
6.	-	Industry Oriented Course – II	-	-	-	1	SDC
7.	MF23601	Advanced Manufacturing Lab	L	0-0-2	4	2	SDC
TOTAL CREDITS						**18**	
Courses for Honours Degree							
1.	MF23D02	Capstone Design Project – Level II	CDP	0-0-12	12	6	SDC
OR							
1.	-	Honours Elective – III	T	3-0-0	3	3	PEC
2.	-	Honours Elective – IV	T	3-0-0	3	3	PEC
Courses for Minor Degree							
1.	-	Minor Elective – III	T	3-0-0	3	3	PEC
2.	-	Minor Elective – IV	T	3-0-0	3	3	PEC

SEMESTER VII

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS PER WEEK		CREDITS	CATEGORY
				L-T-P	TCP		
1.	MF23701	Manufacturing Management Systems	T	3-0-0	3	3	PCC
2.	ME23C12	Mechatronics and IoT	LIT	3-0-2	5	4	PCC
3.	-	$$$Open Elective – II	T	3-0-0	3	3	OEC
4.	-	Professional Elective VI	T	3-0-0	3	3	PEC
5.	-	Emerging Technology Course- II	T	3-0-0	3	3	ETC 2
6.	-	Industry Oriented Course – III		-	-	1	SDC
7.	UC23E01	Engineering Entrepreneurship Development	LIT	2-0-2	4	3	UC
8.	MF23U01	Standards for Manufacturing Engineering	T	1-0-0	1	1	UC
9.	-	Skill Development - III	LIT	0-0-4	4	2	SDC
TOTAL CREDITS						**23**	

COURSES FOR HONOURS DEGREE							
1.	MF23D03	Capstone Design Project – Level III	CDP	0-0-12	12	6	SDC
OR							
1.	-	Honours Elective – V	T	3-0-0	3	3	PEC
2.	-	Honours Elective – VI	T	3-0-0	3	3	PEC
COURSES FOR MINOR DEGREE							
1.	-	Minor Elective – V	T	3-0-0	3	3	PEC
2.	-	Minor Elective – VI	T	3-0-0	3	3	PEC

[$$$]Open Elective II (shall be chosen from the list of open electives offered by other programmes)

SEMESTER VIII

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE[#]	PERIODS PER WEEK		CREDITS	CATEGORY
				L-T-P	TCP		
1.	MF23801	Project Work / Internship cum Project Work	PW	0-0-16	16	8	SDC
TOTAL CREDITS						**8**	

TOTAL CREDITS RANGE: 168

EMERGING TECHNOLOGY COURSES

S. NO.	COURSE CODE	COURSE TITLE	COURSE TYPE[#]	PERIODS PER WEEK		CREDITS	CATEGORY
				L-T-P	TCP[*]		
1.	MF23E01	Smart Manufacturing	T	3-0-0	3	3	ETC 1
2.	MF23E02	Advanced Composite Materials and Manufacturing	T	3-0-0	3	3	ETC 1
3.	MF23E03	Electronic Chip Manufacturing	T	3-0-0	3	3	ETC 2
4.	MF23E04	Nano Manufacturing and Characterization	T	3-0-0	3	3	ETC 2

LIST OF INDUSTRY ORIENTED COURSES

S. NO.	COURSE CODE	COURSE NAME	COURSE TYPE#	PERIODS PER WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1.		Six Sigma and Quality Control	T	1-0-0	1	1	SDC
2.		Geometric Dimensioning and Tolerancing	T	1-0-0	1	1	SDC
3.		Non-Destructive Testing	T	1-0-0	1	1	SDC
4.		Semiconductor Manufacturing	T	1-0-0	1	1	SDC
5.		Industrial Automation	T	1-0-0	1	1	SDC
6.		Data Analytics for Manufacturing	T	1-0-0	1	1	SDC
7.		Digital Twins in Manufacturing	T	1-0-0	1	1	SDC
8.		Finance and accounting	T	1-0-0	1	1	SDC

SKILL DEVELOPMENT COURSES

S. No.	Course Code	Course Title	Course Type#	Periods Per Week		Credits	Category
				L-T-P	TCP*		
1.	MF23S01	Practical Skills in Manufacturing Processes	LIT	1-0-2	3	2	SDC
2.	MF23S02	Practical Skills in Component Manufacturing	LIT	1-0-2	3	2	SDC
3.	MF23S03	Design and Fabrication Project	L	0-0-4	4	2	SDC

PROFESSIONAL ELECTIVE COURSES: VERTICALS

Professional Elective	Vertical I	Vertical II	Vertical III	Vertical IV	Vertical V	Verticals VI
	Robotics and Automation	**Industrial Engineering**	**Design**	**Advanced Manufacturing**	**Industry 4.0**	**Additive Manufacturing Processes**
1.	Industrial Robotics and Automation	Operations Research	Design of Jigs, Fixtures And Guages	Advances in Conventional Manufacturing Technologies	Design of Mechatronics System	An Introduction to Reverse Engineering
2.	Machine vision	Total Productive Maintenance	Finite Element Analysis	Precision Manufacturing and Nano Technology	IIoT in Manufacturing	Industrial Standards and Quality control for Additive Manufacturing
3.	Drives and Actuators	Total Quality Management	Design for Manufacturing	Micromachining and Microfabrication Technologies	Data Analytics	Business Improvement Strategies with Additive Manufacturing
4.	Sensors for Condition Monitoring and Intelligent systems	Supply Chain Analytics	New Product Development	Sustainable Manufacturing	Haptics and Immersive Technologies	Metallurgical aspects of Additive Manufacturing
5.	Flexible Manufacturing systems	Engineering Quality Control	Design for Sustainability	Electronics Manufacturing Technology	Blockchain in Manufacturing	Design for Additive Manufacturing
6.	Drone Technologies	Fundamentals of Lean Six Sigma	Ergonomics and Human factors Engineering	Laser Based Manufacturing	Modern Robotics	Modelling and Simulation in Additive Manufacturing

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered from Semesters V to VII. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, more than one course is permitted from the same row, provided each course is enrolled in different semester.

The registration of courses for B.E./B.Tech (Hons) shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E/B.Tech (Hons) also. For more details on B.E./B.Tech (Hons) refer to the Regulations 2023, Clause 4.11.

VERTICAL I: ROBOTICS AND AUTOMATION

S. NO.	COURSE CODE	COURSE TITLE	COURSE TYPE	PERIODS PER WEEK		CREDITS	CATEGORY
				L-T-P	TCP		
1.	MF23001	Industrial Robotics and Automation	T	3-0-0	3	3	PEC
2.	PR23C05	Machine vision	T	3-0-0	3	3	PEC
3.	MF23002	Drives and Actuators	T	3-0-0	3	3	PEC
4.	MF23003	Sensors for Condition Monitoring and Intelligent systems	T	3-0-0	3	3	PEC
5.	MF23004	Flexible Manufacturing system	T	3-0-0	3	3	PEC
6.	ME23C16	Drone Technologies	T	3-0-0	3	3	PEC

VERTICAL II: INDUSTRIAL ENGINEERING

S. NO.	COURSE CODE	COURSE TITLE	COURSE TYPE	PERIODS PER WEEK		CREDITS	CATEGORY
				L-T-P	TCP		
1.	IE23C06	Operations Research	T	3-0-0	3	3	PEC
2.	MF23C04	Total Productive Maintenance	T	3-0-0	3	3	PEC
3.	IE23C07	Total Quality Management	T	3-0-0	3	3	PEC
4.	IE23C10	Supply Chain Analytics	T	3-0-0	3	3	PEC
5.	IE23C01	Engineering Quality Control	T	3-0-0	3	3	PEC
6.	IE23C02	Fundamentals of Lean Six Sigma	T	3-0-0	3	3	PEC

VERTICAL III: DESIGN

S. NO.	COURSE CODE	COURSE TITLE	COURSE TYPE	PERIODS PER WEEK		CREDITS	CATEGORY
				L-T-P	TCP		
1.	PR23C03	Design of Jigs, Fixtures and Guages	T	3-0-0	3	3	PEC
2.	ME23C09	Finite Element Analysis	T	3-0-0	3	3	PEC
3.	MF23005	Design for Manufacturing	T	3-0-0	3	3	PEC
4.	MF23006	New Product Development	T	3-0-0	3	3	PEC
5.	MF23007	Design for Sustainability	T	3-0-0	3	3	PEC
6.	MF23C03	Ergonomics and Human factors Engineering	T	3-0-0	3	3	PEC

VERTICAL IV: ADVANCED MANUFACTURING

S. NO.	COURSE CODE	COURSE TITLE	COURSE TYPE	PERIODS PER WEEK		CREDITS	CATEGORY
				L-T-P	TCP		
1.	MF23008	Advances in Conventional Manufacturing Technologies	T	3-0-0	3	3	PEC
2.	MF23C06	Precision Manufacturing and Nano Technology	T	3-0-0	3	3	PEC
3.	MF23009	Micromachining and Microfabrication Technologies	T	3-0-0	3	3	PEC
4.	MF23C05	Sustainable Manufacturing	T	3-0-0	3	3	PEC
5.	MF23010	Electronics Manufacturing Technology	T	3-0-0	3	3	PEC
6.	MF23011	Laser Based Manufacturing	T	3-0-0	3	3	PEC

VERTICAL V: Industry 4.0

S. NO.	COURSE CODE	COURSE TITLE	COURSE TYPE	PERIODS PER WEEK		CREDITS	CATEGORY
				L-T-P	TCP		
1.	MF23012	Design of Mechatronics System	T	3-0-0	3	3	PEC
2.	MF23013	IIoT in Manufacturing	T	3-0-0	3	3	PEC
3.	RA23C01	Engineering Data Analytics	T	3-0-0	3	3	PEC
4.	ME23C10	Haptics and Immersive Technologies	T	3-0-0	3	3	PEC
5.	MF23014	Blockchain in manufacturing	T	3-0-0	3	3	PEC
6.	ME23C13	Modern Robotics	T	3-0-0	3	3	PEC

VERTICAL VI: ADDITIVE MANUFACTURING PROCESSES

S. NO.	COURSE CODE	COURSE TITLE	COURSE TYPE	PERIODS PER WEEK		CREDITS	CATEGORY
				L-T-P	TCP		
1.	MF23015	An Introduction to Reverse Engineering	T	3-0-0	3	3	PEC
2.	MF23016	Industrial Standards and Quality control for Additive Manufacturing	T	3-0-0	3	3	PEC
3.	MF23017	Business Improvement Strategies with Additive Manufacturing	T	3-0-0	3	3	PEC
4.	MF23018	Metallurgical aspects of Additive Manufacturing	T	3-0-0	3	3	PEC
5.	MF23019	Design for Additive Manufacturing	T	3-0-0	3	3	PEC
6.	MF23020	Modelling and Simulation in Additive Manufacturing	T	3-0-0	3	3	PEC

OPEN ELECTIVE I

(Students can choose a maximum of one open elective from provided in the table)

S. NO.	COURSE CODE	COURSE TITLE	COURSE TYPE	PERIODS PER WEEK		CREDITS	CATEGORY
				L-T-P	TCP		
1.	MF23901	Introduction to Gender Studies	T	3-0-0	3	3	OEC
2.	MF23902	Elements of Literature	T	3-0-0	3	3	OEC
3.	MF23903	Constitution of India	T	3-0-0	3	3	OEC
4.	MF23904	Disaster Risk Reduction and Management	T	3-0-0	3	3	OEC
5.	MF23905	Well Being with Traditional Practices	T	3-0-0	3	3	OEC
6.	MF23906	History of Science and Technology in India	T	3-0-0	3	3	OEC
7.	MF23907	Political and Economic Thought for a Humane Society	T	3-0-0	3	3	OEC
8.	MF23908	Nation Building and Politics in India	T	3-0-0	3	3	OEC

OPEN ELECTIVE – II

(TO BE OFFERED TO OTHER DEPARTMENTS)

SL. NO.	COURSE CODE	COURSE TITLE	COURSE TYPE	PERIODS PER WEEK		CREDITS	CATEGORY
				L-T-P	TCP		
1.	MF23909	Electronics Packaging Technology	T	3-0-0	3	3	OEC
2.	MF23910	Industrial and Bio-Inspired Robotics	T	3-0-0	3	3	OEC

*Each department shall provide syllabus of the proposed list of open electives

No. of open elective offered by each department = 2 X N (N = no. of batches of the offering department)

Registration of Professional Elective Courses from Verticals:

a. Professional Elective Courses will be registered in Semesters VI and VII. These courses are listed in groups called verticals that represent a particular area of specialization / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise).

b. The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VII. The procedure for registration of courses explained above shall be followed for the courses of B.E/B.Tech (Honours) or Minor degree also. For more details on B.E./B.Tech (Honours) or Minor degree refer to the Regulations 2023, Clause 4.11.

COURSES FOR HONOURS DEGREE

S. NO.	COURSE CODE	COURSE TITLE	COURSE TYPE	PERIODS PER WEEK		CREDITS	CATEGORY
				L-T-P	TCP		
1.	MF23021	Design and Manufacturing of Aerospace Components	T	3-0-0	3	3	Honours
2.	MF23022	System Simulation for Manufacturing Engineers	T	3-0-0	3	3	Honours
3.	MF23023	Micro and Nano Manufacturing	T	3-0-0	3	3	Honours
4.	MF23024	Surface Engineering And Tribology	T	3-0-0	3	3	Honours
5.	MF23025	Smart Materials	T	3-0-0	3	3	Honours
6.	MF23026	Biomanufacturing and Biomedical Device Fabrication	T	3-0-0	3	3	Honours
7.	MF23027	Machine Learning In Manufacturing	T	3-0-0	3	3	Honours
8.	MF23028	Enterprise Resource Planning	T	3-0-0	3	3	Honours

COURSES FOR MINOR DEGREE

(INTEGRATED MANUFACTURING SYSTEMS AND TECHNOLOGIES)

S. NO.	COURSE CODE	COURSE TITLE	COURSE TYPE	PERIODS PER WEEK		CREDITS	CATEGORY
				L-T-P	TCP		
1.	MF23029	Manufacturing Processes	T	3-0-0	3	3	Minor
2.	MF23030	CAD-CAM	T	3-0-0	3	3	Minor
3.	MF23031	Advances in Manufacturing	T	3-0-0	3	3	Minor
4.	MF23032	Metrology and Statistical Quality Control	T	3-0-0	3	3	Minor
5.	MF23033	Smart Manufacturing	T	3-0-0	3	3	Minor
6.	MF23034	Manufacturing Management Systems	T	3-0-0	3	3	Minor

BRIDGE COURSE FOR LATERAL ENTRY STUDENTS (DIPLOMA)							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP**		
1.	ME23C03	Engineering Mechanics	T	3-1-0	4	4	ESC

BRIDGE COURSE FOR LATERAL ENTRY STUDENTS (B.SC.)							
S. NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE**	**PERIODS / WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP**		
1.	ME23C03	Engineering Mechanics	T	3-1-0	4	4	ESC
2.	ME23C01	Engineering Drawing and Computer Aided Drafting	T	2-0-4	6	4	SDC

EN23C01 **FOUNDATION ENGLISH** **L T P C**

2 0 2 3

COURSE OBJECTIVES:

- To develop students' foundational skills in reading, writing, grammar and vocabulary to enable them to understand and produce various forms of communication.
- To enhance students' proficiency in reading comprehension, narrative and comparative writing.
- To comprehend and analyse descriptive texts and visual images
- To articulate similarities and differences in oral and written forms.
- To improve students' proficiency in reading and writing formal letters and emails.

UNIT I BASICS OF COMMUNICATION **6**

Reading - Telephone message, bio-note; Writing – Personal profile; Grammar – Simple present tense, Present continuous tense, wh-questions, indirect questions; Vocabulary – Word formation (Prefix and Suffix).

LAB ACTIVITY: **6**

Listening – Telephone conversation; Speaking Self-introduction; Telephone conversation – Video conferencing etiquette

UNIT II NARRATION **6**

Reading – Comprehension strategies - Newspaper Report, An excerpt from an autobiography; Writing – Narrative Paragraph writing (Event, personal experience etc.); Grammar – Subject-verb agreement, Simple past, Past continuous Tenses; Vocabulary – One-word substitution

LAB ACTIVITY: **6**

Listening – Travel podcast; Speaking – Narrating and sharing personal experiences through a podcast

UNIT III DESCRIPTION **6**

Reading – A tourist brochure, Travel blogs, descriptive article/excerpt from literature, visual images; Writing – Descriptive Paragraph writing, Grammar – Future tense, Perfect tenses, Preposition; Vocabulary – Descriptive vocabulary

LAB ACTIVITY: **6**

Listening – Railway / Airport Announcements, Travel Vlogs; Speaking – Describing a place or picture description

UNIT IV COMPARE AND CONTRAST **6**

Reading – Reading and comparing different product specifications - Writing – Compare and Contrast Essay, Coherence and cohesion; Grammar – Degrees of Comparison; Vocabulary – Transition words (relevant to compare and contrast)

LAB ACTIVITY: **6**

Listening – Product reviews, Speaking – Product comparison based on product reviews - similarities and differences

UNIT V EXPRESSION OF VIEWS **6**

Reading – Formal letters, Letters to Editor ; Writing – Letter writing/ Email writing (Enquiry / Permission, Letter to Editor); Grammar – Compound nouns, Vocabulary – Synonyms, Antonyms

LAB ACTIVITY: **6**

Listening – Short speeches; Speaking – Making short presentations (JAM)

TOTAL: 60 PERIODS

TEACHING METHODOLOGY

Interactive lectures, role plays, group discussions, listening and speaking labs, technology enabled language teaching, flipped classroom.

EVALUATION PATTERN

Internal Assessment

Written assessments

Assignment

Lab assessment

Listening

Speaking

External Assessment

End Semester Examination

LEARNING OUTCOMES

By the end of the courses, students will be able to

- Use appropriate grammar and vocabulary to read different types of text and converse appropriately.
- Write coherent and engaging descriptive and comparative essay writing.
- Comprehend and interpret different kinds of texts and audio visual materials
- Critically evaluate reviews and articulate similarities and differences
- Write formal letters and emails using appropriate language structure and format

TEXT BOOKS:

1. “English for Engineers and Technologists” Volume I by Orient Blackswan, 2022

2. “English for Science & Technology - I” by Cambridge University Press, 2023

REFERENCES

1. “Interchange” by Jack C.Richards, Fifth Edition, Cambridge University Press, 2017.

2. “English for Academic Correspondence and Socializing” by Adrian Wallwork, Springer, 2011.

3. “The Study Skills Handbook” by Stella Cortrell, Red Globe Press, 2019

4. www.uefap.com

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										√		√
CO2										√		
CO3										√		√
CO4										√		
CO5										√		√

MA23C01	MATRICES AND CALCULUS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To develop the use of matrix algebra techniques in solving practical problems.
- To familiarize the student with functions of several variables.
- To solve integrals by using Beta and Gamma functions.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals.
- To acquaint the students with the concepts of vector calculus which naturally arise in many engineering problems.

UNIT I MATRICES 9+3

Eigenvalues and Eigenvectors of a real matrix – Properties of Eigenvalues and Eigenvectors- Cayley-Hamilton theorem (excluding proof) – Diagonalization of matrices - Reduction of Quadratic form to canonical form by using orthogonal transformation - Nature of a Quadratic form.

UNIT II FUNCTIONS OF SEVERAL VARIABLES 9+3

Limit, continuity, partial derivatives – Homogeneous functions and Euler's theorem - Total derivative – Differentiation of implicit functions – Jacobians -Taylor's formula for two variables - Errors and approximations – Maxima and Minima of functions of two variables – Lagrange's method of undermined multipliers.

UNIT III INTEGRAL CALCULUS 9+3

Improper integrals of the first and second kind and their convergence – Differentiation under integrals - Evaluation of integrals involving a parameter by Leibnitz rule – Beta and Gamma functions-Properties – Evaluation of single integrals by using Beta and Gamma functions..

UNIT IV MULTIPLE INTEGRALS 9+3

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of Solids – Change of variables in double and triple integrals-
Evaluation of double and triple integrals by using Beta and Gamma functions.

UNIT V VECTOR CALCULUS 9+3

Gradient of a scalar field, directional derivative – Divergence and Curl – Solenoidal and Irrotational vector fields - Line integrals over a plane curve - Surface integrals – Area of a curved surface – Volume Integral - Green's theorem, Stoke's and Gauss divergence theorems (without proofs)– Verification and applications in evaluating line, surface and volume integrals.

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students wherever applicable from the content of the course.

General engineering applications / branch specific applications from the content of each units wherever possible will be introduced to students.

Suggested Laboratory based exercises / assignments / assessments :

Matrices

1. Finding eigenvalues and eigenvectors
2. Verification of Cayley-Hamilton theorem
3. Eigenvalues and Eigenvectors of similar matrices
4. Eigenvalues and Eigenvectors of a symmetric matrix
5. Finding the powers of a matrix
6. Quadratic forms

Functions of Several Variables

1. Plotting of curves and surfaces
2. Symbolic computation of partial and total derivatives of functions

Integral Calculus

1. Evaluation of beta and gamma functions
2. Computation of error function and its complement

Multiple Integrals

1. Plotting of 3D surfaces in Cartesian and Polar forms

Vector Calculus

1. Computation of Directional derivatives
2. Computation of normal and tangent to the given surface

OUTCOMES:

CO 1 :Use the matrix algebra methods for solving practical problems.
CO 2 :Use differential calculus ideas on several variable functions.
CO 3 :Apply different methods of integration in solving practical problems by using Beta and Gamma functions.
CO 4 :Apply multiple integral ideas in solving areas and volumes problems.
CO 5 :Apply the concept of vectors in solving practical problems.

TEXT BOOKS:

1. Joel Hass, Christopher Heil, Maurice D.Weir "'Thomas' Calculus", Pearson Education., New Delhi, 2018.
2. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 45th Edition, New Delhi, 2020.
3. James Stewart, Daniel K Clegg & Saleem Watson "Calculus with Early Transcendental Functions", Cengage Learning, 6th Edition, New Delhi,2023.

REFERENCES:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt Ltd., New Delhi, 2018.
2. Greenberg M.D., "Advanced Engineering Mathematics", Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.
3. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics",Narosa Publications, 5th Edition, New Delhi, 2017.

4. Narayanan S. and Manicavachagom Pillai T. K., “Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Peter V.O’Neil, “Advanced Engineering Mathematics”, Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi , 2012.
6. Ramana B.V., “Higher Engineering Mathematics”, Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO5 :	3	3	2	3	1	2	1	1	1	1	1	3

PH23C01	ENGINEERING PHYSICS	L	T	P	C
	(Common to all branches of B.E/B.Tech Programmes)	3	0	2	4

COURSE OBJECTIVES

- To familiarize with crystal structure, bonding and crystal growth.
- To impart knowledge on Mechanics of Materials.
- To impart knowledge of oscillations, sound and Thermal Physics
- To facilitate understanding of optics and its applications, different types of Lasers and fiber optics.
- To introduce the basics of Quantum Mechanics and its importance.

UNIT I CRYSTAL PHYSICS 9+6

Crystal Bonding – Ionic – covalent – metallic and van der Walls's/ molecular bonding. Crystal systems - unit cell, Bravais lattices, Miller indices - Crystal structures - atomic packing density of BCC, FCC and HCP structures. NaCl, Diamond, Graphite, Graphene, Zincblende and Wurtzite structures - crystal imperfections- point defects - edge and screw dislocations – grain boundaries. Crystal Growth – Czocharalski method – vapor phase epitaxy – Molecular beam epitaxy- Introduction to X-Ray Diffractometer.

1. Determination of Lattice parameters for crystal systems.
2. Crystal Growth – Slow Evaporation method
3. Crystal Growth Sol – Gel Method

UNIT II MECHANICS OF MATERIALS 9+6

Rigid Body – Centre of mass – Rotational Energy - Moment of inertia (M.I)- Moment of Inertia for uniform objects with various geometrical shapes. Elasticity –Hooke's law - Poisson's ratio - stress-strain diagram for ductile and brittle materials – uses- Bending of beams – Cantilever - Simply supported beams - uniform and non-uniform bending - Young's modulus determination - I shaped girders –Twisting couple – Shafts. Viscosity – Viscous drag – Surface Tension.

4. Non-uniform bending -Determination of Young's modulus of the material of the beam.
5. Uniform bending -Determination of Young's modulus of the material of the beam
6. Viscosity – Determination of Viscosity of liquids.

UNIT III OSCILLATIONS, SOUND AND THERMAL PHYSICS 9+6

Simple harmonic motion - Torsional pendulum –- Damped oscillations –Shock Absorber -Forced oscillations and Resonance –Applications of resonance.- Waves and Energy Transport –Sound waves – Intensity level – Standing Waves - Doppler effect and its applications - Speed of blood flow. Ultrasound – applications - Echolocation and Medical Imaging. Thermal Expansion – Expansion joints – Bimetallic strip – Seebeck effect – thermocouple -Heat Transfer Rate – Conduction – Convection and Radiation.

7. Torsional pendulum-Determination of rigidity modulus of wire and moment of inertia of the disc
8. Melde's string experiment - Standing waves.
9. Ultrasonic interferometer – determination of sound velocity and liquids compressibility

UNIT IV OPTICS AND LASERS 9+6

Interference - Thin film interference - Air wedge- Applications -Interferometers–Michelson Interferometer -– Diffraction - CD as diffraction grating – Diffraction by crystals -Polarization - polarizers -– Laser – characteristics – Spontaneous and Stimulated emission- population – inversion - Metastable states - optical feedback - Nd-YAG laser, CO_2 laser, Semiconductor laser - Industrial and medical applications - Optical Fibers – Total internal reflection – Numerical aperture and acceptance angle – Fiber optic communication – Fiber sensors – Fiber lasers.

10. Laser - Determination of the width of the groove of the compact disc using laser.
Laser Parameters
Determination of the wavelength of the laser using grating

11. Air wedge -Determination of the thickness of a thin sheet/wire
12. Optical fibre - Determination of Numerical Aperture and acceptance angle
-Determination of bending loss of fibre.
13. Michelson Interferometer (Demonstration)

UNIT V QUANTUM MECHANICS 9+6

Black body radiation (Qualitative) – Planck's hypothesis – Einstein's theory of Radiation - Matter waves–de Broglie hypothesis - Electron microscope – Uncertainty Principle – The Schrodinger Wave equation (time-independent and time-dependent) – Meaning and Physical significance of wave function - Normalization - Particle in an infinite potential well-particle in a three-dimensional box - Degenerate energy states - Barrier penetration and quantum tunneling - Tunneling microscope.

14. Photoelectric effect – Determination of Planck's constant.
15. Black Body Radiation (Demonstration)
16. Electron Microscope (Demonstration)

TOTAL: 75 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1: Understand the significance of crystal structure and bonding. Learn to grow crystals.
CO2: Obtain knowledge on important mechanical and thermal properties of materials and determine them through experiments.
CO3: Conceptualize and visualize the oscillations and sound.
CO4: Grasp optical phenomenon and their applications in real life.
CO5: Appreciate and evaluate the quantum phenomenon.
CO6 Develop skill set to solve engineering problems and design experiments.

TEXT BOOKS:

1. Raymond A. Serway, John W. Jewett, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2013.
2. D. Halliday, R. Resnick and J. Walker, Principles of Physics. John Wiley & Sons, 10th Edition, 2015.
3. N. Garcia, A. Damask and S. Schwarz, Physics for Computer Science Students, Springer-Verlag, 2012.
4. Alan Giambattista, Betty McCarthy Richardson and Robert C. Richardson, College Physics, McGraw-Hill Higher Education, 2012.

REFERENCES:

1. R. Wolfson, Essential University Physics. Volume 1 & 2. Pearson, 2016.
2. D. Kleppner and R. Kolenkow. An Introduction to Mechanics, McGraw Hill Education, 2017.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1		1							
CO2	3	2	1	1								
CO3	3	2	1	1								
CO4	3	2	1	1	1							
CO5	3	2	1	1	1							
CO6	3	2	1	2								

ME23C01	ENGINEERING DRAWING AND 3D MODELING	L	T	P	C
		2	0	4	4

COURSE OBJECTIVES

After successful completion of this course, the students will be able to:

1. Understand and use the engineering curves in engineering applications and projection techniques to construct conic curves, points and lines.
2. Develop skills in projecting surfaces and solids and create 2D models using CAD software.
3. Develop skills in 3D projection and 3D modeling of simple parts manually as well as using CAD software.
4. Understand and apply sectioning techniques to solids and assemble components.
5. Develop skills in lateral surface development and sheet metal design.

INTRODUCTION

Manual drawing tools (Mini Drafter, Set Squares, Protractor, Compass, and different grades of pencil). **'**BIS' specifications and rules of Engineering Drawing – Arrows (2H thin line body, HB Filled head and L:W = 3:1 ratio), lettering (Digital fonts, font sizes pertaining to usage and representation), types of line and their syntax (Drawing based – Continuous thin & thick, dashed, dashed dotted and Application based – extension, dimensioning, construction, projection, reference, axis, section, hatching, and break lines), scaling (up, down and equal), and dimensioning. Placing and positioning the 'A3' size drawing sheet over the drawing table. Principal planes and projection, Division of line and circle in to equal parts, and construction of polygons

UNIT I ENGINEERING CURVES, PROJECTION OF POINTS AND LINES

Construction of conic curves with their tangent and normal – ellipse, parabola, and hyperbola by eccentricity method

Construction of special curves with their tangent and normal – cycloid, epicycloid, and involute

Projection of points and I angle projection of lines inclined to both principal planes by rotating line method and trapezoidal rule – marking their traces.

Lab exercises: Study exercise – Introduction to Sketching (or) Drawing, and modification tools in CAD software (AutoCAD, CREO, CATIA, Solid Works, Inventor, Fusion 360)

(6+12 = 18 Hours)

Activities based learning: Identification of the curves used in the application given in the flash card, demonstration of the instantaneous centre of rotation of governors with respect to angle of inclination of the arms of the governors

UNIT II PROJECTION OF SURFACES & SOLIDS, AND 2D MODELING

Projection of surfaces inclined to both the principal planes – polygonal, trapezoidal, rhomboidal and circular

Projection of solids – prisms, pyramids, and axisymmetric solids when the axis inclined to both the principal planes – freely hanging – contour resting condition on either of the planes by rotating object method

Lab exercises: Construction of basic sketches – lines, circle, polygon, spline curves, coils, along with dimensioning. Familiarizing with geometric constraints and their types

(6+12 = 18 Hours)

Activities based learning: Making the solids using cardboards, shadow mapping and contour drawing at different orientation of the solids using torches

UNIT III 3D PROJECTION OF SOLIDS AND 3D MODELING OF SIMPLE PARTS

Free hand sketching – I & III angle projections of engineering parts and components

Isometric projection of combination of solids – prisms, pyramids, axisymmetric solids, frustum

Perspective projection of prisms, pyramids and axisymmetric solids by visual ray method

Lab exercises: 3D Modeling and 2D drafting of machine parts

(6+12 = 18 Hours)

Activities based learning: Flipped classroom for Free hand sketching, Jig saw activity for Isometric projection, arts and crafts for perspective view

UNIT IV SECTION OF SOLIDS AND SECTIONED DRAFTING OF ASSEMBLED COMPONENTS

Section of simple and hollow solids – prisms, pyramids and axisymmetric solids, solids with holes/ slots when the section plane perpendicular to one principal plane and inclined to other principal plane (‘On the axis’ and ‘from the axis’ conditions)

Application based – section of beams (I, T, L, and C), section of pipe bracket, wood joints, composite walls, shells, flange of a coupling and other similar applications

Lab exercises: Assembly of parts with respect to engineering constraints, and sectioned drafting of assembled components

(6+12 = 18 Hours)

Activities based learning: Making of mitered joint in wood, sectioning the beams in different angles of orientation and identifying the true shape

UNIT V LATERAL SURFACE DEVELOPMENT AND SHEET METAL DESIGN

Lateral surface development of sectioned solids when the section plane perpendicular to VP and inclined to HP.

Application based – construction of funnel, chimney, dish antenna, door latch, trays, AC vents, lamp shade, commercial packaging boxes with respect to sectioning conditions and other similar applications

Lab exercises: Sheet metal design and drafting, drafting of coils, springs and screw threads

(6+12 = 18 Hours)

Activities based learning: Fabrication of funnels, chimney, lamp shade, boxes using card boards, ply woods, acrylics

Total: 90 Hours

Note: Activities based learning should not be covered in the regular class hours. It should be given as assignments to the group of maximum 3 members

COURSE OUTCOMES

After successful completion of the course, the students will be able to:

CO1: Construct and identify different types of conic curves and special curves, and project the points and lines pertaining to engineering applications

CO2: Project and visualize surfaces and solids in different orientations and utilize the CAD tools for designing.

CO3: Create and draft accurate 3D models and 2D drawings of machine parts manually as well as using CAD software

CO4: Determine the true shape of a sectioned solid and draft the assembled parts accordingly

CO5: Develop lateral surfaces of sectioned solids and design sheet metal components

TEXT BOOK

1. “Engineering Drawing” by N S Parthasarathy and Vela Murali, Oxford University Press; UK ed. Edition, 2015.
2. “Engineering Drawing + Auto CAD” by Venugopal K, V. Prabhu Raja, New Age International Publishers, Sixth edition (1 January 2022).

REFERENCES

1. "Basic Engineering Drawing: Mechanical Semester Pattern" by Mehta and Gupta, Charotar Publishing House, 2nd edition, 2018.
2. "Engineering Drawing" by Basant Agrawal and C M Agrawal, Vikas Publishing House, 3rd edition, 2020.
3. "Engineering Drawing With Auto CAD" by B V R Gupta, McGraw Hill Education, 4th edition, 2019.
4. "Engineering Drawing" by P S Gill, Tata McGraw Hill Education, 5th edition, 2018.
5. "Engineering Drawing with an Introduction to AutoCAD" by Dhananjay Jolhe, Cengage Learning, 2nd edition, 2020.

6. "Engineering Drawing" by M B Shah, Charotar Publishing House, 3rd edition, 2019
7. "Fundamentals of Engineering Drawing" by Imtiaz Hashmi, Pearson Education, 2nd edition, 2018.
8. "Computer Aided Engineering Drawing" by S Trymbaka Murthy, Scitech Publications, 3rd edition, 2020.
9. "CAED: Computer Aided Engineering Drawing for I/II Semester BE/Btech Courses" by Reddy K B, CBS Publishers & Distributors, 2nd, 2019.
10. "Computer-Aided Engineering Drawing" by Subrata Pal, Oxford University Press, 2nd, 2020.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2		1				3	1		3	3	3	2
2	3	3	2		2				3	2		3	3	3	2
3	3	3	3	1	2				3	3		3	3	3	2
4	3	3	3	1	3				3	3		3	3	3	2
5	3	3	3	1	3				3	3		3	3	3	2

EE23C03	BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING	L	T	P	C
		2	0	2	3

UNIT-I BASIC ELECTRICAL CIRCUITS 6

Basic Elements: R,L,C- DC Circuits: Ohm's Law - Kirchhoff's Laws –Mesh and Nodal Analysis(Only Independent Sources). AC Circuits: Average Value, RMS Value, Impedance Instantaneous Power, Real Power, Reactive Power and Apparent Power, Power Factor-Steady state Analysis of RL,RC and RLC circuits.

UNIT II AC AND DC MACHINES 6

Magnetic Circuit Fundamentals -DC Machines - Construction and Working Principle, Types and Application of DC generator and Motor, EMF and Torque Equation.

AC Machines: Principle, Construction, Working and Applications of Transformer -Three phase Alternator - Three Phase Induction Motor.

UNIT III ANALOG AND DIGITAL ELECTRONICS 6

Operation and Characteristics of electronic devices: PN Junction Diodes, Zener Diode and BJT Applications: Diode Bridge Rectifier and Shunt Regulator.

Introduction to Digital Electronics: Basics Logic Gates-Flip Flops.

UNIT IV SENSORS AND TRANSDUCERS 6

Solenoids, electro-pneumatic systems, proximity sensors, limit switches, Strain gauge, LVDT, Piezo electric transducer, optical and digital transducers, Smart sensors, Thermal Imagers.

UNIT V MEASUREMENTS AND INSTRUMENTATION 6

Functional Elements of an Instrument, Operating Principle of Moving Coil and Moving Iron Instruments, Power Measurement, Energy Meter, Instrument Transformers - CT and PT, Multimeter- DSO - Block Diagram Approach.

TOTAL:30 PERIODS

LAB COMPONENET:

1. Verification of ohms and Kirchhoff's Laws.
2. Load test on DC Shunt Motor.
3. Load test on Single Phase Transformer.
4. Load test on 3 Phase Induction Motor.
5. Uncontrolled diode bridge Rectifiers.
6. Application of Zener diode as shunt regulator.
7. Verification of truth table of logic gates and flip flops.
8. Characteristics of LVDT.
9. Three phase power measurement using two wattmeter method.
10. Study of DSO.

COURSE OUTCOMES: Students will be able to

CO1 Compute the electric circuit parameters for simple circuits.

CO2 Understand the working principles and characteristics of electrical machines.

CO3 Understand the basic electronic devices.

CO4 Understand the basic operating principles of sensors and transducer.

CO5 Understand the operating principles measuring devices

TEXT BOOKS:

1. Kotharai DP and Nagarath IJ, “Basic Electrical and Electronics Enigneering”, McGraw Hill Education, Second Edition, 2020.
2. Bhattacharya SK, “Basic Electrical and Electronics Engineering”, Pearson Education, Second Edition, 2017.

REFERENCES:

1. Mehta V.K. & Mehta Rohit, “Principles of Electrical Engineering and Electronics”, McGraw Hill Education, Second Edition, 2020.
2. Mehta V.K. & Mehta Rohit, “Principles of Electrical Machines”, S. Chand Publishing, second edition 2006.
3. Albert Malvino & David Bates, “Electronic principles”, McGraw Hill Education, Seventh Edition, 2017.

MAPPING COS AND POS:

COs	Pos												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1														
CO2	2	1														
CO3	2	1														
CO4	2	1														
CO5	2	1														
Avg	2	1														

ME23C04	MAKERSPACE	L	T	P	C
		1	0	4	3

COURSE OBJECTIVES:

1. To practice the usage of various tools towards assembly and dis-assembly of different items / equipment.
2. To make simple part / component using welding processes.
3. To train on the basic wiring practices of boards, machines, etc.
4. To provide a hands-on experience on the use of electronic components, equipment, sensors and actuators.
5. To expose to modern computer tools and advanced manufacturing / fabrication processes.

LIST OF ACTIVITIES **1L,4P**

(A).Dis-assembly & Assembly Practices

i. Tools and its handling techniques.
ii. Dis-assembly and assembly of home appliances – Grinder Mixer Grinder, Ceiling Fan, Table Fan & Washing Machine.
iii. Dis-assembly and assembly of Air-Conditioners & Refrigerators.
iv. Dis-assembly and assembly of a Bicycle.

(B).Welding Practices

i. Welding Procedure, Selection & Safety Measures.
ii. Power source of Arc Welding – Gas Metal Arc Welding & Gas Tungsten Arc Welding processes.
iii. Hands-on session of preparing base material & Joint groove for welding.
iv. Hands-on session of MAW, GMAW, GTAW, on Carbon Steel & Stainless Stell plates / pipes, for fabrication of a simple part.

(C).Electrical Wiring Practices

i. Electrical Installation tools, equipment & safety measures.
ii. Hands-on session of basic electrical connections for Fuses, Miniature Circuit Breakers and Distribution Box,
iii. Hands-on session of electrical connections for Lightings, Fans, Calling Bells.
iv. Hands-on session of electrical connections for Motors & Uninterruptible Power Supply.

(D).Electronics Components / Equipment Practices

i. Electronic components, equipment & safety measures.

ii. Dis-assembly and assembly of Computers.

iii. Hands-on session of Soldering Practices in a Printed Circuit Breaker.

iv. Hands-on session of Bridge Rectifier, Op-Amp and Transimpedance amplifier.

v. Hands-on session of integration of sensors and actuators with a Microcontroller.

vi. Demonstration of Programmable Logic Control Circuit.

(E).Contemporary Systems

i. Demonstration of Solid Modelling of components.

ii. Demonstration of Assembly Modelling of components.

iii. Fabrication of simple components / parts using 3D Printers.

iv. Demonstration of cutting of wood / metal in different complex shapes using Laser Cutting Machine.

TOTAL: 75 Periods (15 Lecture + 60 Practical)

COURSE OUTCOMES:

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

CO1: Assemble and dis-assemble various items / equipment.
CO2: Make simple parts using suitable welding processes.
CO3: Setup wiring of distribution boards, machines, etc.
CO4: Utilise the electronic components to fabricate a simple equipment, aided with sensors and actuators.
CO5: Take advantage of modern manufacturing practices.

REFERENCES:

1. Stephen Christena, Learn to Weld: Beginning MIG Welding and Metal Fabrication Basics, Crestline Books, 2014.
2. H. Lipson, Fabricated - The New World of 3D Printing, Wiley, 1st edition, 2013.
3. Code of Practice for Electrical Wiring Installations (IS 732:2019)
4. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Oxford University Press, 7th ed. (Indian edition), 2017.
5. Mazidi, Naimi, Naimi, AVR Microcontroller and Embedded Systems: Using Assembly and C, Pearson India, 1st edition 2013.
6. Visualization, Modeling, and Graphics for Engineering Design, D.K. Lieu, S.A. Sorby, Cengage Learning; 2nd edition.

UC23H01 **தமிழர் மரபு** **L T P C**
1 0 0 1

அலகு I **மொழி மற்றும் இலக்கியம்**: **3**
இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II **மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை**: **3**
நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு III **நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்**: **3**
தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு IV **தமிழர்களின் திணைக் கோட்பாடுகள்**: **3**
தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V **இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு**: **3**
இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.

7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

UC23H01 **HERITAGE OF TAMILS** **L T P C**
1 0 0 1

UNIT I LANGUAGE AND LITERATURE 3

Language Families in India - Dravidian Languages – Tamil as aClassical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III FOLK AND MARTIAL ARTS 3

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV THINAI CONCEPT OF TAMILS 3

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

NCC Credit Course Level 1*

UC23P01	**(ARMY WING) NCC Credit Course Level - I**	**L T P C**
		2 0 0 2

NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour ‘Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

UC23P02	**(NAVAL WING) NCC Credit Course Level – I**	**L T P C**
		2 0 0 2

NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

UC23P03	**(AIR FORCE WING) NCC Credit Course Level – I**	**L T P C**
		2 0 0 2

NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

UC23U01 **UNIVERSAL HUMAN VALUES** **L T P C**

1 0 2 2

COURSE OBJECTIVE:

The objective of the course is four-fold:

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

MODULE I INTRODUCTION (3L,6P)

Purpose and motivation for the course, recapitulation from Universal Human Values-I, Self-Exploration– Its content and process; 'Natural acceptance' and Experiential Validation- as the process for self-exploration Continuous Happiness and Prosperity- A look at basic Human Aspirations Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Practical Session: Include sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking

MODULE II HARMONY IN THE HUMAN BEING (3L,6P)

Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body' - happiness and physical facility, Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer), Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Health.

Practical Session: Include sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.

MODULE III HARMONY IN THE FAMILY AND SOCIETY (3L,6P)

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship, Understanding the meaning of Trust; Difference between intention and competence, Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship, Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals, Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Practical Session: Include sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives

MODULE IV HARMONY IN THE NATURE AND EXISTENCE (3L,6P)

Understanding the harmony in the Nature, Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self regulation in nature, Understanding Existence as Co-existence of mutually interacting units in all- pervasive space, Holistic perception of harmony at all levels of existence.

Practical Session: Include sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

MODULE V IMPLICATIONS OF HARMONY ON PROFESSIONAL ETHICS (3L,6P)

Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems, Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations, Sum up.

Practical Session: Include Exercises and Case Studies will be taken up in Sessions E.g. To discuss the conduct as an engineer or scientist etc.

TOTAL: 45 (15 Lectures + 30 Practicals) PERIODS

COURSE OUTCOME:

By the end of the course, the students will be able to:

1. Become more aware of themselves, and their surroundings (family, society, nature);
2. Have more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
3. Have better critical ability.
4. Become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
5. Apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

REFERENCES:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 3rd revised edition, 2023.
2. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
3. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
4. The Story of Stuff (Book).
5. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
6. Small is Beautiful - E. F Schumacher.
7. Slow is Beautiful - Cecile Andrews.
8. Economy of Permanence - J C Kumarappa
9. Bharat Mein Angreji Raj - PanditSunderlal

10.Rediscovering India - by Dharampal

11. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi

12. India Wins Freedom - Maulana Abdul Kalam Azad

13. Vivekananda - Romain Rolland (English)

14. Gandhi - Romain Rolland (English)

Web URLs:

1. Class preparations: https://fdp-si.aicte-india.org/UHV-II%20Class%20Note.php
2. Lecture presentations: https://fdp-si.aicte-india.org/UHV-II_Lectures_PPTs.php
3. Practice and Tutorial Sessions: https://fdp-si.aicte-india.org/UHV-II%20Practice%20Sessions.php

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						1	1	1	3			3
CO2						1	1	1	3			3
CO3						3	3	2	3		1	3
CO4						3	3	2	3		1	3
CO5						3	3	3	3		2	3

EN23C02 **PROFESSIONAL COMMUNICATION** **L T P C**

2 0 2 3

COURSE OBJECTIVES:

- To read and comprehend different forms of official texts.
- To develop students' writing skills in professional context.
- To actively listen, read and understand written and oral communication in a professional context.
- To comprehend and analyse the visual content in authentic context.
- To write professional documents with clarity and precision

UNIT I CAUSE AND EFFECT **6**

Reading – Newspaper articles on Social and Environmental issues; Writing – Instructions, Cause and effect essay; Grammar - Modal verbs; Vocabulary – Cause and effect, Idioms

LAB ACTIVITY: **6**

Listening and Speaking – Listen to news reports and summarise in oral form.

UNIT II CLASSIFICATION **6**

Reading – An article, social media posts and classifying based on the content; Writing – Definition, Note making, Note taking (Cornell notes etc.) and Summarising; Grammar – Connectives; Vocabulary – Phrasal verbs

LAB ACTIVITY: **6**

Listening and speaking: Social interaction (Conversation including small talk)

UNIT III PROBLEM AND SOLUTION **6**

Reading – Visual content (Tables/charts/graphs) for comprehension; Writing - Problem and Solution Essay; Grammar – If conditionals; Vocabulary – Sequential words.

LAB ACTIVITY: **6**

Listening – Group discussion; Speaking – Participating in a group discussion

UNIT IV REPORT **6**

Reading – Formal report on accidents (industrial/engineering); Writing – Industrial Accident report; Grammar – Active and passive voice, Direct and Indirect speech; Vocabulary – Numerical adjectives.

LAB ACTIVITY: **6**

Listening / watching – Television documentary and discussing its content, purpose etc.

UNIT V JOB APPLICATION AND INTERVIEW **6**

Reading - Job advertisement and company profile; Writing – Job application (cover letter and CV) Grammar – Mixed Tenses; Vocabulary – Collocations related to work environment

LAB ACTIVITY: **6**

Listening – Job interview; Speaking – Mock interviews

TOTAL: 60 PERIODS

TEACHING METHODOLOGY

Interactive lectures, role plays, group discussions, listening and speaking labs, technology enabled language teaching, flipped classroom.

EVALUATION PATTERN

Internal Assessment

Written assessments

Assignment

Lab Assessment

Group discussion (Peer assessment)

Listening

External Assessment

End Semester Examination

LEARNING OUTCOMES

By the end of the courses, students will be able to

- To apply appropriate language structure and vocabulary to enhance both spoken and written communication in formal contexts.
- Comprehend different forms of official documents
- Write professional documents coherently and cohesively.
- Interpret verbal and graphic content in authentic context
- Analyse and evaluate verbal and audio visual materials.

TEXT BOOKS:

1. “English for Engineers and Technologists” Volume 2 by Orient Blackswan, 2022

2. “English for Science & Technology - II” by Cambridge University Press, 2023.

REFERENCES:

1. “Communicative English for Engineers and Professionals” by Bhatnagar Nitin, Pearson India, 2010.

2. ”Take Off – Technical English for Engineering” by David Morgan, Garnet Education, 2008.

3. “Advanced Communication Skills” by Mathew Richardson, Charlie Creative Lab, 2020.

4. www.uefap.com

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										√		√
CO2										√		√
CO3										√		√
CO4										√		√
CO5										√		√

MA23C02	ORDINARY DIFFERENTIAL EQUATIONS AND TRANSFORM TECHNIQUES	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To acquaint the students with Differential Equations which are significantly used in engineering problems.
- To make the students to understand the Laplace transforms techniques.
- To develop the analytic solutions for partial differential equations used in engineering by Fourier series.
- To acquaint the student with Fourier transform techniques used in wide variety of situations in which the functions used are not periodic.
- To develop Z- transform techniques in solving difference equations.

UNIT I ORDINARY DIFFERENTIAL EQUATIONS 9+3

Homogeneous linear ordinary differential equations of second order -superposition principle - general solution- Particular integral - Operator method - Solution by variation of parameters - Method of undetermined coefficients - Homogeneous equations of Euler–Cauchy and Legendre's type – System of simultaneous linear differential equations with constant coefficients.

UNIT II LAPLACE TRANSFORMS 9+3

Existence theorem - Transform of standard functions – Transform of Unit step function and Dirac delta function – Basic properties - Shifting theorems - Transforms of derivatives and integrals – Transform of periodic functions - Initial and Final value theorem - Inverse Laplace transforms- Convolution theorem (without proof) – Solving Initial value problems by using Laplace Transform techniques.

UNIT III FOURIER SERIES 9+3

Dirichlet's conditions – General Fourier series – Odd and even functions – Half-range Sine and Cosine series – Complex form of Fourier series – Parseval's identity – Computation of harmonics.

UNIT IV FOURIER TRANSFORMS 9+3

Fourier integral theorem – Fourier transform pair - Fourier sine and cosine transforms – Properties – Transform of elementary functions – Inverse Fourier Transforms - Convolution theorem (without proof) – Parsevals's identity.

UNIT V Z – TRANSFORM AND DIFFERENCE EQUATIONS 9+3

Z-transform – Properties of Z-transform – Inverse Z-transform – Convolution theorem – Evaluation of Inverse Z transform using partial fraction method and convolution theorem - Initial and final value theorems – Formation of difference equations – Solution of difference equations using Z - transform.

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students from the content of the course wherever applicable.

Branch specific / General Engineering applications based on the content of each units will be introduced to students wherever possible.

Suggested Laboratory based exercises / assignments / assessments :

Ordinary differential equations

1. Symbolic computation of linear ordinary differential equations
2. Solving System of simultaneous linear differential equations using ODE SOLVER

Laplace transforms

1. Symbolic computation of Laplace transform and Inverse Laplace transform
2. Plotting Laplace transforms

Fourier Series

1. Symbolic computation of Fourier Coefficients
2. Computation of harmonics
3. Plotting truncated Fourier Series

Fourier Transform

1. Symbolic computation of Fourier Transforms
2. Plotting truncated Fourier Transforms

Z – transform

1. Symbolic computation of Z-Transforms

OUTCOMES:

CO1 :Solve higher order ordinary differential equations which arise in engineering applications.

CO2 :Apply Laplace transform techniques in solving linear differential equations.

CO3 :Apply Fourier series techniques in engineering applications.

CO4 :Understand the Fourier transforms techniques in solving engineering problems.

CO5 :Understand the Z-transforms techniques in solving difference equations.

TEXT BOOKS:

1.Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, 45th Edition, New Delhi, 2020.

2.Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt Ltd., New Delhi, 2018.

REFERENCES:

1.N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008

2.Greenberg M.D., “Advanced Engineering Mathematics”, Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.

3.Jain R.K. and Iyengar S.R.K., “Advanced Engineering Mathematics”,Narosa Publications, 5 th Edition, New Delhi, 2017.

4.Peter V.O’Neil, “Advanced Engineering Mathematics”, Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi , 2012.

5.Ramana B.V., “Higher Engineering Mathematics”, Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO 1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 5 :	3	3	2	3	1	2	1	1	1	1	1	3

CY23C01 **ENGINEERING CHEMISTRY** **L T P C**

3 0 2 4

UNIT I WATER TECHNOLOGY

Water – sources and impurities – water quality parameters: colour, odour, pH, hardness, alkalinity, TDS, COD, BOD, and heavy metals. Boiler feed water – requirement – troubles (scale & sludge, caustic embrittlement, boiler corrosion and priming & foaming. Internal conditioning – phosphate, Calgon, and carbonate treatment. External conditioning – demineralization. Municipal water treatment (screening, sedimentation, coagulation, filtration, disinfection-ozonolysis, UV treatment, chlorination), Reverse Osmosis – desalination.

PRACTICAL:

- Estimation of HCl using Na_2CO_3 as the primary standard
- Determination of alkalinity in the water sample.
- Determination of hardness of water by EDTA method.
- Determination of DO content of water sample by Winkler's method.

UNIT II NANOCHEMISTRY

Basics-distinction between molecules, nanomaterials and bulk materials; size-dependent properties (optical, electrical, mechanical, magnetic and catalytic). Types –nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro-spinning. Characterization - Scanning Electron Microscope and Transmission Electron Microscope - Principle and instrumentation (block diagram). Applications of nanomaterials – medicine including AYUSH, automobiles, electronics, and cosmetics.

PRACTICAL:

- Preparation of nanoparticles by Sol-Gel method/sonication method.
- Preparation of nanowire by Electrospinning.
- Study of morphology of nanomaterials by scanning electron microscopy

UNIT III CORROSION SCIENCE

Introduction to corrosion – chemical and electrochemical corrosions – mechanism of electrochemical and galvanic corrosions – concentration cell corrosion-soil, pitting, inter-granular, water line, stress and microbiological corrosions-galvanic series-factors influencing corrosion- measurement of corrosion rate. Electrochemical protection – sacrificial anodic protection and impressed current cathodic protection. Protective coatings-metallic coatings (galvanizing, tinning), organic coatings (paints). Paints: Constituents and functions.

PRACTICAL:

- Corrosion experiment-weight loss method.
- Salt spray test for corrosion study.
- Corrosion prevention by electroplating.
- Estimation of corroded Iron by Potentiometry/UV-visible spectrophotometer

UNIT IV ENERGY SOURCES

Electrochemical cell, redox reaction, electrode potential – oxidation and reduction potential. Batteries – Characteristics; types of batteries; primary battery (dry cell), secondary battery (lead acid, lithium-ion battery) and their applications. Emerging energy sources – metal hydride battery, hydrogen energy, Fuel cells – H_2-O_2

fuel cell. Supercapacitors –Types and Applications, Renewable Energy: solar heating and solar cells. Recycling and disposal of batteries.

PRACTICAL:

- Study of components of Lead acid battery.
- Measurement of voltage in a photovoltaic cell.
- Working of $H_2 – O_2$ fuel cell

UNIT V POLYMER CHEMISTRY

Introduction: Functionality-degree of polymerization. Classification of polymers (Source, Structure, Synthesis and Intermolecular forces). Mechanism of free radical addition polymerization. Properties of polymers: Tg, tacticity, molecular weight-number average, weight average, viscosity average and polydispersity index (Problems). Techniques of polymerization: Bulk, emulsion, solution and suspension. Compounding and Fabrication Techniques: Injection, Extrusion, Blow and Calendaring. Polyamides, Polycarbonates and Polyurethanes – structure and applications. Recycling of polymers.

PRACTICAL:

- Determination of molecular weight of a polymer using Ostwald viscometer.
- Preparation of a polymer.
- Determination of molecular weight by Gel Permeation Chromatography.

TOTAL: 75 PERIODS

COURSE OUTCOMES:

CO1: To demonstrate knowledge of water quality in various industries and develop skills in analyzing water quality parameters for both domestic and industrial purposes.

CO2: To identify and apply fundamental concepts of nanoscience and nanotechnology for engineering and technology applications, and to develop skills in synthesizing nanomaterials and studying their morphology.

CO3: To apply fundamental knowledge of corrosion protection techniques and develop skills to conduct experiments for measuring and preventing corrosion.

CO4: To study the fundamentals of energy storage devices and develop skills in constructing and experimenting with batteries.

CO5: To recognize and apply basic knowledge of different types of polymeric materials and develop skills in preparing and determining their applications for futuristic material fabrication needs.

TEXT BOOKS:

1. Jain P. C. & Monica Jain., “Engineering Chemistry”, 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2015.
2. Sivasankar B., “Engineering Chemistry”, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.
3. Dara S.S., “A Textbook of Engineering Chemistry”, Chand Publications, 2004.
4. Laboratory Manual - Department of Chemistry, CEGC, Anna University (2023).

REFERENCES:

1. Schdeva M.V., “Basics of Nano Chemistry”, Anmol Publications Pvt Ltd, 2011.
2. Friedrich Emich, “Engineering Chemistry”, Medtech, 2014.
3. Gowariker V.R., Viswanathan N.V. and Jayadev Sreedhar, “Polymer Science” New AGE International Publishers, 2009.
4. Vogel’s Textbook of Quantitative Chemical Analysis (8th edition, 2014).

CO - PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	3	-	-	-	-	-
CO2	3	-	2	-	2	-	3	-	-	-	-	-
CO3	3	3	2	-	2	-	3	-	-	-	-	-
CO4	3	3	-	-	-	-	3	-	-	-	-	-
CO5	3	-	-	-	-	-	3	-	-	-	-	-
Avg	3	3	-	-	-	-	3	-	-	-	-	-

1’ = Low; ‘2’ = Medium; ‘3’ = High

CS23C02 **COMPUTER PROGRAMMING IN PYTHON** **L T P C**

3 0 2 4

COURSE OBJECTIVES:

- To understand fundamental structural programming concepts and problem-solving process.
- To solve problems using modular programming and decomposition techniques.
- To solve problems using data structures and abstraction techniques.
- To create programming solutions using libraries and packages.
- To design solutions to domain problems using programming problem-solving techniques.

UNIT I – STRUCTURED PROGRAMMING **9+6**

Problem-Solving Strategies. Basic Problem-Solving Tools: Flowcharts, Pseudocode. Introduction to Programming Languages and Development Environments. Programming. Basic Concepts and Syntax: Variables, Identifiers, Data Types: Primitive Types and Strings, Statements, Operators, Expressions and its evaluation, Operator Precedence, Basic Arithmetic Operations. Principles of Structured Programming – Control Structures: Sequence, Selection, Iteration and Branching.

PRACTICALS:

- Design algorithms for simple computational problems
- Create Pseudo-code and Flow charts for simple computational problems
- Create Python programs using simple and nested selective control statements
- Create Python programs using simple and nested sequence & iterative control statements
- Create Python programs to generate series/patterns using control statements

UNIT II – MODULARITY AND DECOMPOSITION **9+6**

Principles of Modular and Decomposition. Functions: Defining functions –Argument types – Function Name-spaces – Scoping: Global and Non-local. Principles of Recursion: Base case and Recursive cases – Develop and Analyze Recursive functions: Factorial, Fibonacci. Principles of First-Class and Higher-Order functions: Lambda functions – Functions as arguments.

PRACTICALS:

- Create Python programs using functions
- Create python program using recursion
- Create Python programs using lambda functions
- Create Python programs using first-class functions
- Create Python programs using higher-order functions

UNIT Ill – DATA STRUCTURES AND ABSTRACTIONS **9+6**

Principles of Data Structures and Abstractions. String Methods and Manipulations,.Lists: List Operations and Methods, List comprehensions, Nested List comprehensions, Matrix operations using Lists. Tuples and sequences. Sets and Operations. Dictionaries: Dictionary operations, Dictionary comprehensions, Nested Dictionary comprehensions. Comparing Data Structures. Search and Sort Data Structures. Principle of Functional Programming and Tools : map, filter, and reduce.

PRACTICALS:

- Create Python programs for strings manipulations.
- Design Python programs using Lists, Nested Lists and Lists comprehensions
- Create Python programs using Tuples, Nested Tuples, and Tuple comprehensions
- Create Python programs creating Sets and performing set operations
- Create Python programs using Dictionary, Nested Dictionary and comprehensions
- Create Python programs by applying functional programming concepts

UNIT IV – LIBRARIES AND MODULES 9+6

Exceptions: Syntax errors, Exceptions, Exception types, Handling exceptions, Raising exceptions. Files: File Path, Type of files, opening modes, Reading and Writing text files, Handling other format Data files. Modules: Creating Modules, import and from statements, Executing modules as scripts, Standard modules. Packages and Importing from packages

PRACTICALS:

- Design Python programs to handle errors and exceptions
- Create, import, and use pre-defined modules and packages
- Create, import, and use user-defined modules and packages
- Create Python programs to perform various operations on text files
- Create Python programs to perform various operations on other data file formats.

UNIT V – SIMPLE PROBLEM SOLVING TECHNIQUES IN PROGRAMMING 9+6

Data Structures for Problem Solving: Stack, Queue. Principles of Divide and Conquer: Binary Search. Principles of Greedy Algorithms: Minimum Coin Change Problem. Case studies on programming application of problem-solving techniques in different fields of engineering.

PRACTICALS:

- Create python programs to implement stack and queue.
- Create python programs to implement binary search.
- Create python programs to solve minimum coin change problem.
- Case study on developing python solution to a domain specific problems.

TOTAL = 45 + 30 = 75 PERIODS

COURSE OUTCOMES

1. Understand fundamental structural programming concepts and problem-solving process.
2. Solve problems using modular programming and decomposition techniques.
3. Solve problems using data structures and abstraction techniques.
4. Create programming solutions using libraries and packages.
5. Design solutions to domain problems using programming problem-solving techniques.

TEXT BOOKS

1. Reema Thareja, Python Programming using Problem Solving Approach, Oxford University Press, First Edition, 2017.
2. S. Sridhar, J. Indumathi, V. M. Hariharan, Python Programming, Pearson Education, First Edition, 2023

REFERENCE BOOKS

1. Paul Deitel, Harvey Deitel, Python for Programmers, Pearson Education, 2020.
2. John V Guttag. Introduction to Computation and Programming Using Python, With Application to Computational Modeling and Understanding Data. Third Edition, The MIT Press, 2021
3. Mark Lutz, Learning Python, 5th Edition, O'Reilly Media, Inc.
4. Python official documentation and tutorial, https://docs.python.org/3/
5. Numerical Python official documentation and tutorial, https://numpy.org/

CO's-PO's & PSO's MAPPING

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2		2		1								1	1	
2	2		2		1								1	1	
3	2	1	2		1								1	1	
4	2	1	2	1	1								1	1	
5	2	1	2	1	1								1	1	
Avg	2	1	2	1	1								1	1	

1 - low, 2 - medium, 3 - **high,** '-' - **no correlation**

MF23201 EVOLUTION OF MANUFACTURING ENGINEERING

L	T	P	C
2	0	0	2

COURSE OBJECTIVES:

- To introduce manufacturing engineering and evolution to the students
- To explain Evolution of manufacturing engineering and systems

UNIT I THE FACTORY SYSTEM 5

Introduction: Manufacturing - Overview, History, Economic Impact-Failure and Success in Manufacturing—The General Motors–Toyota NUMMI Joint Venture-The Age of the Artisan-The Emergence of Society: - Early Division of Labor- - The First Standardization

UNIT II INDUSTRIAL REVOLUTION 10

The Industrial Revolution—Manufacturing Gets Mechanized- Early Modern Europe. - Manufacturing Technology Working Together—The Emergence of the Manufactory-The Science of Manufacturing Processes-Steam Power: Steam Engine- The First Engineering Workshops- Steel—A New Industry Based on Fire and Iron-Technological Advances: Electricity- New Manufacturing Technologies Based on Electricity - Plastics and Rubber- Machine Technology

UNIT III MASS PRODUCTION 10

Science Meets Shop Floor: Interchangeable Parts: The End of Filing in Assembly -Honoré Blanc and French Musket Production- The American System of Manufacturing- Eli Whitney- Working Conditions in the Factories-The Beginning of Manufacturing Management -FW Taylor—Progress in Scientific Management - Time Studies— REFA and MTM-The Assembly Line and the Era of the Industrial Empires -The First Assembly Lines—Consumer Products-—Mass Production.

UNIT IV THE CUTTING EDGE 5

The Birth of the Automobile - The Father of Mass Production—Henry Ford and His Model T-Computers in Manufacturing - Continuous Processing Industry-Computer-Controlled Machine Tools-Industrial Robots - Computerized Production Planning- The Toyota Production System and Lean Manufacturing: Lessons Learned from History - The Big Potential: Decision Making - Need for Speed - Need for Flexibility- Need for Labor Relations -Things to Come - Three Dimensional Printing- Downfall of the Automotive Industry

T: 30 PERIODS

TEXT BOOKS and REFERENCES

1. Christoph Roser ,"Faster, Better, Cheaper in the History of Manufacturing From the Stone Age to Lean Manufacturing and Beyond" Productivity Press, 2016, ISBN 9781498756303.
2. Behzad Esmaeilian, Sara Behdad, Ben Wang (2016), "The evolution and future of manufacturing: A review", Journal of Manufacturing Systems, Vol.39 pp.79–100

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: By exploring the history and economic impact of manufacturing, students will gain a comprehensive understanding of its evolution and significance in society.

CO2: Students will critically evaluate the General Motors–Toyota NUMMI Joint Venture, analysing its successes and failures within the context of manufacturing.

CO3: Through studying the emergence of the factory system and mass production techniques, students will analyse the impact of technological advances on manufacturing processes.

CO4: By examining the role of computers in manufacturing and lean production methodologies like the Toyota Production System, students will create innovative solutions for improving efficiency and productivity in manufacturing operations.

CO5: Students will apply their knowledge of manufacturing history and contemporary practices to assess and address challenges such as the downfall of the industry, demonstrating practical problem-solving skills in real-world contexts.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	2				1	3		3			3			1	2
2		3	3											1	1
3	3				3	3					3		1	2	3
4	3				3	3	3	3					2	3	3
5	3	3	3			3						3	1	2	2
Avg.	2.75	3	3		2.33	3	3	3			3	3	1.33	1.8	2.2

ME23C03 **ENGINEERING MECHANICS** **L T P C**
3 1 0 4

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

- Determining the resultant forces acting on a particle in 2D and 3D and for applying methods of equilibrium on a particle in 2D and 3D.
- Evaluating the reaction forces for bodies under equilibrium, for determining the moment of a force, moment of a couple, for resolving force into a force-couple system and for analyzing trusses
- Assessing the centroids of 2D sections / center of gravity of volumes and for calculating area moments of inertia for the sections and mass moment of inertia of solids.
- Evaluating the frictional forces acting at the contact surfaces of various engineering systems and for applying the work-energy principles on a particle.
- Determining kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces.

UNIT I STATICS OF PARTICLES 9+3

Fundamental Concepts and Principles, Systems of Units, Method of Problem Solutions, Statics of Particles -Forces in a Plane, Resultant of Forces, Resolution of a Force into Components, Rectangular Components of a Force, Unit Vectors. Equilibrium of a Particle- Newton's First Law of Motion, Space and Free-Body Diagrams, Forces in Space, Equilibrium of a Particle in Space.

UNIT II EQUILIBRIUM OF RIGID BODIES AND TRUSSES 9+3

Principle of Transmissibility, Equivalent Forces, Vector Product of Two Vectors, Moment of a Force about a Point, Varignon's Theorem, Rectangular Components of the Moment of a Force, Scalar Product of Two Vectors, Mixed Triple Product of Three Vectors, Moment of a Force about an Axis, Couple - Moment of a Couple, Equivalent Couples, Addition of Couples, Resolution of a Given Force into a Force -Couple system, Further Reduction of a System of Forces, Equilibrium in Two and Three Dimensions - Reactions at Supports and Connections – Analysis of Trusses – Method of Joints and Method of Sections.

UNIT III DISTRIBUTED FORCES 9+3

Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration, Theorems of Pappus-Guldinus, Distributed Loads on Beams, Centre of Gravity of a Three-Dimensional Body, Centroid of a Volume, Composite Bodies, Determination of Centroids of Volumes by Integration.

Moments of Inertia of Areas and Mass - Determination of the Moment of Inertia of an Area by Integration , Polar Moment of Inertia , Radius of Gyration of an Area , Parallel-Axis Theorem , Moments of Inertia of Composite Areas, Moments of Inertia of a Mass - Moments of Inertia of Thin Plates , Determination of the Moment of Inertia of a Three-Dimensional Body by Integration.

UNIT IV FRICTION AND WORK PRINCIPLES 9+3

The Laws of Dry Friction. Coefficients of Friction, Angles of Friction, Wedges, Wheel Friction. Rolling Resistance, Ladder friction. Work of a Force, Kinetic Energy of a Particle, Principle of Work and Energy, Principle of Impulse and Momentum, Impact, Method of Virtual Work - Work of a Force, Potential Energy, Potential Energy and Equilibrium.

UNIT V DYNAMICS OF PARTICLES AND RIGID BODIES 9+3

Kinematics - Rectilinear Motion and Curvilinear Motion of Particles. Kinetics- Newton's Second Law of Motion -Equations of Motions, Dynamic Equilibrium, Energy and Momentum Methods – Kinematics of Rigid Bodies and Plane Kinetics.

TOTAL : 60 Periods

COURSE OUTCOMES:

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

1. To determine the resultant forces acting on a particle in 2D and 3D and to apply methods of equilibrium on a particle in 2D and 3D.
2. Evaluate the reaction forces for bodies under equilibrium, to determine moment of a force, moment of a couple, to resolve force into a force-couple system and to analyze trusses
3. Assess the centroids of 2D sections / center of gravity of volumes and to calculate area moments of inertia for the sections and mass moment of inertia of solids.
4. Evaluate the frictional forces acting at the contact surfaces of various engineering systems and apply the work-energy principles on a particle. evaluate the kinetic and kinematic parameters of a particle.
5. Determine kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces.

TEXT BOOKS:

1. Beer Ferdinand P, Russel Johnston Jr., David F Mazurek, Philip J Cornwell, Sanjeev Sanghi, Vector Mechanics for Engineers: Statics and Dynamics, McGraw Higher Education., 12th Edition, 2019.
2. Vela Murali, "Engineering Mechanics-Statics and Dynamics", Oxford University Press, 2018.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	3									3		
2	3	3	2	3									3		
3	3	3	2	3									3		
4	3	3	2	3									3		
5	3	3	2	3									3		
Avg	3	3	2	3									3		

UC23H02 தமிழரும் தொழில்நுட்பமும்/Tamils and Technology L T P C

1 0 0 1

அலகு I நெசவு மற்றும் பானைத் தொழில்நுட்பம்: **3**

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் – கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்: **3**

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

அலகு III உற்பத்தித் தொழில் நுட்பம்: **3**

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு IV வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்: **3**

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

அலகு V அறிவியல் தமிழ் மற்றும் கணித்தமிழ்: **3**

அறிவியல் தமிழின் வளர்ச்சி –கணித்தமிழ் வளர்ச்சி – தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும்

   கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)

4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils – The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi – 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

UC23H02 **TAMILS AND TECHNOLOGY** **L T P C**

1 0 0 1

UNIT I WEAVING AND CERAMIC TECHNOLOGY 3

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY 3

Designing and Structural construction House & Designs in household materials during Sangam Age -Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period -Type study (Madurai Meenakshi Temple)- Thirumalai NayakarMahal -ChettiNadu Houses, Indo-Saracenic architecture at Madras during British Period.

UNIT III MANUFACTURING TECHNOLOGY 3

Art of Ship Building - Metallurgical studies -Iron industry - Iron smelting, steel -Copper and gold- Coins as source of history - Minting of Coins – Beads making-industries Stonebeads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT IV AGRICULTURE ANDIRRIGATION TECHNOLOGY 3

Dam, Tank, ponds, Sluice, Significance of KumizhiThoompuof Chola Period,Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing -KnowledgeofSea -Fisheries – Pearl - Conche diving - Ancient Knowledge ofOcean -KnowledgeSpecificSociety.

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCEBOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும்

   கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils – The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).

8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi – 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

MF23301 THERMODYNAMICS AND HEAT TRANSFER L T P C
4 0 0 4

COURSE OBJECTIVES:

- To describe first and second law of thermodynamics
- To Comprehend the principles of conduction, convective and radiation heat transfer
- To apply thermodynamic and heat transfer concepts in real systems

UNIT I LAWS OF THERMODYNAMICS 12

Basics - First Law of Thermodynamics; application to closed and open systems - Second law of thermodynamics; Kelvin-Planck and Clausius statements and their equivalence - Concept of entropy; the principle of increase of entropy, second law analysis of control volume; availability and irreversibility

UNIT II PROPERTIES OF SUBSTANCES 12

Thermodynamic properties of pure substances in solid, liquid and vapor phases, P-V-T behavior, Thermodynamic property tables and charts – Thermodynamics relations – Thermodynamic behavior of real gases – Gas mixtures

UNIT III CONDUCTION HEAT TRANSFER 12

Fundamental equations of conduction; Cartesian, Cylindrical, spherical Coordinates - One dimensional steady state heat conduction; Heat conduction through plane wall, cylindrical, spherical and Composite systems – Plane wall with internal heat generation – Extended surfaces; rectangular and pin fins – Introduction to Unsteady Heat Conduction

UNIT IV CONVECTION AND RADIATION HEAT TRANSFER 12

Conservation Equations, Boundary Layer Concept – Forced Convection; Flow over a flat plate - Free Convection; Flow over a vertical plate. Basics of thermal radiation – Laws of radiation – Black Body and Gray Body Radiation - Radiative heat exchange between surfaces; shape factor - Radiation shields-Heat exchangers; types of heat exchangers

UNIT V APPLICATION 12

Heat treatment process - Heat transfer in casting, welding, machining and additive manufacturing processes- Case Studies.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course the students shall be able to:

CO1: Evaluate thermodynamics system based on first and second law.
CO2: Estimate the properties of pure substances, real and ideal gas mixtures
CO3: Summarize the mechanism of heat conduction under steady and transient conditions.
CO4: Elucidate the principles of convective and radiation heat transfer.
CO5: Apply thermodynamics and heat transfer in manufacturing processes

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	-	-	-	-	-	-	-	-	1	3	2	
2	3	2	1	-	-	-	-	-	-	-	-	1	3	2	
3	3	2	1	-	-	-	-	-	-	-	-	1	3	2	
4	3	2	1	-	-	-	-	-	-	-	-	1	3	2	
5	3	2	1	-	-	-	-	-	-	-	-	1	3	2	
Avg	3	2	1									1	3	2	

TEXT BOOKS:

1. Nag P.K., "Engineering Thermodynamics", 6th edition, McGraw Hill, United States, 2017.
2. R.C. Sachdeva, "Fundamentals of Engineering Heat & Mass transfer",6th edition, New Age International Publishers, 2022

REFERENCES:

1. Cengel Y.A. and Boles M.A., "Thermodynamics an Engineering Approach", 9th edition, McGraw hill, United States, 2019
2. Claus Borgnakke and Sonntag "Fundamentals of Engineering Thermodynamics" 10th edition, John Wiley & Sons, United States, 2022.
3. Holman J.P., "Heat transfer", 10th edition, McGraw Hill, United States 2017.
4. Ozisik, M.N., "Heat Transfer", McGraw Hill Book Co., 199
5. Jean-Luc Battaglia, "Heat Transfer in Materials Forming Processes", ISTE and Wiley, 2008
6. D.R.Poirier and E.J.Poirier, "Heat transfer fundamentals for metal casting", John Wiley & Sons, 2010

MF23302 **CASTING AND WELDING TECHNOLOGY** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To impart the basics of casting processes and its types.
- To be acquainted with design of gating system and advances in casting.
- To elaborate various welding methods and its basic principles, limitations, applications and metallurgical aspects of welding

UNIT I BASICS OF CASTING **9**

Patterns: Materials used for pattern, Classification of patterns, various pattern allowances and their importance- Sand molding: Types of base sand, requirement of base sand-testing-Binder- Additives, need and types- - Cores: Definition, need, types. Method of making cores. Melting equipment for foundries and Types of furnaces. Preparation of sand molds.

UNIT II CASTING PROCESSES **9**

Classification of casting Processes-Sand mould: Green sand - Sweep mold- CO_2 mold- Casting using metal molds: Gravity die casting, Pressure die casting, Centrifugal casting, Slush casting, Thixocasting-Precision Moulds: Shell mold, Investment mold, Plaster mold. Special casting Processes – Stir Casting, Squeeze casting and Magnetic molding.

UNIT III GATING, SOLIDIFICATION , ADVANCES IN CASTING **9**

Gates and risers - their functions – types - design principles, design of gating and riser - illustrative problems in riser and gating design -Solidification: definition, nucleation, solidification variables, directional Solidification-. Degasification methods. - Fettling , cleaning and heat treatment of castings: Sand casting defects- causes and remedies. Foundry mechanization, Molding machines- Jolt type, squeeze type and sand slinger. Application of computers in foundries – Casting design, analysis and simulation.

UNIT IV WELDING PROCESSES **9**

Welding processes: Principle, classification, application, advantages & limitations of Welding-Arc welding: Metal arc welding (MAW), Flux shielded metal arc welding (FSMAW), Submerged Arc Welding (SAW), Inert Gas Welding (TIG & MIG), Plasma Arc Welding and Atomic Hydrogen Welding (AHW)-Resistance welding: Seam welding, Butt welding, Spot welding and Projection welding. Gas Welding: Oxy-Acetylene welding, oxy-hydrogen welding, air- acetylene welding, Gas cutting, powder cutting. Soldering, brazing. Special type of welding: Friction welding, Explosive welding, Thermit welding, Laser welding, Electron beam welding, Friction stir welding and Underwater welding.

UNIT V METALLURGICAL ASPECTS IN WELDING **9**

Structure of welds, Weld thermal cycle, Formation of different zones during welding, Heat Affected Zone (HAZ), Parameters affecting HAZ. Effect of carbon content on structure and properties of steel, Hydrogen embrittlement, Shrinkage in welds & Residual stresses-Pre and Post Weld Treatments- Welding defects-Detection, causes & remedies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course the students shall be able to:

CO1: Imply the techniques to make the pattern, core and moulding.

CO2: Identify the appropriate casting techniques for applications.

CO3: Apply the knowledge of gating design and grasp the significance of advances in casting to overcome defects in casting.

CO4: Identify the appropriate welding processes according to the requirements.

CO5: Apply metallurgical aspects of welding to overcome defects in welding.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	2	2	2	-	-	-	-	-	-	-	3	1	1
2	2	2	2	2	2	-	2	-	-	-	-	-	3	3	3
3	2	2	2	2	2	-	2	-	-	-	-	-	3	3	2
4	2	2	2	2	2	-	2	-	-	-	-	-	1	3	2
5	2	2	2	2	2	-	2	-	-	-	-	-	1	3	3
Avg	2	2	2	2	2		2						2.2	2.6	2.2

TEXT BOOKS:

1. Heine R W, Loper C R,Rosenthal P C "Principles of Metal Casting", Tata McGraw Hill, New Delhi, 2012.
2. Parmer R.S., "Welding Processes & Technology", Khanna Publishers, India, 2013, ISBN: 9788174091260, 8174091262.
3. Gowri S., Suresh Babu A., and Hariharan P., "Manufacturing Technology-I", PearsonEducation, India, 2008, ISBN: 9788131710234, 8131710238.

REFERENCES:

1. ASM Hand Book Vol: 15, "Casting", ASM International, Geauga County, Ohio, 2008, ISBN: 978-0-87170-711-6.
2. Campbell J., "Castings Practice: The Ten Rules of Castings", Butterworth-Heinemann., United Kingdom, 2004, ISBN (13): 978 0750647915, (10) 9780750647915.
3. Cary H.B., "Modern Welding Technology", 6th Edition, Prentice Hall, United States, 2004,ISBN(10): 0131130293,(13): 978-0131130296
4. Jeffus L., "Welding: Principles and Applications", Delmar, Cengage Learning, Delmar Publishers., United States, 2012, ISBN (13): 978-1111039172,10: 1111039178.
5. Jeffus L., "Welding for Collision Repair", Cengage Learning, Delmar Publishers., United States, 1999, ISBN (10): 0766809668, (13): 978-0766809666

MF23303	FORMING TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To describe types of deformations and classification of forming processes.
- To classify and explain bulk forming processes.
- To describe sheet metal forming processes.
- To elaborate various stages involved in the powder forming processes.
- To describe various types of plastic forming processes.

UNIT I INTRODUCTION **9**

Mechanical behaviour of materials- Elastic and plastic deformations - Classification of forming processes - Temperature in metal working: Cold, Warm and hot working - Introduction to the theory of plastic deformation.

UNIT II BULK FORMING **9**

Introduction - Plastic deformation in forging, rolling, extrusion, rod/wire, tube drawing and swaging processes and their applications - Effect of friction, calculation of forces, work done, process parameters, equipment's and defects.

UNIT III SHEET METAL FORMING **9**

Introduction - Sheet metal characteristics - Conventional sheet metal forming processes like shearing, bending and miscellaneous forming processes - High energy rate forming processes - Super plastic forming processes - Deep drawing process - Principles, process parameters, advantages, limitations and applications of the above - Formability of sheet metals - Equipment's - Defects.

UNIT IV POWDER FORMING **9**

Introduction - Powder production methods - Particle size characterization – Blending – Compacting –Sintering - Secondary and finishing operations - Advantages and applications of powder metallurgy - Powder forging, rolling, extrusion, drawing.

UNIT V PLASTIC FORMING **9**

Introduction - Extrusion, injection moulding, foam moulding, blow moulding, rotational moulding, calendaring, thermoforming, compression moulding, transfer moulding, laminating.

TOTAL: 45 PERIODS

Course Outcomes

At the end of this course the students will be able to:

CO1 : Illustrate deformation types and classification of forming processes.
CO2 : Describe bulk forming processes and their applications.
CO3 : Elaborate different sheet metal forming processes and their applications.
CO4 : Discuss powder forming processes and its applications
CO5 : Elaborate various types of plastic forming processes and their applications.

CO PO PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3											1	1	3	
2	3	2		2								1	3	3	
3	3	2	2									1	3	3	
4	3											1	3	3	
5	3		2									1	3	3	
Avg	3	2	2	2								1	2.6	3	

TEXT BOOKS

1. Kalpakjian S. and Schmid S.R., “Manufacturing Processes for Engineering Materials”, Pearson., New Delhi, India, 2012.
2. Kalpakjian S. and Schmid S.R., “Manufacturing Engineering and Technology”, Pearson., New Delhi, India, 2018.

REFERENCES

1. Heinz Tschätsch, “Metal Forming Practise: Processes - Machines – Tools”, Springer-Verlag Berlin Heidelberg., Germany, 2006.
2. Juneja B.L., “Fundamentals of Metal forming Processes”, New Age International Publishers Ltd., Chennai, India, 2018.
3. Kumar Surender, “Technology of Metal Forming Processes”, PHI learning Pvt. Ltd., New Delhi, India, 2008.
4. Mikell P. Groover, “Fundamental of Modern Manufacturing: Materials, Processes and Systems”, John Wiley and Sons Ltd., United States, 2013.
5. Nagpal G.R., “Metal Forming Processes”, Khanna Publishers., New Delhi, India, 2000.

MF23304 **ENGINEERING MATERIALS AND METALLURGY** **L T P C**

3 0 2 4

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

Gaining a comprehensive understanding of material science by creating phase diagrams, applying heat treatments, and analyzing microstructures. Explore the engineering uses of ferrous and non-ferrous alloys, polymers, ceramics, and composites while developing skills in testing methods and understanding failure mechanisms to improve material performance and reliability.

UNIT I **CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS** **9**

Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, Isomorphous, eutectic, eutectoid, peritectic, and peritectoid reactions, Iron – Iron carbide equilibrium diagram. Classification of steel and cast Iron microstructure, properties and application.

UNIT II **HEAT TREATMENT** **9**

Definition – Full annealing, stress relief, recrystallisation and spheroidising –normalizing, hardening and Tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram – continuous cooling Transformation (CCT) diagram – Austempering, Martempering – Hardenability, Jominy end quench test -case hardening, carburizing, Nitriding, cyaniding, carbonitriding – Flame and Induction hardening – Vacuum and Plasma hardening – Thermo- mechanical treatments- elementary ideas on sintering.

UNIT III **FERROUS AND NON-FERROUS METALS** **9**

Effect of alloying additions on steel (Mn, Si, Cr, Mo, V Ti & W) – stainless and tool steels – HSLA - Maraging steels – Grey, white, malleable, spheroidal – alloy cast irons, Copper and its alloys – Brass, Bronze and Cupronickel – Aluminium and its alloys; Al-Cu – precipitation strengthening treatment – Titanium alloys, Mg-alloys, Ni-based super alloys – shape memory alloys- Properties and Applications

UNIT IV **NON-METALLIC MATERIALS** **9**

Polymers – types of polymer, commodity and engineering polymers – Properties and applications of PE, PP, PS, PVC, PMMA, PET, PC, PA, ABS,PAI, PPO, PPS, PEEK, PTFE, Thermo set polymers – Urea and Phenol formaldehydes - Engineering Ceramics – Properties and applications of Al2O3, SiC, Si3N4, PSZ and SIALON – intermetallics- Composites- Matrix and reinforcement Materials- applications of Composites - Nano composites.

UNIT V **MECHANICAL PROPERTIES AND DEFORMATION MECHANISMS** **9**

Mechanisms of plastic deformation, slip and twinning – Types of fracture – fracture mechanics- Griffith’s theory- Testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Vickers and Rockwell), Micro and nano-hardness tests, Impact test Izod and charpy, fatigue and creep failure mechanisms.

Laboratory 30

1. microstructural studies.Annealing and normalizing of hardened steels
2. Effect of quenching media on hardening of steel
3. Effect of tempering temperature and time on tempering of steel
4. Carburizing – Low carbon steel
5. Hardenability test – Jominy End Quench Test
6. Heat treatment of cast iron

TOTAL: 75 (45+30) PERIODS

Course Outcomes

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

CO1 : Construct the iron-iron carbide phase diagram and estimate the phases present in the microstructure.

CO2 : Select a suitable heat treatment process for ferrous alloys based on the requirements.

CO3 : Choose suitable ferrous and non-ferrous alloys for specific engineering applications

CO4 : Use different polymer, ceramics and composites for a specific engineering applications

CO5 : Describe testing procedures and failure mechanisms

CO PO PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	1		1	1						2	1	
2	3	2	2										2	1	
3	3		2			1							2	1	
4	3		2			1							2	1	
5	3	3	2	1									2	1	
Avg	3	2.7	2	1		1	1						2	1	

TEXT BOOKS

1. Kenneth G.Budinski and Michael K. Budinski, “Engineering Materials”, Prentice Hall of India Private Limited, 4th Indian Reprint 2002.
2. Sydney H.Avner, “Introduction to Physical Metallurgy”, McGraw Hill Book Company, 1994.

REFERENCES

1. Alavudeen, N. Venkateshwaran, and J. T.WinowlinJappes, A Textbook of Engineering Materials and Metallurgy, Laxmi Publications, 2006.
2. Amandeep Singh Wadhwa, and Harvinder Singh Dhaliwal, A Textbook of Engineering Material and Metallurgy, University Sciences Press, 2008.
3. G.S. Upadhyay and Anish Upadhyay, “Materials Science and Engineering”, Viva Books Pvt.Ltd, New Delhi, 2006.
4. Raghavan.V, “Materials Science and Engineering”, Prentice Hall of India Pvt.Ltd. 1999.
5. Williams D Callister, “Material Science and Engineering” Wiley India Pvt Ltd, Revised Indian edition 2007.

CE23C01 **MECHANICS OF MATERIALS** **L T P C**
3 0 2 4

COURSE OBJECTIVES:

1. To develop the understanding of the principle concepts of stress, strain and deformation of solids for various engineering applications.
2. To analyse the flexural and shear stresses induced in beams due to different loading conditions
3. To analyse the effect of torsion on shafts and springs.
4. To understand and analyse the deflection of beams for different support and loading conditions
5. To examine the stresses induced in thin and thick shells.

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS 9

Rigid bodies and deformable solids –Stresses and strains: Tension, Compression and Shear - Elastic constants – Relationships – Compound bars – Thermal stresses –Volumetric strains – Stress on inclined planes – Principal stresses and principal planes – Mohr's circle of stress.

PRACTICALS

- Tension test on mild steel rod

UNIT II TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM 9

Beams – Types - Transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over hanging beams - Theory of simple bending – Bending stress distribution - Load carrying capacity - Proportioning of sections –Flitched beams –Carriage springs – Shear stress distribution- Shear Centre.

PRACTICALS

- Deflection test on carriage spring

UNIT III TORSION 9

Theory of Pure Torsion- Stresses and deformation in circular and hollows shafts – Transmission of power through hollow & solid shafts – Stepped shafts –Shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs.

PRACTICALS

- Torsion test on mild steel rod

UNIT IV DEFLECTION OF BEAMS 9

Double Integration method – Macaulay's method – Area moment method - Conjugate beam method - Strain energy method - computation of slopes and deflections in beams- Maxwell's reciprocal theorem.

PRACTICALS

- Compression test on helical spring

UNIT V THIN &THICK SHELLS, THEORIES OF FAILURE 9

Stresses and deformations in thin cylindrical shells and spherical shells subjected to internal pressure – Stresses in thick cylinders – Lame's theory – Application of theories of failure- Euler's buckling theory.

PRACTICALS

- Hardness test on metal beam (Rockwell and Brinell hardness test)

TOTAL: 45L+30P =75 PERIODS

COURSE OUTCOMES:

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

CO1 Have thorough understanding of the fundamental concepts of stress and strains and understand the mechanical behaviour of materials such as tension, compression and hardness.

CO2 Understand the bending and shear stress distribution in beams.

CO3 Have sufficient knowledge on designing shafts to transmit power and understand the behaviour of helical springs

CO4 Have the ability to determine the deflection of beams and carriage springs

CO5 Have the knowledge of behaviour of cylindrical and spherical shells.

TEXT BOOKS:

1. Bansal, R.K., Strength of Materials, Laxmi Publications (P) Ltd., 2018
2. Rajput, R.K., Strength of Materials, S Chand And Company Ltd., New Delhi, 2018

REFERENCES:

1.) Strength of Materials Laboratory Manual, Anna University, Chennai - 600025.
2.) IS 432 (art I) -1992, Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
3.) Egor. P.Popov"Engineering Mechanics of Solids" Prentice Hall of India, New Delhi, 2015.
4.) Ferdinand P. Beer, Russell Johnson, Jr. and John J. Dewole Mechanics of Materials, 7 th Edition, Tata McGraw Hill publishing 'co. Ltd., New Delhi, 2014.
5.) Hibbeler, R.C., Mechanics of Materials, Pearson Education, 10th Edition, 2022.
6.) Subramanian R., Strength of Materials, Oxford University Press, Oxford Higher Education Series, 2007

CO-PO-PSO MAPPING: MECHANICS OF MATERIALS

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	3	2	2	2	3	3	1	1	2	3	3	2
2	3	3	3	3	2	3	2	3	1	1	1	2	3	2	2
3	3	3	3	3	2	3	2	3	3	1	1	2	3	3	2
4	3	3	3	3	2	2	2	2	3	1	1	2	3	2	2
5	3	3	3	3	2	3	2	3	1	1	1	2	3	3	2
Avg.	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**1**	**1**	**2**	**3**	**3**	**2**

CE23C02	FLUID MECHANICS AND MACHINERY	L	T	P	C
		3	0	2	4

UNIT I FLUID PROPERTIES AND FLOW CHARACTERISTICS 10

Definitions of fluid - Properties of fluids –Fluid pressure and its measurements – Forces on plane and curved surfaces - Buoyancy and floatation - Flow characteristics - Eulerian and Lagrangian Principle of fluid flow– concept of control volume and system – Continuity equation, energy equation and momentum equation - Applications.

PRACTICALS

- Calibration of Venturimeter

UNIT II FLOW THROUGH PIPES AND BOUNDARY LAYER 9

Reynold's Experiment- Laminar flow through circular conduits- Hagen Poiseuille equation -Darcy Weisbach equation – friction factor- Moody diagram- minor losses- Hydraulic gradient and total energy gradient – Pipes in series and parallel - Boundary layer concepts – types of boundary layer thickness.

PRACTICALS

- Determination of friction factor for flow through pipes

UNIT III DIMENSIONAL ANALYSIS AND MODEL STUDIES 7

Fundamental dimensions - Dimensional homogeneity - Rayleigh's method and Buckingham Pi theorem - Dimensionless parameters - Similitude and model studies - Distorted and undistorted models.

UNIT IV TURBINES 10

Impact of jets - Velocity triangles - Theory of rotodynamic machines - Classification of turbines – Pelton wheel, Francis turbine and Kaplan turbine- Working principles - Work done by water on the runner - Efficiencies – Draft tube - Specific speed - Performance curves for turbines

PRACTICALS

- Characteristics of Pelton wheel turbine

UNIT V PUMPS 9

Classification of pumps- Centrifugal pumps – Working principle - Heads and efficiencies– Work done by the impeller - NPSH – Minimum speed to start the pump - Pumps connected in series and parallel - Performance curves - Reciprocating pump working principle – Indicator diagram and its variations – Air vessels - Work saved by air vessels.

PRACTICALS

- Characteristics of centrifugal pumps
- Characteristics of reciprocating pump

TOTAL: 45 L + 30 P = 75 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Understand the difference between solid and fluid, its properties and behaviour in static conditions along with the conservation laws applicable to fluid flow and its application through fluid kinematics and dynamics. Verify and apply Bernoulli's equation for flow measurement like Orifice/ Venturimeter.

CO2 Estimate losses in pipelines for both laminar and turbulent conditions and analysis of pipes connected in series and parallel and to understand the concept of boundary layer theory. Measure friction factor in pipes and compare with Moody diagram.

CO3 Formulate the relationship among the parameters involved in the given fluid phenomenon and to predict the performances of prototype by model studies.

CO4 Design of Pelton wheel, Francis and Kaplan turbines and explain the working Principles of each turbine with draft tube theory for reaction turbines. Determine the performance characteristics of Pelton wheels.

CO5 Differentiate pumps and explain the working principle with characteristic curves and design of centrifugal and reciprocating pumps. Determine the performance characteristics of centrifugal and reciprocating pump.

TEXT BOOKS:

1. Modi P.N. and Seth S.M., Hydraulics and Fluid Mechanics including Hydraulics Machines, 22nd Ed., Standard Book House. New Delhi, 2019.
2. Jain A. K. Fluid Mechanics including Hydraulic Machines, Khanna Publishers, New Delhi, 2014.

REFERENCES:

1. Kumar K.L, Engineering Fluid Mechanics, (8th Ed.) S. Chand Publishing (India) Pvt. Ltd., New Delhi, 2016.
2. Som S.K. Gautam Biswas and Chakraborty S, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill Education Pvt. Ltd., 2017.
3. Subramanya, K. Fluid Mechanics and Hydraulic Machines,2nd Ed., Tata McGraw- Hill Pub. Co., New Delhi, 2018.
4. Yunus A. Cengel ; John M. Cimbala, Fluid Mechanics,4th Ed., McGraw Hill Education Pvt. Ltd.,2019.
5. Streeter, V. L. and Wylie E. B., Fluid Mechanics, McGraw Hill Publishing Co.,1998.
6. Hydraulic Laboratory Manual, Centre for Water Resources, Anna University, 2023.

MAPPING OF CO'S WITH PO'S

PO/PSO		COURSE OUTCOME					OVERALL CORRELATION OF COS TO POS
		CO 1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	3	3	3	3	3	3
PO2	Problem analysis	2	3	3	3	3	3

PO3	Design / development of solutions	1	3	3	3	3	3
PO4	Investigation	1	1	2	2	2	2
PO5	Modern Tool Usage	1	1	1	1	1	1
PO6	Individual and Team work	1	1	1	1	1	1
PO7	Communication	1	1	1	1	1	1
PO8	Engineer and Society	2	2	2	3	3	2
PO9	Ethics	1	1	1	1	1	1
PO10	Environment and Sustainability	1	1	1	1	1	1
PO11	Project Management and Finance	1	1	1	1	1	1
PO12	Life Long Learning	2	2	2	3	3	2
PSO1	Knowledge of Civil Engineering discipline	3	3	3	3	3	3
PSO2	Critical analysis of Civil Engineering problems and innovation	2	3	3	3	3	3
PSO3	Conceptualization and evaluation of engineering solutions to Civil Engineering Issues	2	3	2	3	3	3

MF23S01 PRACTICAL SKILLS IN MANUFACTURING PROCESSES L T P C

1 0 2 2

OBJECTIVE

This course focuses on developing practical skills in key manufacturing processes, including welding, casting, rolling, and drawing. Through hands-on lab sessions, students will gain direct experience in using various machines and techniques to fabricate, cast, and shape materials. The course emphasizes safety, precision, and quality control.

Lab Exercise

1. **Introduction and Safety Protocols**
    - Introduction to manufacturing processes
    - Lab safety training
    - Overview of lab equipment and tools
2. **Basics of Gas Metal Arc Welding (GMAW)**
    - Principles of GMAW
    - Equipment setup and electrode selection
    - Basic welding practice
3. **Welding Techniques and Joint Fabrication**
    - Types of welding joints (butt, lap, T-joints)
    - Hands-on practice welding different joints
4. **Advanced Welding and Structural Shape Fabrication**
    - Advanced GMAW techniques
    - Troubleshooting welding issues
    - Fabrication of simple structural shapes
5. **Aluminium Casting with Stir Casting Machine**
    - Aluminium properties and casting techniques
    - Stir casting process
    - Pouring aluminium into sand moulds
6. **Casting Quality Control and Defect Inspection**
    - Common casting defects
    - Inspection and testing methods
    - Refining casting techniques
7. **Rolling Process Fundamentals**
    - Basics of rolling (hot vs. cold rolling)
    - Rolling machine setup and operation
    - Hands-on practice reducing plate thickness
8. **Drawing Process Fundamentals**
    - Fundamentals of wire and rod drawing
    - Drawing machine setup and operation
    - Hands-on practice with metal rods

9. **Integration of Manufacturing Processes**
    - Combining welding, casting, rolling, and drawing
    - Process planning and optimization
    - Final project: fabrication of a complex part using multiple processes

Lab Equipment and Materials:

- Gas Metal Arc Welding machine
- Sand moulding equipment
- Stir casting machine
- Rolling machine
- Drawing machine
- Safety gear (gloves, goggles, aprons)

TOTAL: 30 PERIODS

OUTCOME

Upon completing of the course students will be able to:

- Proficiency in Gas Metal Arc Welding (GMAW)
- Mastery of Sand Mould Preparation and Aluminium Casting
- Precision in Rolling and Drawing Operations
- Implementation of Quality Control Measures
- Integration of Manufacturing Processes

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1			2			1			3	3		3	1
2	2	1			2			1			3	3		3	1
3	2	1			2			1			3	3		3	1
4	2	1			2			1			3	3		3	1
5	2	1			2			1			3	3		3	1
Avg	2	1			2			1			3	3		3	1

MF23401 **MACHINING TECHNOLOGY** **L T P C**

3 0 0 3

OBJECTIVE

The main objective of this course is to impart fundamental aspects of machining, provide theoretical & practical knowledge on various machine tools & their operations, explain the importance of machine tool testing and study the effect of machining.

UNIT I BASICS OF METAL CUTTING 9

Introduction to metal cutting - Chip formation, cutting tool geometry in ASA and ORS; Mechanics of cutting, Orthogonal and Oblique cutting, Cutting forces, Stresses, Shear angle, Shear strain and Velocity relationships; Measurement of cutting force, Tool dynamometers; Cutting tool materials; Temperatures in machining, causes, measurement and control, Cutting fluids; Tool wear, Tool life, Machinability and Surface finish, Effect of cutting variables on tool life and surface finish.

UNIT II MACHINING PROCESSES 9

General purpose machine tools – Lathe machines, Kinematics, Cutting tool geometry, types, setting and chip control, Operations; Drilling and boring machines - kinematics, Drill geometry, Drilling, Reaming, Boring and Tapping operations; Milling machines - Kinematics, geometry of milling cutter, operations, indexing, types and applications; Reciprocating machine tools - Shaper, Planer, Broaching Machines and applications. Vibration and chatter in machining.

UNIT III ABRASIVE FINISHING PROCESSES 9

Grinding – principles and applications, Specification and selection of grinding wheels, wheel balancing, dressing and truing, Types of grinding machines and operations, cutting fluids, safety in grinding; Super finishing processes - Honing, Lapping, Super finishing and applications.

UNIT IV WORK HOLDING DEVICES IN MACHINING OPERATIONS 9

Work holding devices - Concepts of jigs and fixtures, advantages and applications; Principles of jigs and fixtures design, degrees of freedom, location, clamping and their devices; Development of jigs and fixtures for drilling, milling, broaching and grinding operations - Case studies.

UNIT V PRODUCTION MACHINE TOOLS AND PERFORMANCE EVALUATION 9

Production Machine tools - Capstan and Turret lathes, Single spindle and multi-spindle automats, Cutting off, Swiss type, Automatic screw machines and Transfer machines; Gear shaping and Gear hobbing machines, Thread cutting machines; Erection and Testing of machine tools - performance evaluation procedures, Acceptance tests.

TOTAL: 45 PERIODS

List of experiments for Lab component (30 periods)

1. Taper Turning and eccentric turning in a Centre lathe.
2. Internal and External thread cutting in a Centre lathe.
3. Measurement and analysis of cutting force in Turning operation.
4. Drilling and Reaming using vertical drilling machine.

5. Milling contours on plates using vertical milling machine.
6. Generating gears using gear shaping and hobbing machines.
7. Grinding components using cylindrical, surface and centerless grinding machines.

OUTCOME

Upon completing of the course students will be able to:

CO1: Understand the basics of metal cutting theory and apply them for suitable selection of cutting tools.
CO2: Recognise the types of machine tools, their capabilities and machine sample components by applying the basics of metal cutting.
CO3: Apply the principles of grinding & other finishing processes and study their importance in improving surface finish and dimensional accuracy by undertaking practical tests.
CO4: Develop Jigs and Fixtures for various machining operations and understand their importance through case studies.
CO5: Study different types of special purpose production machine tools and analyse the performance of machine tools through suitable testing procedures.

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	-	1	1	-	-	-	1	1	-	3	2	2	1
2	3	1	-	1	1	-	-	-	1	1	-	3	2	2	1
3	3	1	-	-	-	-	-	-	1	1	-	3	3	2	
4	3	1	-	-	-	-	-	-	1	1	-	3	2	2	
5	3	1	1	1	-	-	-	-	-	1	-	3	3	2	
Avg	3	1	1	1	1				1	1		3	2.4	2	1

ME23C15 DESIGN OF MACHINE ELEMENTS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for familiarizing the various steps involved in the design process using standard practices and standard data, evaluating the design parameters of a component to satisfy functional and strength requirements.

UNIT I FUNDAMENTAL CONCEPTS IN DESIGN 9

Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers- Direct, Bending, and torsional loading- Modes of failure - Factor of safety – Combined loads – Principal stresses curved beams – crane hook and 'C' frame- theories of failure – Design based on strength and stiffness – stress concentration – Fluctuating stresses – Endurance limit –Design for finite and infinite life under variable loading - Exposure to standards.

UNIT II DESIGN OF SHAFTS AND COUPLINGS 9

Shafts and Axles - Design of solid and hollow shafts based on strength, rigidity, and critical speed – Keys and splines – Rigid and flexible couplings.

UNIT III DESIGN OF JOINTSAND POWER SCREWS 9

Threaded fasteners - Bolted joints – Simple and eccentrically loaded bolted joints- Welded joints – Butt, Fillet and parallel transverse fillet welds – welded joints subjected to bending, torsional

Terminology of Power Screw- Torque Requirement- Self-Locking screw- Efficiency of Screws-Collar Friction Torque.

UNIT IV DESIGN OF SPRINGSAND PIPE JOINTS 9

Types of springs, design of helical and concentric springs–Surge in springs, Design of laminated springs Introduction to pipe joints and fittings- soldered fittings-screwed connections - pipe connections- oval type flanged pipe joint

UNIT V DESIGN OF BEARINGS 9

Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi & Boyd graphs - Selection of Rolling Contact bearings - Seals and Gaskets.

TOTAL: 45 PERIODS

Note: Use of approved design data book is permitted.

COURSE OUTCOMES:

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

CO1 Design machine members subjected to static and variable loads.

CO2 Design shafts and couplings for various applications.

CO3 Design bolted, welded joints and power screws for various kinds of loads.

CO4 Design helical, leaf springs, and pipe joints for various applications.

CO5 Design sliding and rolling contact bearings

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	2	-	-	-	1	1	1	-	2	3	2	2
2	3	3	3	2	-	-	-	1	1	1	-	2	3	2	2
3	3	3	3	2	-	-	-	1	1	1	-	2	3	2	2
4	3	3	3	2	-	-	-	1	1	1	-	2	3	2	2
5	3	3	3	2	-	-	-	1	1	1	-	2	3	2	2
Avg	3	3	3	2	-	-	-	1	1	1	-	2	3	2	2

TEXTBOOKS:

1. Bhandari V B, “Design of Machine Elements”, 4th Edition, Tata McGraw-Hill Book Co, 2016
2. Joseph Shigley, Richard G. Budynas and J. Keith Nisbett “Mechanical Engineering Design” 10th Edition, Tata McGraw-Hill, 2015.

REFERENCES:

1. Ansel C Ugural, “Mechanical Design – An Integral Approach”, 1st Edition, Tata McGraw-Hill Book Co, 2004.
2. Design Data Hand Book”, PSG College of Technology, Coimbatore, 2013.
3. Merhyle Franklin Spotts, Terry E. Shoup, and Lee EmreyHornberger, “Design of Machine Elements” 8th Edition, Printice Hall, 2004.
4. Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine Component Design”,6th Edition, Wiley, 2017.
5. Sundararajamoorthy T. V. and Shanmugam. N, “Machine Design”, Anuradha Publications, Chennai, 2003.

ME23C11 KINEMATICS AND DYNAMICS OF MACHINERY

L	T	P	C
3	0	2	4

COURSE OBJECTIVES:

The main learning objective of this course is:

1 to understand the principles in the formation of mechanisms and their kinematics.
2 to learn the basic concepts of toothed gearing and kinematics of gear trains.
3 to study the effect of friction in different machine elements.
4 to analyze the forces and torque acting on simple mechanical systems.
5 to understand the importance of balancing and vibration.

UNIT – I KINEMATIC ANALYSIS IN SIMPLE MECHANISMS AND CAMS 9

Mechanisms – Terminology and definitions – kinematics inversions and analysis of 4 bar and slide crank chain – velocity and acceleration polygons – Cams – classifications – displacement diagrams-layout of plate cam profiles.

UNIT – II TOOTHED GEARING AND GEAR TRAINS 9

Gear terminology – law of toothed gearing – involute gearing – Gear tooth action - Interference and undercutting – gear trains – parallel axis gear trains – epicyclic gear trains.

UNIT – III FRICTION ASPECTS IN MACHINE COMPONENTS 9

Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads – Friction clutches – Belt drives – Friction aspects in brakes.

UNIT – IV STATIC AND DYNAMIC FORCE ANALYSIS 9

Applied and Constrained Forces – Free body diagrams – Static equilibrium conditions – Static Force analysis in simple mechanisms – Dynamic Force Analysis in simple machine members – Inertia Forces and Inertia Torque – D'Alembert's principle.

UNIT – V BALANCING OF ROTATING MASSES AND VIBRATION 9

Static and Dynamic balancing – Balancing of revolving masses – Balancing machines – Free vibrations – natural Frequency – Damped Vibration – Critical speed of simple shafts – Forced vibration – Harmonic forcing – Vibration isolation.

Laboratory Experiments 30

List of Experiments:

1. Study of gear parameters: Experimental study of velocity ratios of simple, compound, epicyclic and differential gear trains.
2. Determination of Mass moment of inertia of Fly wheel and Axle system.
3. Determination of Mass Moment of Inertia of axisymmetric bodies using Turn table apparatus. 4. Motorized gyroscope – Study of gyroscopic effect and couple.
5. Governor - Determination of range sensitivity and effort for Watts, Porter, Proell, and Hartnell Governors.
6. Cams – Cam profile drawing and Motion curves
7. Single degree of freedom Spring Mass System – Determination of natural Frequency and verification of Laws of springs
8. Determination of torsional natural frequency of single undamped rotor system
9. Whirling of shafts – Determination of critical speeds of shafts with concentrated loads.

TOTAL :75 PERIODS

COURSE OUTCOMES:

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

CO1 design the linkages and the cam mechanisms for specified output motions.

CO2 determine the gear parameters of toothed gearing and speeds of gear trains in various applications.

CO3 evaluate the frictional torque in screw threads, clutches, brakes and belt drives and to determine mass moment of inertia of flywheel and axle system and axisymmetric bodies.

CO4 determine the forces on members of mechanisms during static and dynamic equilibrium conditions and to determine gyroscopic couple and various parameters of governors

CO5 determine the balancing masses on rotating machineries and the natural frequencies of free and forced vibratory systems.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	3	2	2	2	3	1	1	1	2	3	1	
2	3	3	3	3	2	3	2	3	1	1	1	2	3	1	
3	3	3	3	3	2	3	2	3	1	1	1	2	3	1	
4	3	3	3	3	2	2	2	2	1	1	1	2	3	1	
5	3	3	3	3	2	2	2	2	1	1	1	2	3	1	
Avg	3	3	2.8	3	2	2.4	2	2.6	1	1	1	2	3	1	

TEXT BOOKS

1.Uicker, J.J., Pennock G.R and Shigley, J.E., “Theory of Machines and Mechanisms”, Oxford University Press, 2017.

REFERENCES

1.Cleghorn. W. L., Nikolai Dechev, “Mechanisms of Machines”, Oxford University Press, 2015.
2. Rao.J.S. and Dukkipati.R.V. “Mechanism and Machine Theory”, New Age International Pvt. Ltd., 2006.
3. Rattan, S.S, “Theory of Machines”, McGraw-Hill Education Pvt. Ltd., 2014
4. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill, 2017.
5. Thomas Bevan, “The Theory of Machines”, Pearson Education Ltd., 2010.

MF23402	FLUID POWER SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To impart knowledge on the fluid power principles, fluids and components in fluid power system.
2. To impart knowledge on the design and application of fluid power system in process, and manufacturing Industries.
3. To familiarize the students with pneumatic components and design of pneumatic circuits.
4. To provide the knowledge of trouble shooting methods in fluid power systems.

UNIT – I FLUID POWER PRINICIPLES AND PROPERTIES 9

Introduction, Fluid power Scenario, Basic system of Hydraulics - Major advantages and disadvantages, Comparison among Electrical, Hydraulics and Pneumatics System, Principles of Hydraulic Fluid power, Pascal's Law and its application, Fluid Power ANSI Symbols, Electrical Elements used in hydraulic circuits. Hydraulic Oils, Fluid Properties and Filter: Types, Properties, physical characteristics & functions of hydraulic Oils, Classification Mineral based, Fire resistant & Biodegradable Oils, Filters, Contaminations, location of filter. Basic Requirements for Pneumatic System, Gas laws and properties of compressed air, Basic Symbols of Pneumatic Systems. Electrical elements used in Pneumatic System.

UNIT – II HYDRAULIC PUMPS, MOTORS, VALVES AND ACTUATORS 9

Classification of hydraulic pumps, Construction and working, Advantages, Disadvantages- Gear Pumps, Vane Pumps, Piston Pumps, Axial piston pumps, Hydraulic cushioning, Hydraulic motors, Types, Construction and Operation- Direction control valves, Pressure control valves, Flow control valves, Non-return valves, Servo and Proportional valves- Applications, Accumulators, Pressure Intensifiers, Pressure Switches, Reservoirs, Hydraulic power pack. Types of Hydraulic Actuators, Selection criterion of Actuators, Linear and Rotary Actuators, Hydrostatic Transmission Systems.

UNIT – III DESIGN OF HYDRAULIC CIRCUITS 9

Accumulators, Intensifiers and their circuits, Hydraulic industrial circuits – Regenerative, Pump Unloading, Double Pump, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Deceleration circuits, Sizing of hydraulic systems, Electro hydraulic circuits, Case study of Automation using Hydraulics.

UNIT – IV DESIGN OF PNEUMATIC SYSTEM AND CIRCUITS 9

Types & Selection criteria for Air Compressors, Air receiver, Pipeline Layout, Air filter, Pressure regulator and Lubricator (FRL unit), Muffler. Types of Pneumatic Cylinders & Air motors, Cushion assembly, mounting Arrangements, Pneumatic Direction control valves, Quick exhaust valve, Time delay Shuttle valve. Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram, Introduction to fluidics and pneumatic logic circuits. Low cost Automation.

UNIT – V APPLICATIONS AND TROUBLE SHOOTING 9

Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools. Design of Pneumatic circuits for metal working. Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

1. Explain the fluid power principle and selection of components for applications.
2. Summarize the features and working principles of Hydraulic pumps, Hydraulic motors, Flow control valves and Actuators
3. Explain the different types of Hydraulic circuits and systems.
4. Explain the working of different pneumatic circuits and systems.
5. Design hydraulic and pneumatic circuits for manufacturing industries and the various trouble shooting methods in fluid power systems.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	1	-	-	-	-	-	-	-	-	1	2	3	2
2	3	1	1	-	-	-	-	-	-	-	-	1	2	3	2
3	3	2	3	1	2	-	-	-	-	-	-	1	2	3	2
4	3	2	3	1	2	-	-	-	-	-	-	1	2	3	2
5	3	2	3	1	2	-	-	-	-	-	-	1	2	3	2
Avg	3	1.6	2.2	1	2							1	2	3	2

TEXTBOOKS:

1. Majumdar S.R., Oil Hydraulics Systems- Principles and Maintenance, Tata McGraw Hill, 2003.
2. Anthony Esposito, “Fluid Power with Applications”, Prentice Hall, 2009
3. James A. Sullivan, “Fluid Power Theory and Applications”, Prentice Hall, 1997

REFERENCES:

1. Shanmugasundaram.K., “Hydraulic and Pneumatic Controls”. Chand & Co, 2006.
2. Dudelyt, A. Pease and John T. Pippenger, Basic Fluid Power, Prentice Hall, 1987
3. Jagadeesha. T., “Pneumatics Concepts, Design and Applications “, Universities Press, 2015.
4. Joshi. P., Pneumatic Control”, Wiley India, 2008.
5. Srinivasan. R., “Hydraulic and Pneumatic Controls”, Vijay Nicole Imprints, 2008.
6. Michael J, Prinches and Ashby J. G, Power Hydraulics, Prentice Hall, 1989

MF23403	COMPUTER AIDED DESIGN	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Applying the fundamental concepts of computer graphics and its tools in a generic framework.
2. Creating and manipulating geometric models using curves, surfaces and solids.
3. Applying concept of CAD systems for 3D modeling and visual realism.
4. Creating and adding geometric tolerances in assembly modeling.
5. Applying CAD standard practices in engineering design.

UNIT I FUNDAMENTALS OF COMPUTER GRAPHICS 9

Product cycle- Design process - Computer Aided Design — Computer graphics — co-ordinate systems- 2D and 3D transformations- homogeneous coordinates - graphic primitives (point, line, circle drawing algorithms) - Clipping- viewing transformation.

UNIT II GEOMETRIC MODELING 9

Representation of curves - Hermite cubic spline curve, Bezier curve, B-spline curves, Surface Modeling — Surface Entities, Representation of Surface, Bezier Surface, B-Spline Surface and Coons Surface. Solid Modeling - Solid Entities, Solid Representation, Boundary Representation (B- Rep), Sweeps Representation, Constructive Solid Geometry (CSG).

UNIT III VISUAL REALISM 9

Need for hidden surface removal, The Depth - Buffer Algorithm, Properties that help in reducing efforts, Scan Line coherence algorithm, Span - Coherence algorithm, Area-Coherence Algorithms, Warnock's Algorithm, Priority Algorithms– shading — coloring — computer animation.

UNIT IV PART ASSEMBLY 9

Mass properties - Assembly modeling — Inference of position and orientation – Geometric Dimensioning and Tolerancing – parting line- Functional importance of various types of fits, Geometrical dimensioning and Tolerancing, Tolerance stacking – types and remedies.

UNIT V CAD STANDARDS 9

Standards for computer graphics- Graphical Kernel System (GKS) - Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, ACIS and DXF - communication standards.

DRAFTING 30

Drawing, Editing, Dimensioning, Layering, Hatching, Block, Array, Detailing, Detailed Drawing.

1. Bearings – Bush Bearing

2. Couplings – Flange, Oldham's, Muff, Gear couplings.
3. Joints – Universal, Knuckle, Gib& Cotter, Strap, Sleeve &Cotter joints.
4. Engine parts — Piston, Connecting Rod, Crosshead (vertical and horizontal), Stuffing box, Multi-plate clutch.
5. Machine Components — Screw Jack, Machine Vice, Lathe Tail Stock, Lathe Chuck, Plummer Block, Vane and Gear pumps.

The above tasks can be performed manually and using standard commercial CAD software.

TOTAL: 75 (45+30) PERIODS

Course Outcomes

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

CO1 : Employ the fundamental concepts of computer graphics and its tools in a generic framework.

CO2 : Create and manipulate the geometric models using curves, surfaces and solids

CO3 : Develop 3D model and visual realism in CAD systems.

CO4 : Apply geometrical dimensioning and tolerancing in assembly modeling.

CO5 : Adapt the standard CAD practices in engineering design.

CO PO PSO MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	3	1	3			1		3	1	3	3	2	
2	2	1	3	1	3			1		3	1	3	3	2	
3	2	1	3	1	3			1		3	1	3	3	2	
4	2	1	3	1	3			1		3	1	3	3	2	
5	2	1	3	1	3			1		3	1	3	3	2	
Avg	2	1	3	1	3			1		3	1	3	**3**	**2**	

MF23C01 **ADDITIVE MANUFACTURING** **L T P C**
3 0 2 4

COURSE OBJECTIVES:

Gain knowledge of design considerations, software tools, processes, and techniques for creating customized physical components and understand their medical and industrial applications using Additive Manufacturing (AM).

UNIT I INTRODUCTION **9**

Overview – Distinction between traditional manufacturing and AM – Evolution of Additive Manufacturing (AM) - AM Process workflow - Classification – Benefits. AM Standards - AM Considerations-Business and Societal Implications of AM -Economic aspects.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING (DfAM) **9**

AM Unique Capabilities- Need for DfAM- Design consideration in AM- Part Consolidation - Topology Optimization- Generative Design- Lightweight Structure - DfAM for Part Quality Improvement. CAD Model Preparation - File formats for AM (STL, PLY, VRML, AMF) - Part Orientation and Support Structure Generation - Model Slicing - Tool Path Generation.

UNIT III PHOTO POLYMERIZATION, MATERIAL EXTRUSION, AND POWDER BED FUSION PROCESSES **9**

Photo polymerization: Stereolithography Apparatus (SLA) - Materials - Process - Capabilities - Applications. Digital Light Processing (DLP) - Materials – Process - Capabilities - Applications. Continuous Liquid Interface Production (CLIP) - Materials - Process - Capabilities and Applications. Extrusion Based System: Fused Deposition Modeling (FDM) - Process – Types- Materials - Applications. Powder Bed Fusion: Selective Laser Sintering (SLS): Process – Materials - Application. Multijet fusion. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials – Principle - Process - Capabilities and Applications.

UNIT IV SHEET LAMINATION, DIRECT ENERGY DEPOSITION, BINDER AND MATERIAL JETTING PROCESSES **9**

Sheet Lamination Process: Laminated Object Manufacturing (LOM) - Basic Principle- Mechanism: Gluing or Adhesive Bonding – Thermal Bonding- Materials-Application and Limitation

Direct Energy Deposition Process: Laser Engineered Net Shaping (LENS) and Wire Arc Additive Manufacturing (WAAM) - Process -Material Delivery - Process Parameters -Materials - Capabilities – Industrial Applications. Binder and Material Jetting: Three-Dimensional Printing - Materials - Physics of 3DP – Process- Types of printing – Material - Capabilities - Application.

Hybrid Additive Manufacturing – Need - Principles - Synergy in Hybrid AM Materials - Part Quality - Process Efficiency.

UNIT V APPLICATION OF ADDITIVE MANUFACTURING **9**

Rapid tooling - Direct tooling - Indirect tooling – Soft tooling - ridge tooling. Rapid Tooling for Investment Casting, sand casting, Injection molding. Case Studies/Application: Aerospace - Automotive industries, Medical - Healthcare - Architecture - Construction - Food Printing -Printing Electronics - Consumer products - Fashion.

LIST OF EXPERIMENTS **30**

1.Modeling creative designs in CAD Software

2. Generating STL files from the CAD Models and repairing STL file
3. Part orientation, support, and Tool path generation using 3D printing Software.
4. Build-time calculation, amount of model and support material consumption using 3D printing Software.
5. Fabrication of physical part on an extrusion-based AM machine using tool path data with polymer material.
6. Fabrication of physical part on an extrusion-based AM machine using tool path data with composite material.
7. Fabrication of physical part on photo-polymerization based AM machine using tool path data.
8. Converting CT/MRI scan data into STL file using Medical modeling software (Demo)

TOTAL: 45 L + 30 P = 75 PERIODS

COURSE OUTCOMES:

At the end of this course students shall be able to:

CO1: Gain an understanding of Additive Manufacturing and its development and Identify different business opportunities associated with Additive Manufacturing.

CO2: Develop a comprehensive understanding of design considerations specific to Additive Manufacturing and familiarize oneself with a range of software tools used in the design process for Additive Manufacturing.

CO3: Elaborate the photopolymerization, material extrusion processes, powder bed fusion processes and their applications. Fabrication of physical parts using extrusion-based and VAT Photo polymerization-based additive manufacturing machines.

CO4: Acquire knowledge on processes and applications of sheet lamination, direct energy deposition, Binder and Material Jetting Processes and introduce the concept of hybrid Additive Manufacturing processes that combine multiple techniques to achieve desired outcomes.

CO5: Achieve in-depth knowledge of Rapid Tooling techniques in Additive Manufacturing and explore case studies and industrial applications of AM.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	1	1	1	1	1	1	1	1	1	3	1	1	1
2	3	3	3	3	3	1	1	1	2	2	1	3	2	3	2
3	3	2	1	3	3	1	1	1	2	2	1	3	2	2	1
4	3	3	2	1	1	1	1	1	1	1	1	3	2	2	1
5	3	3	3	3	3	1	2	1	2	2	1	3	3	3	2
Avg	3	2.4	2	2.2	2.2	1	1.2	1	1.6	1.6	1	3	2	2.2	1.4

TEXT BOOKS:

1. Gibson, Ian, David Rosen, Brent Stucker, Mahyar Khorasani, Ian Gibson, David Rosen, Brent Stucker, and Mahyar Khorasani. "Design for additive manufacturing." Additive manufacturing technologies (2021), ISBN : 978-3-030-56126-0.

2. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2016, ISBN: 978-1-56990-582-1.

REFERENCES:

1. A Practical Guide to Design for Additive Manufacturing, Diegel, Olaf, Axel Nordin, and Damien Motte, Springer, 2020.
2. Additive Manufacturing, Second Edition, Amit Bandyopadhyay Susmita Bose, CRC Press Taylor & Francis Group, 2020, ISBN- 978-1-4822-2360-6.
3. The 3D Printing Handbook: Technologies, Design and Applications, Redwood, Ben, Filemon Schoffer, and Brian Garret, 3D Hubs, 2017.
4. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, Second Edition, CRC Press., United States, 2020, ISBN 9781032238593.
5. Additive Manufacturing: Principles, Technologies and Applications, C.P Paul, A.N Junoop, McGrawHill, 2021.

MF23S02 PRACTICAL SKILLS IN COMPONENT MANUFACTURING L T P C
1 0 2 2

OBJECTIVE

This course provides hands-on training in precision machining processes, focusing on drilling, reaming, and the fabrication of bolts, nuts, and cylindrical dowels. Students will learn to use vertical drilling machines, lathes, and threading tools. Emphasis will be placed on precision, quality control, and adherence to safety standards.

Lab Exercise

1. **Introduction and Safety Protocols**
    a. Introduction to precision machining
    b. Lab safety training
    c. Overview of lab equipment and tools
2. **Drilling Basics and Vertical Drilling Machine Setup**
    a. Principles of drilling
    b. Vertical drilling machine setup and safety
    c. Hands-on practice: Drill basic holes in various materials
3. **Introduction to Reaming**
    a. Principles of reaming
    b. Types of reaming tools and their applications
    c. Hands-on practice: Ream drilled holes to precise tolerances
4. **Threading Basics and Fastener Fabrication**
    a. Introduction to threading and fasteners
    b. Overview of bolts and nuts fabrication
    c. Hands-on practice: Thread cutting using dies
5. **Making Bolts**
    a. Fabrication of bolts using lathes and threading tools
    b. Ensuring precision and quality in thread cutting
    c. Hands-on practice: Make a bolt to specified dimensions
6. **Making Nuts**
    a. Fabrication of nuts using threading tools
    b. Ensuring precise fits with bolts
    c. Hands-on practice: Make a nut to match a previously fabricated bolt
7. **Making Cylindrical Dowels**
    a. Purpose and applications of cylindrical dowels
    b. Machining techniques for dowels using lathes
    c. Hands-on practice: Fabricate cylindrical dowels to precise dimensions
8. **Final Project: Integration of Machining Processes**
    a. Combine drilling, reaming, threading, and dowel making
    b. Process planning and documentation
    c. Hands-on practice: Fabricate a complex part using multiple machining processes and present the project

Lab Equipment and Materials:

- Vertical drilling machine
- Reaming tools
- Lathes

- Threading tools and dies
- Measurement tools (calipers, micrometers)
- Safety gear (gloves, goggles, aprons)

TOTAL: 30 PERIODS

OUTCOME

Upon completing of the course students will be able to:

1. Demonstrate Proficiency in Machining Safety Protocols
2. Execute Precision Drilling and Reaming Operations
3. Fabricate High-Quality Fasteners
4. Produce Precision Cylindrical Dowels
5. Integrate Multiple Machining Processes

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1			2			1			3	3		3	1
2	2	1			2			1			3	3		3	1
3	2	1			2			1			3	3		3	1
4	2	1			2			1			3	3		3	1
5	2	1			2			1			3	3		3	1
Avg	2	1			2			1			3	3		3	1

MF23501 **CNC MACHINE TOOLS** **L T P C**
3 0 2 4

COURSE OBJECTIVES:

- To introduce the evolution, types, principles and constructional features of CNC machine tools
- To acquaint the students with various drives and axis measuring systems used in CNC machine tools
- To gain knowledge on CNC part program and to familiarize with various tooling and work holding devices used in CNC machine tools
- Familiarize students with manual CNC part programming and simulation software for Generate of CNC part programs
- Gain hands-on experience by machining parts on CNC machines and exploring robot programming methods.

UNIT I INTRODUCTION TO CNC MACHINE TOOLS 9

Evolution of CNC Technology - principles - features - advantages - applications - CNC and DNC concept - CNC controllers - characteristics - interpolators - types of CNC Machines -, construction / operation, machine specification of turning centre - machining centre (3 and higher axes) - grinding machine - vertical turret lathe - turn-mill centre – multitask machines.

UNIT II STRUCTURE OF CNC MACHINE TOOL 9

CNC Machine building - structural details - configuration and design - guide ways – Friction, Anti friction and other types of guide ways - elements used to convert the rotary motion to a linear motion - Screw and nut - recirculating ball screw - spindle assembly - torque transmission elements - gear box - timing belts - flexible couplings - Bearings-Integrated spindle motor for top dynamics.

UNIT III DRIVES AND CONTROLS 9

Spindle drives - feed drives - stepper motor (simple problems) - servo motor - linear motor - Axis measuring system - analytical problems to determine number of pulses- open loop and closed loop control - synchro - synchro resolver- gratings- moiré fringe gratings- encoders - inductosyn - laser interferometer.

UNIT IV CNC PROGRAMMING 9

Coordinate system - structure of a CNC part program - G & M Codes - tool length compensation - cutter radius and tool nose radius compensation - mirror image - canned cycles- programming for machining centre and turning centre for well known controllers - macro programming - generation of CNC codes from CAM packages-Concept of 3D Milling Tool paths - CNC Process Planning for Process Efficiency

UNIT V TOOLING AND WORK HOLDING DEVICES 9

Cutting tool materials for CNC machine tools- Nano-laminated Graphene - Carbide for Green Machining - hard metal insert tooling- inserts and tool holder classification - qualified - semi qualified and preset tooling - ATC - APC - Tool Holders - ISO - BT - CAT - Big Plus HSK -

Special Tooling to counter Chatter, Vibration and Resonance - Silent tool - Special Tool Holders with through coolant - Minimal Quantity Lubrication (MQL) - integrated Tool Holders - IoT Connector as standard - intelligent tool holders - Sturdy NC Swivelling Rotary Table Concept for 5 axis simultaneous Machining - use of probes in CNC machines - work holding devices for rotating and fixed work parts - Modular fixtures - economics of CNC - maintenance of CNC machines. - Online Measurement of Process Parameters in Machining

LIST OF EXPERIMENTS **30**

1. Programming and simulation for turning, taper turning, circular interpolation, thread cutting, facing and parting operations using canned cycles for CNC Lathe.
2. Programming and simulation for 2D profile milling, drilling, tapping, circular & rectangular pocket milling and mirroring operations.
3. CNC code generation using CAM software package – CNC Lathe.
4. CNC code generation using CAM software package - 3 and 5 Axis Machining centre.
5. Programming for CNC Wire cut EDM.
6. Robot programming for Material handling applications.
7. Programming for CNC Laser Engraving.

LIST OF EQUIPMENT REQUIRED:

1. Computers - 30.
2. CNC programming and machine simulation software for turning and milling.
3. CAM software for turning and milling operations.
4. CNC Production type turning centre.
5. CNC Machining centre-5 axes.
6. CNC Wire Cut EDM.
7. Articulated Robot.
8. CNC Laser Engraving machine

TOTAL: 45L+30P= 75 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Recognize the evolution, types and principle of CNC machine tools
CO2: Acquire knowledge on constructional features of CNC machine tools
CO3: Identify drives and axis measuring system used in CNC machine tools
CO4: Demonstrate competency in manual part program, generation of CNC part program using CAM packages and exploring robot programming methods
CO5: Elaborate various tooling and work holding devices used in CNC machine tools

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	-	1	-	2	-	-	-	-	-	-	2	1	2	1
2	3	-	2	-	2	-	-	-	-	-	-	2	2	2	2
3	3	1	1	-	2	-	-	-	-	-	-	2	2	1	1
4	3	3	1	2	2	-	-	-	-	-	-	2	2	2	2
5	3	-	1	-	2	-	2	-	-	-	1	2	2	2	2
Avg	3	2	1.2	2	2		2				1	2	1.8	1.8	1.6

TEXT BOOKS:

1. HMT, “Mechatronics”, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2017, ISBN-13: 978-0074636435.
2. Radhakrishnan P., “Computer Numerical Control Machines and Computer Aided Manufacturing”, New Age International Publishers., United States, 2018, ISBN-13: 978- 8122433975.

REFERENCES:

1. Evans K., Polywka J. and Stanley Gabrel. “Programming of CNC Machines”, 4thEdition, Industrial Press Inc., New York, 2016, ISBN: 9780831135249.
2. Jones B.L., “Introduction to Computer Numerical Control”, Pitman, London, 1987.
3. Rao P.N., “CAD/CAM Principles and Applications”, 3rd Edition, Tata McGraw, Hill Publishing Company Limited, New Delhi, 2017, ISBN-13: 978-0070681934.
4. Mike Mattson., “CNC Programming Principles and Applications”, 2nd Edition, Delmar Cengagelearning, United States, 2010, ISBN: 9781418060992.
5. Smid P., “CNC Programming Hand book”, 3rd Edition, Industrial Press Inc., United States, 2008, ISBN-13: 978-0831133474.

MF23C02 **NON-TRADITIONAL MACHINING PROCESSES** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- Understand the need and importance of various non-traditional machining processes and their selection.
- Acquire knowledge in the elementary mechanism and the machinability of materials with different non-traditional machining processes.
- Determine the basic principles of operation and various parameters influencing for each non-traditional machining process and its applications.

UNIT I **INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES** **9**

Introduction - Need for non-traditional machining processes - Classification of non-traditional machining processes - Applications, advantages and limitations of non-traditional machining processes - Abrasive jet machining, Abrasive water jet machining, Ultrasonic machining their principles, Stationary and rotary ultrasonic machining system - equipment, effect of process parameters, applications, advantages and limitations.

UNIT II **CHEMICAL AND ELECTRO CHEMICAL ENERGY BASED PROCESSES** **9**

Principles, equipment, effect of process parameters, applications, advantages and limitations of Chemical machining, Electro-chemical machining, insulation design in ECM, Electro-stream drilling, Electro-chemical honing, Electro-chemical grinding, Electro chemical deburring, Electrochemical boring. Micro ECM process, mechanism of material removal, opportunities, challenges and applications.

UNIT III **THERMO-ELECTRIC ENERGY BASED PROCESSES** **9**

Mechanics of material removal, equipment, effect of process parameters, applications, advantages and limitations of Electric discharge machining, such as taper and overcut, Micro EDM process, mechanism of material removal, opportunities, challenges and applications. Wire electric discharge machining, Laser beam machining - Types of lasers and feedback mechanisms in Lasers, Mechanics of material removal in Laser machining, Plasma arc machining, Electron beam machining, Mechanics of EBM, Ion beam machining and Focused ion beam machining.

UNIT IV **NANO FINISHING PROCESSES** **9**

Need for nano finishing processes - Principles, equipment, effect of process parameters, applications, advantages and limitations of Abrasive flow machining – Chemo mechanical polishing, Magnetic abrasive finishing, Magnetorheological finishing, Magneto rheological abrasive flow finishing.

UNIT V **HYBRID NON-TRADITIONAL MACHINING PROCESSES** **9**

Introduction – Need for hybrid machining processes - Classification of hybrid non-traditional machining processes, their working principles, equipment, effect of process parameters,

applications, advantages and limitations. Selection and comparison of different non-traditional machining processes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course the students shall be able to:

CO1: Illustrate non-traditional machining processes, mechanism of Mechanical energy based non-traditional machining processes, its applications and limitations.

CO2: Evaluate the process capabilities of Chemical and Electro Chemical machining processes.

CO3: Understand the principles, processes and applications of Thermo-electric metal removal processes and adopt them for the development of precision micro parts.

CO4: Understand the principles of advanced nano finishing techniques and apply them for achieving different surface requirements.

CO5: Hybridize various non-traditional machining processes and select the best suitable non-traditional machining process for processing advanced materials employed in the industries.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	2	2	2	-	-	-	-	1	3	3	3
2	2	2	2	2	2	2	2	-	-	-	-	1	3	3	3
3	2	2	3	3	3	3	2	-	-	-	-	1	3	3	3
4	2	2	3	3	3	3	2	-	-	-	-	1	3	3	3
5	2	2	3	3	3	3	2	-	-	-	-	1	3	3	3
Avg	2.2	2.2	2.6	2.6	2.6	2.6	2					1	3	3	3

TEXT BOOKS:

1. Adithan. M., "Unconventional Machining Processes", Atlantic, New Delhi, India, 2018. ISBN 13: 9788126910458
2. Anand Pandey, "Modern Machining Processes", Ane Books Pvt. Ltd., New Delhi, India, 2019.
3. Bijoy Bhattacharyya and Biswanath Doloi, Modern machining technology- Advanced, Hybrid, Micro Machining and Super Finishing Technology, Academic press, UK, 2020.

REFERENCES:

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

MF23502 METROLOGY AND COMPUTER AIDED INSPECTION L T P C

3 0 0 3

COURSE OBJECTIVES:

To provide foundational knowledge in metrology, teach accurate measurement techniques for linear and angular dimensions, equip students with methods for assessing surface finish and form, introduce laser-based measurement technologies, and enhance understanding of computer-aided inspection and modern advancements in metrology.

UNIT I BASIC CONCEPTS OF MEASUREMENTS 9

Metrology terminologies - Elements of measurements, need for measurement - Factors influencing measurements - Precision and Accuracy - Methods of measurement - Errors in measurements - Causes - Standards and Calibration - Types-Handling of measuring instruments - Do's and Don'ts - Maintenance of Instruments - Clean room.

UNIT II LINEAR AND ANGULAR MEASUREMENTS 9

Measurement of engineering components - Comparators, Slip gauges, Rollers, Limit gauges - Design - Types - Principles - Applications: Auto collimator - Angle dekkor - Alignment telescope - Sine bar - Bevel protractors'

UNIT III SURFACE FINISH AND FORM MEASUREMENTS 9

Measurement of various elements of screw threads and gears - Radius measurement - Surface finish measurement - Straightness, Flatness and roundness- form Measurements-Principles - Application — Computerized form measuring equipments. Geometric dimensioning & tolerancing- limits and fits.

UNIT IV LASER METROLOGY 9

Precision instrument based on Laser - Use of Lasers - Principle –Interferometers, Interference microscope -Optical flats - Laser Interferometer - Application in Linear and Angular measurements-Testing of machine tools using Laser Interferometer.

UNIT V COMPUTER AIDED INSPECTION AND ADVANCES IN METROLOGY 9

Co-ordinate Measuring Machines - Constructional features - Types - Applications of CMM - CNC CMM applications - Measurement arms, Laser tracker - Fundamentals of Computer Aided Inspection - Machine Vision and applications in Metrology - Introduction to Nanometrology.

LABORATORY 30

1. Comparison between any two methods of measurement.
2. Calibration of Mechanical/electrical comparator and checking of dimensions.
3. Measurement of tooth thickness using gear tooth Vernier caliper.
4. Measurement of Surface Roughness parameters using Roughness tester.
5. Measurement of components using Video measuring system.
6. Experiment on light wave interference and interferometry.

COURSE OUTCOMES

At the end of this course, the student shall be able to:

CO1 : Recognize the basics of metrology, understand the measurement concepts and perform measurement tasks accurately.

CO2 : Understand the design principle working and construction of various instruments for measuring various elements of a component

CO3 : Identify the right instrument and method of measurement for surface finish and form measurements

CO4 : Describe understand and apply various measurement techniques using laser metrology

CO5 : Learn to adapt computer aided inspection and advances in metrology in industries and organizations

CO PO PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2											3	
2	3	3	2										2	3	2
3	3	3	3											3	
4	3	3	3										2	3	2
5	3	3	2										2	3	2
Avg	3	3	2.4										2	3	2

TOTAL: 75 (45+30) PERIODS

MF23U02 PERSPECTIVES OF SUSTAINABLE DEVELOPMENT IN MANUFACTURING ENGINEERING

L	T	P	C
2	0	2	3

COURSE OBJECTIVES:

This course introduces sustainability in engineering and technology, covering historical perspectives, UN SDGs, and environmental, social, and economic dimensions. Through practical activities like case studies and sustainable product design, students will develop skills to address sustainability challenges in manufacturing, fostering critical thinking and innovative solutions.

MODULE I INTRODUCTION 6

Principles & Historical perspectives, Importance and need for sustainability in engineering and technology, impact and implications. United Nations Sustainability Development Goals (SDG), UN summit – Rio & outcome, Sustainability and development indicators.

MODULE II ENVIRONMENTAL SUSTAINABILITY 6

Climate change, Biodiversity loss, Pollution and waste management, Renewable vs. non-renewable resources, Water and energy conservation, Sustainable agriculture and forestry. National and international policies, Environmental regulations and compliance, Ecological Footprint Analysis

MODULE III SOCIAL & ECONOMIC SUSTAINABILITY 9

Equity and justice, Community development, Smart cities and sustainable infrastructure, Cultural heritage and sustainability, Ethical considerations in sustainable development.

Triple bottom line approach, Sustainable economic growth, Corporate social responsibility (CSR), Green marketing and sustainable product design, Circular economy and waste minimization, Green accounting and sustainability reporting.

MODULE IV IMPLEMENTING SUSTAINABILITY IN MANUFACTURING ENGINEERING 9

Energy Efficiency and Conservation in Manufacturing **-** Sustainable Manufacturing Practices **-** Social and Economic Impacts of Manufacturing**-** Resource Management and Optimization **-** Environmental Impact Assessment **-** Green Supply Chain Management **-** Innovations in Sustainable Manufacturing Technologies **-** Ethical Considerations in Manufacturing Sustainability

MODULE V SUSTAINABILITY PRACTICES (ACTIVITY BASED) 30

- Group discussion on the challenges and opportunities for sustainability in the manufacturing industry.
- Case study analysis of a manufacturing company facing environmental challenges. Students develop potential solutions.
- Evaluate energy use in a manufacturing facility and propose strategies for energy savings.
- Design a waste management plan for a manufacturing process, including recycling and waste minimization techniques.
- Develop a prototype for a sustainable product, considering lifecycle impacts, material selection, and eco-design principles.

- Case study Analyze pertaining to the circular economy business model of a successful company.
- Group presentation on a selected case study, highlighting key learnings and potential replication.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Understand the principles and historical perspectives of sustainability in engineering and technology.

CO2: Analyze the environmental impacts and implications of engineering activities.

CO3: Evaluate social and economic aspects of sustainability and their relevance to community development and corporate practices.

CO4: Implement sustainable manufacturing practices and assess their impact on the environment, society, and economy.

CO5: Engage in activities and discussions to propose sustainable solutions for manufacturing challenges.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3				1	2	3	2	1	1	1	2	1	1	1
2	3				2	2	3	2	1	1	1	2	2	2	2
3	2				1	3	3	3	2	2	2	2	3	3	2
4	3				3	3	3	2	2	2	2	3	3	3	3
5	2				2	2	2	2	3	3	2	3	2	2	2
Avg	2.6				1.8	2.4	2.8	2.2	1.8	1.8	1.6	2.4	2.2	2.2	2

REFERENCES:

1. Allen, D., & Shonnard, D. R. (2011). Sustainable engineering: Concepts, design and case studies. Prentice Hall.
2. Munier, N. (2005). Introduction to sustainability (pp. 3558-6). Amsterdam, The Netherlands: Springer.
3. Blackburn, W. R. (2012). The sustainability handbook: The complete management guide to achieving social, economic and environmental responsibility. Routledge.
4. Clini, C., Musu, I., & Gullino, M. L. (2008). Sustainable development and environmental management. Published by Springer, PO Box, 17, 3300.
5. Bennett, M., James, P., & Klinkers, L. (Eds.). (2017). Sustainable measures: Evaluation and reporting of environmental and social performance. Routledge.
6. Seliger, G. (2012). Sustainable manufacturing for global value creation (pp. 3-8). Springer Berlin Heidelberg.
7. Stark, R., Seliger, G., & Bonvoisin, J. (2017). Sustainable manufacturing: Challenges, solutions and implementation perspectives. Springer Nature.
8. Davim, J. P. (Ed.). (2013). Sustainable manufacturing. John Wiley & Sons.
9. David A. Dornfeld - *Green Manufacturing: Fundamentals and Applications* (1st Edition, 2014)
10. N. Duflou, M. Reuter, and P. W. Sutherland - *Sustainable Manufacturing: Shaping Global Value Creation* (1st Edition, 2012)

UC23E01 ENGINEERING ENTREPRENEURSHIP DEVELOPMENT

L	T	P	C
2	0	2	3

COURSE OBJECTIVES:

1. Learn basic concepts in entrepreneurship, develop mind-set and skills necessary to explore entrepreneurship
2. Apply process of problem - opportunity identification and validation through human centred approach to design thinking in building solutions as part of engineering projects
3. Analyse market types, conduct market estimation, identify customers, create customer persona, develop the skills to create a compelling value proposition and build a Minimum Viable Product
4. Explore business models, create business plan, conduct financial analysis and feasibility analysis to assess the financial viability of a venture ideas & solutions built with domain expertise
5. Prepare and present an investible pitch deck of their practice venture to attract stakeholders

MODULE – I ENTREPRENEURIAL MINDSET 4L,8P

Introduction to Entrepreneurship: Definition – Types of Entrepreneurs – Emerging Economies – Developing and Understanding an Entrepreneurial Mindset – Importance of Technology Entrepreneurship – Benefits to the Society.

Case Analysis: Study cases of successful & failed engineering entrepreneurs - Foster Creative Thinking: Engage in a series of Problem-Identification and Problem-Solving tasks

MODULE – II OPPORTUNITIES 4L,8P

Problems and Opportunities – Ideas and Opportunities – Identifying problems in society – Creation of opportunities – Exploring Market Types – Estimating the Market Size, - Knowing the Customer and Consumer - Customer Segmentation - Identifying niche markets – Customer discovery and validation; Market research techniques, tools for validation of ideas and opportunities

Activity Session: Identify emerging sectors / potential opportunities in existing markets - Customer Interviews: Conduct preliminary interviews with potential customers for Opportunity Validation - Analyse feedback to refine the opportunity.

MODULE – III PROTOTYPING & ITERATION 4L,8P

Prototyping – Importance in entrepreneurial process – Types of Prototypes - Different methods – Tools & Techniques.

Hands-on sessions on prototyping tools (3D printing, electronics, software), Develop a prototype based on identified opportunities; Receive feedback and iterate on the prototypes.

MODULE – IV BUSINESS MODELS & PITCHING 4L,8P

Business Model and Types - Lean Approach - 9 block Lean Canvas Model - Riskiest Assumptions in Business Model Design – Using Business Model Canvas as a Tool – Pitching Techniques: Importance of pitching - Types of pitches - crafting a compelling pitch – pitch presentation skills - using storytelling to gain investor/customer attention.

Activity Session: Develop a business model canvas for the prototype; present and receive feedback from peers and mentors - Prepare and practice pitching the business ideas- Participate in a Pitching Competition and present to a panel of judges - receive & reflect feedback

MODULE – V ENTREPRENEURIAL ECOSYSTEM 4L,8P

Understanding the Entrepreneurial Ecosystem – Components: Angels, Venture Capitalists, Maker Spaces, Incubators, Accelerators, Investors. Financing models – equity, debt, crowdfunding, etc, Support from the government and corporates. Navigating Ecosystem Support: Searching & Identifying the Right Ecosystem Partner – Leveraging the Ecosystem - Building the right stakeholder network

Activity Session: Arrangement of Guest Speaker Sessions by successful entrepreneurs and entrepreneurial ecosystem leaders (incubation managers; angels; etc), Visit one or two entrepreneurial ecosystem players (Travel and visit a research park or incubator or makerspace or interact with startup founders).

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Develop an Entrepreneurial Mind-set and Understand the Entrepreneurial Ecosystem Components and Funding types

CO2: Comprehend the process of opportunity identification through design thinking, identify market potential and customers

CO3: Generate and develop creative ideas through ideation techniques

CO4: Create prototypes to materialize design concepts and conduct testing to gather feedback and refine prototypes to build a validated MVP

CO5: Analyse and refine business models to ensure sustainability and profitability Prepare and deliver an investible pitch deck of their practice venture to attract stakeholders

REFERENCES:

1. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha (2020). Entrepreneurship, McGrawHill, 11th Edition
2. Bill Aulet (2024). Disciplined Entrepreneurship: 24 Steps to a Successful Startup. John Wiley & Sons.
3. Bill Aulet (2017). Disciplined Entrepreneurship Workbook. John Wiley & Sons.
4. Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business
5. Blank, S. G., & Dorf, B. (2012). The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company. K&S Ranch
6. Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons
7. Marc Gruber & Sharon Tal (2019). Where to Play: 3 Steps for Discovering Your Most Valuable Market Opportunities. Pearson.

MF23U01 **STANDARDS FOR MANUFACTURING ENGINEERING** **L T P C**

1 0 0 1

OBJECTIVE

To understand and apply key engineering standards for materials, mechanical testing, and manufacturing processes, including IS and international guidelines.

MODULE I OVERVIEW OF STANDARDS 6

Basic concepts of standardization; Purpose of Standardization, marking and certification of articles and processes; Importance of standards to industry, policy makers, trade, sustainability and innovation. Objectives, roles and functions of BIS, Bureau of Indian Standards Act, ISO/IEC Directives; WTO Good Practices for Standardization. Important Indian and International Standards.

MODULE II STANDARDS FOR MANUFACTURING PRACTICES 9

Scope and Notable standards - International Organization for Standardization (ISO), American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM) standards, Institute of Electrical and Electronics Engineers (IEEE), National Institute of Standards and Technology (NIST), German Standards Institute DIN, Russian Standards GOST and Japanese Standards JIS, British Standards Institution (BS), Society of Automotive Engineers (SAE) standards, Bureau of Indian Standards (BIS) - Related to Manufacturing processes, Materials, Testing, Quality control, Limits, Fits & Tolerance, Safety, Reliability and Waste disposal (Example - ISO 9001, ISO 14001, ISO 27001, BS 970, ASTM E8/E8M, IS 226, IS 2062, IS 1030, IS 919, IS 2101, IS 1363, IS 1364, IS 4218, IS 3073, IS 8000).

TOTAL: 15 PERIODS

OUTCOME

Upon completing of the course students will be able to:

CO1: To acquire overall knowledge about the standards, standardisation and their importance.

CO2: Familiarise with national and international standards to select right standards for manufacturing, and quality assurance applications.

CO3: Application of Standards in Manufacturing Practices

CO4: Critical Analysis of Standardization Policies

CO5**:** Integration of Standards in Innovative Manufacturing Solutions

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1										3	2	
2	3	2	1										3	2	
3	2	2	1										3	2	
4	2	2	2										3	2	
5	2	2	2										3	2	
Avg	2.4	2	1.4										3	2	

MF23S03 **DESIGN AND FABRICATION PROJECT** **L T P C**

0 0 4 2

OBJECTIVE

- To enable students to apply manufacturing engineering principles by designing, fabricating, and testing a device or system to address a practical problem. The project focuses on process optimization, automation, sustainability, and cost reduction, enhancing hands-on problem-solving and innovation skills.

PRACTICAL SYLLABUS:

Design and Fabrication project shall be carried out as per the following

- Students must select a project topic in consultation with their faculty guides.
- The project should focus on solving a practical manufacturing-related problem by designing and fabricating a device, tool, or system for a specific application.
- Projects should align with core manufacturing principles, such as process optimization, automation, sustainability and cost reduction etc.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Identify and analyze practical manufacturing problems and develop effective design solutions.

CO2: Apply manufacturing principles to design, fabricate, and test a functional prototype.

CO3: Utilize modern CAD tools to create detailed designs and simulations for manufacturability.

CO4: Implement manufacturing processes efficiently, ensuring precision and quality in the final product.

CO5: Evaluate and optimize the product based on testing results, addressing performance and cost considerations.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	2	1	1	1	-	2	2	-	-	3	3	1
2	3	3	3	3	2	1	2	-	2	2	-	-	3	3	1
3	3	2	3	2	3	-	1	-	1	2	-	-	3	3	-
4	3	2	3	3	3	-	1	-	2	3	1	-	3	3	-
5	3	3	3	3	2	-	2	-	2	3	2	1	3	3	-
Avg	3	2.6	2.8	2.6	2.2	1	1.4		1.8	2.4	1.5	1	3	3	1

MF23503 **SUMMER INTERNSHIP** **L T P C**

0 0 4 2

COURSE OBJECTIVE:

To provide industrial exposure, work pattern and hands-on experience

DURATION:

The students have to undergo practical industrial training for four weeks (During the Fourth Semester holidays) in recognized industrial establishments.

At the end of the training they have to submit a report with following information:

1. Profile of the Industry
2. Product range
3. Organization structure,
4. Plant layout,
5. Processes/Machines/Equipment/devices
6. Personnel welfare schemes
7. Details of the training undergone
8. Projects undertaken during the training, if any
9. Learning points.

End Semester examination will be a Viva-Voce Examination during Fifth Semester

COURSE OUTCOMES: At the end of this course, the students shall be able to:

CO1 Learn the application of engineering basics to solve complex industrial problems

CO2 Foresee group dynamics and engage in life long learning

CO3 Gain knowledge on computational and design tools for sustainable product development

CO's- PO's & PSO's MAPPING

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3	1	1	1	1	1	1	3	2	3	1
2	3	3	3	3	3	1	2	2	3	1	1	3	2	3	1
3	3	3	3	3	3	1	3	2	1	2	1	3	2	3	1
Avg	3.0	3.0	3.0	3.0	3.0	1.0	2.0	1.7	1.7	1.3	1.0	3.0	2.0	3.0	1.0

MF23601 **ADVANCED MANUFACTURING LABORATORY** **L T P C**
0 0 2 1

COURSE OBJECTIVES:

- To familiarize the students with advanced machine tools.
- To acquaint students with both traditional and nontraditional machining processes, introduce the manufacturing of polymer composites, and cover concepts related to thin film-based deposition processes.

Simple exercises using the following machines:

1. CNC Friction Stir Welding Machine
2. Abrasive Waterjet Machine (AWJM)
3. Electro Chemical Micro Machine (ECMM)
4. Resin Transfer Moulding System
5. Physical Vapor Deposition (PVD) equipment
6. Wire Electrical Discharge Machining
7. Synthesis of nano powders (Ball milling)

TOTAL: 30 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Acquire knowledge on advanced machine tools and other modern machining processes.

CO2: Demonstrate the manufacture of polymer composites using RTM.

CO3: Value thin film based deposition process.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3		2	3	3		1		2			2	2	2	3
2	3		2	3	3		1		2			2	2	2	3
3	3		2	3	3		1		2			2	2	2	3
Avg	3		2	3	3		1		2			2	2	2	3

MF23701 **MANUFACTURING MANAGEMENT SYSTEMS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To introduce Students planning of a Manufacturing System by Demand and Supply management by through Resource management and shop floor planning and control.
- To gain knowledge on design of forecasting systems and different forecasting methods, MRP, ERP, DRP and the tools available for shop floor data collection and control

UNIT I MANUFACTURING PLANNING AND CONTROL 9

Basic concepts – Types of Production System – Functions of Production Planning and Control – Problems with Production Planning and Control – Computer Integrated Production Management System – Evolution of the Manufacturing Planning and Control (MPC) System-Demand Management in MPC System and the MPC Environment: Make-to-stock, Assemble-to-order, Make-to-order, Engineer-to-order.

UNIT II FORECASTING 9

Forecasting –Forecasting Methods- Intuitive forecasting – Extrapolation- Prediction- Time Horizon – Design of Forecasting Systems – Developing the Forecast Logic – Single and Double Moving Average Methods, Single and Double Exponential Smoothing Methods, Simple Regression Method of Forecasting – Forecast uncertainty- Improving forecast -Measure of Forecast Accuracy.

UNIT III RESOURCE PLANNING 9

Material Requirement Planning (MRP)– Inputs- Open-loop control systems : items and BOMs- Inventory Management concepts -Inventory records - Master production scheduling: Stability- Mechanics- MPS techniques- - Evolution of MRP - Capacity planning- -Infinite vs finite capacity scheduling - Optimization - Sequencing - Problems - Feedback and work to lists- Rough-cut capacity planning -Optimized production technology- OPT principles- Scheduling logic – Distribution Resource Planning (DRP)-Case Studies.

UNIT IV COMPUTER AIDED PROCESS PLANNING 9

Need for Process Planning – Functions of Process Planning – Approaches to Computer Aided Process Planning (CAPP) – Variant Process Planning :Group Technology, Part Family Search – Generative method of CAPP: Input Format – Part Description Methods– Computer Aided Design (CAD) Models – Decision Logic – Artificial Intelligence – Knowledge Representation – Forward and Backward Planning – Databases and Algorithms – Expert Process Planning - Automatic Process Planning – Future Trends–Case Studies.

UNIT V SHOP FLOOR CONTROL 9

Functions of Shop Floor Control – Order Release – Order Scheduling: Job Sequencing and Priority Rules – Order Progress –Shop-floor Data Collection Systems - Online and Offline Data Collection Systems -Definition of shop-floor data collection- Rationale for shop-floor data collection- Methods of shop-floor data collection - Computerized SFDC- Technologies for SFDC - Bar codes - Introduction - Bar code technology - Bar code readers - Characteristics of bar codes - Electronic labels- Implementation- Advantages and problems with electronic labels - Other types of SFDC system - Optical character recognition- Magnetic strips - Direct links to process control devices - Voice recognition systems- The people factor.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Be familiarized with the latest trends in manufacturing planning and control System

CO2: Perceive design of forecasting systems and different forecasting methods

CO3: Be acquainted with the basic concepts of resource requirements

CO4: Recognize the need and approaches of computer aided process planning

CO5: Evaluate the functions of shop floor control and associated systems.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	-	3	3	3	3	-	-	3	3	-	3	3	3	3	3
2	-	3	3	3	3	-	-	3	3	-	3	3	3	3	3
3	-	3	3	3	3	-	-	3	3	-	3	3	3	3	3
4	-	3	3	3	3	-	-	3	3	-	3	3	3	3	3
5	-	3	3	3	3	-	-	3	3	-	3	3	3	3	3
Avg	-	3	3	3	3	-	-	3	3	-	3	3	3	3	3

TEXT BOOKS

1. Groover M.P., "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India., 2016, ISBN-13: 978-9332572492.
2. Thomas E. Vollmann, William Lee Berry, David Clay Whybark and F. Robert Jacobs, "Manufacturing Planning and Control Systems for Supply Chain Management" , MCGraw Hill., United States, 2014, ISBN: 9789339205331.
3. David K. Harrison and David J. Petty," Systems for Planning and Control in Manufacturing Systems and management for competitive manufacture", Newones, 2002 ,ISBN:0750649771

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1. Dr. Franjo Cecelja, "Manufacturing Information and Data Systems" , Penton Press,2002, ISBN 1 8571 8031 3
2. Chand T.C., "Expert process planning for manufacturing", Addison Wesley publishing company., United States, 1990, ISBN-13: 978-0201182972.
3. Groover M. and Zimmers E., "CAD/CAM, Computer Aided Design and Manufacturing", Prentice Hall of India., Reprint 2013, ISBN-13: 978-0131101302.
4. Mahadevan .B, "Operations Management: Theory and practice", Pearson., United Kingdom, 2015, ISBN-13: 978-9332547520.
5. Mahapatra, P.B.," Computer-Aided Production Management", Prentice-Hall of India Pvt. Limited., 2004, ISBN-13: 978-8120317420.
6. Nanua Singh, "System Approach to Computer Integrated Design and Manufacturing", Wiley India Edition., Reprint 2011, ISBN-13: 978-0471585176.
7. Wallace J. Hopp Mark L. Spearman, "Factory Physics", Third Edition, Waveland Press, Inc.,2011, ISBN 978-1-57766-739-1

ONLINE COURSE MATERIALS

Course Material from NPTEL: http://nptel.ac.in/courses/112102101/

ME23C12	MECHATRONICS AND IoT	L	T	P	C
		3	0	2	4

COURSE OBJECTIVE:

To impart knowledge on the principles of sensors, actuators, micro-controllers, Programmable Logic control, Arduino, Raspberry Pi and IOT.

UNIT – I SENSORS AND ACTUATORS 9

Introduction to Mechatronics - Modular Approach, Sensors and Transducers: Static and Dynamic Characteristics, Transducers - Resistive, Capacitive, Inductive and Resonant, Optical Sensors – Photodetectors - Vision Systems – Laser - Fibre optic - Non-fibre Optic, Solid State Sensors, Piezoelectric and Ultrasonic Sensors. Actuators – Brushless Permanent Magnet DC Motor – PM, VR and Hybrid Stepper motors – DC and AC Servo Motors.

UNIT – II SIGNAL CONDITIONING CIRCUITS AND PLC 9

Operational Amplifiers – Inverting and Non-Inverting Amplifier – Wheatstone bridge – Instrumentation Amplifier – PID Controller, Protection Circuits, Filtering Circuits, Multiplexer, Data Logger and Data Acquisition System, Switching Loads by Power Semiconductor Devices Circuits – Thyristors – TRIAC – Darlington Pair – MOSFET and Relays. PLC – Architecture – Input / Output Processing – Logic Ladder Programming – Functional Block Programming using Timers and Counters – Applications.

UNIT – III FUNDAMENTALS OF IoT AND EMBEDDED SYSTEMS 9

The Internet of Things (IoT) - Introduction to the IoT Framework – IoT Enabling Technologies- The Effective Implementation of IoT: The Detailed Procedure. Embedded Systems: An Introduction - Single-Chip Microcontroller Systems - Single-Board Microcontroller Systems - Single-Board Computer Systems - Embedded Systems: Peripherals - Software Considerations.

UNIT – IV ARDUINO AND RASPBERRY Pi 9

Arduino: The Arduino Boards - Arduino Peripherals- Arduino IDE – ESP8266 Wi-Fi module. Raspberry Pi: The Raspberry Pi Boards - The Raspberry Pi Peripherals - The Raspberry Pi Operating System. Interfacing and Controlling I/O devices by Arduino and Raspberry Pi: LEDs - Push buttons - Light intensity sensor - Ultrasonic distance sensor – Temperature sensor- Humidity sensor - Sensor and Actuator interactions

UNIT – V MECHATRONICS AND IoT CASE STUDIES 9

Mechatronics systems: Aerial drone actuation and Control - Autonomous Robot with Vision System, Automotive Mechatronics: Electronic Ignition System - ABS - EBD - Adaptive Cruise Control. IoT case studies: Remote Monitoring Systems- Remotely Operated Autonomous Systems - Centralized Water Management System - IoT Enabled Robotic Camera Dolly - Portable, Wireless, Interactive IoT Sensors for Agriculture - IoT Vehicle Management System with Network Selection.

TOTAL : 45 PERIODS

PRACTICAL EXCERSISES:

1. Data Acquisition System – Measurement of Physical Quantities

2. Modeling and Analysis of Hydraulic, Pneumatic, Electro-Hydraulic and Electro-Pneumatic Circuits by using simulation software.
3. Actuation of double acting cylinder by using Electro-Hydraulic and Electro-Pneumatic circuits.
4. Automating the actuation of cylinder sequence by using Microcontroller.
5. PLC Automation with Timers and Counters.
6. Speed and Direction control of Stepper and Servo motors.
7. Speed and Direction control of DC and AC drives.
8. Automation of material handling application by Six-Axis Articulated Robot.
9. Vision based image acquisition and processing technique for inspection and classification.
10. Remote data acquisition by using IoT.
11. IoT based Home Automation.
12. IoT enabled Robot.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

1. Select suitable sensors and actuators to develop mechatronics systems
2. Devise proper signal conditioning circuit for mechatronics systems, and also able to implement PLC as a controller for an automated system.
3. Elucidate the fundamentals of IoT and Embedded Systems.
4. Implement Arduino and Raspberry Pi as controllers for automated systems.
5. Design and develop an apt mechatronics/IoT based system for the given real-time application.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	1	-	-	-	-	-	-	2	1	2	3
2	3	3	3	1	2	-	-	-	-	-	-	2	1	2	3
3	3	1	2	1	2	-	-	-	-	-	-	2	1	2	3
4	3	3	3	3	3	2	-	-	-	-	-	2	1	2	3
5	3	3	3	3	3	2	-	-	-	-	2	2	1	2	3
Avg	3	2.4	2.4	1.8	2.2	2	-	-	-	-	2	2	1	2	3

TEXTBOOKS:

1. Bradley D.A., Burd N.C., Dawson D., Loader A.J., “Mechatronics: Electronics in Products and Processes”, Routledge, 2017.
2. Sami S.H and Kisheen Rao G, “The Internet of Mechanical Things: The IoT Framework for Mechanical Engineers”, CRC Press, 2022.

REFERENCES:

1. John Billingsley, “Essentials of Mechatronics”, Wiley, 2006.
2. David H., Gonzalo S., Patrick G.,Rob B. and Jerome H.,“IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, Pearson Education, 2018.
3. Nitin G and Sharad S, “Internet of Things: Robotic and Drone Technology”, CRC Press, 2022.

4. Newton C. Braga, “Mechatronics For The Evil Genius”, McGraw Hill, 2005.
5. Bell C., “Beginning Sensor Networks with Arduino and Raspberry Pi”, Apress, 2013.
6. Bolton W., “Mechatronics”, Pearson Education, 2019.

MF23801 PROJECT WORK / INTERNSHIP CUM PROJECT WORK L T P C
0 0 16 8

COURSE OBJECTIVE:

- To provide students with an opportunity to apply their theoretical knowledge and practical skills to solve real-world engineering problems.
- To develop students' project management skills, including planning, execution, and documentation.
- To foster teamwork, communication, and critical thinking abilities in the context of a multidisciplinary engineering project.

PROJECT WORK: A project topic must be selected by the students in consultation with their guides. The ultimate aim of the project work is to deepen comprehension of manufacturing engineering principles by applying them to a new problem which may be the simulation, analysis, design and fabrication of mechanical systems for a specific application.

SEMESTER LONG INTERNSHIP: If the student opts for semester long internship, the student shall undergo the internship in the Government Organizations/Reputed Industries.

PROJECT WORK / SEMESTER LONG INTERNSHIP evaluation is based on Regulations 2023 - University Departments - Undergraduate programmes provided by Centre for Academic Courses, Anna University, Chennai

TOTAL: 300 PERIODS

Course Outcome:

At the end of the course the students shall be able to

CO1: Identify and define an engineering problem or challenge and formulate appropriate project objectives.

CO2: Plan and execute a project, including resource allocation, task scheduling, and progress monitoring.

CO3: Apply engineering principles, methodologies, and tools to design, analyze, and implement a solution to the project problem.

CO4: Work effectively in a team, demonstrating collaboration, communication, and leadership skills.

CO5: Present project outcomes through oral presentations, written reports, and visual aids, effectively communicating technical information to various stakeholders.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	2	3	3	3	3	3	3	3	2	3	3	3	3
2	3	2	3	2	3	2	3	3	3	2	3	2	3	2	2
3	2	3	3	3	2	3	3	2	2	2	3	2	2	3	3
4	3	3	3	2	3	2	3	2	3	3	2	3	3	2	3
5	3	3	3	3	3	3	2	3	3	3	3	3	3	3	2
Avg	2.6	2.8	2.8	2.6	2.8	2.6	2.8	2.6	2.8	2.6	2.6	2.6	2.8	2.6	2.6

EMERGING TECHNOLOGY COURSES

MF23E01 **SMART MANUFACTURING** **L T P C**
3 0 2 4

COURSE OBJECTIVES:

To introduce Industry 4.0, smart factories, Digital Twin, Internet of Things, Artificial Intelligence, Machine Learning, and Cyber-Physical Systems (CPS) along with their various elements.

UNIT I PRINCIPLE OF INDUSTRY 4.0 & SMART FACTORY 9

Industry 4.0 — Definition, principles, Introduction to Industry 4.0: Industry 4.0: Globalization and Emerging Issues, Smart and Connected Business Perspective, Smart Factories, Industry 4.0: Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis Industrial Revolutions, Benefits of Industry 4.0, challenges in Industry 4.0, Smart manufacturing, Internet of Things, Industrial Gateways, Basics of Communication requirements. Application of Industry 4.0 in process & discrete industries.

UNIT II CYBER PHYSICAL SYSTEMS 9

Cyber Physical Systems in Real world, Basic Principle of Cyber Physical Systems, CPS Design Recommendations, CPS system requirements, Cyber Physical System Application, Case study of Cyber Physical Systems, Hardware platforms for Cyber Physical Systems (Sensors/Actuators, Microprocessor/Microcontrollers), Wireless Technologies for Cyber Physical Systems, Continuous Dynamics, Discrete dynamics, Hybrid Systems, Structure of Models, Synchronous Reactive models, Dataflow models of computation, Timed models of computation. Security and Privacy Issues in CPSs, Local Network Security for CPSs, Internet-Wide Secure Communication, Security and Privacy for Cloud-Interconnected CPSs, Case Study: Cybersecurity in Digital Manufacturing/Industry 4.0

UNIT III DIGITAL TWIN IN MANUFACTURING 9

Digital twin - Definition, types of Industry & its key requirements, Importance, Application of Digital Twin in process, product, service industries. Real time use of Digital Twin, Benefits, impact and challenges, Features and Implementation of Digital Twins, Types of Digital Twins, Digital Twin use cases, Applications for digital twins in Manufacturing

UNIT IV AI / ML IN MANUFACTURING 9

Machine Learning Application, Basics of Machine Learning, The Machine Learning Process, Machine Learning working cycle, Preparing Data, Running Experiments, Finding the Model, Training the Model, Deploying and using a Model, Machine Learning in practice (examples of existing or future applications in the field of manufacturing)

UNIT V CPS BUSINESS MODELS 9

Cyber-Physical Systems and new Business Models, How CPS can induce new Business Models, The Role of horizontal and vertical value streams, New Business Models for the Smart Factory, Characteristics of Business Models within the Smart Factory, Examples of new Business Models - Business Model: Service provider - Business Model: Data provider - Business Model: Technology provider - Business Model: Platform provider

T: 45 PERIODS

1. Industrial Internet of Things (IIoT) –

Setting up IIoT devices and sensors for monitoring manufacturing processes.

2. Automation and Robotics

Programming and operating industrial robots for tasks such as assembly, welding, or painting.

3.Digital Twin Technology

Creating a digital twin of a manufacturing process and using it to simulate and optimize the process.

4. Smart Sensors and Condition Monitoring

Implementing condition monitoring systems to predict and prevent failure of CNC machine tools.

5. **Augmented Reality (AR) in Manufacturing**

Applications of AR in Manufacturing processes.

6. Quality 4.0:

Exploring advanced quality control techniques using digital technologies.

7. Energy Monitoring and Management:

Implementing energy monitoring systems to optimize energy usage in CNC machine tools.

P: 30 PERIODS

Total: 75 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Acquire knowledge on Industry 4.0 & smart factory

CO2: Understand various elements of cyber physical systems

CO3: Support and value digital twin in process and discrete industry.

CO4: Support and value AI / ML in manufacturing

CO5: Describe the CPS business models

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	2	2	-	1	2	-	-	2	-	3	2	2	2
2	3	2	1	2	-	1	1	-	-	2	-	3	2	1	1
3	3	2	1	2	-	1	1	-	-	2	-	3	2	3	3
4	3	1	1	1	2	1	1	-	-	2	-	3	2	2	2
5	3	1	1	1	2	1	1	-	-	2	-	3	2	2	2
Avg.	3	1.4	1.2	1.6	2	1	1.2	-	-	2	-	3	2	2	2

TEXT BOOKS:

1. Alp Ustundag and Emre Cevikcan, "Industry 4.0: Managing The Digital Transformation",Springer Series in Advanced Manufacturing., Switzerland, 2017
2. Principles of Cyber Physical Systems, Rajeev Alur, MIT Press, 2015
3. E. A. Lee, Sanjit Seshia , "Introduction to Embedded Systems – A Cyber–Physical Systems Approach", Second Edition, MIT Press, 2017

REFERENCES:

1. Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, "Digital Twin Driven Smart Manufacturing", Elsevier Science., United States, 2019
2. Introduction to Industrial Internet of Things and Industry 4.0, Sudip Misra, Chandana Roy, Anandarup Mukherjee, CRC Press, 2020.
3. Ïnternet of Things - A Hands on Approach, Vijay Madisetti, Arshdeep Bahga, University Press.
4. Introduction to Internet of Things: A practical Approach, Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, ETI Labs.
5. The Internet of Things: Enabling Technologies, Platforms, and Use Cases, Pethuru Raj and Anupama C. Raman, CRC Press. 5. Designing the Internet of Things, Adrian McEwen, Wiley
6. Alasdair Gilchrist , "Industry 4.0: The Industrial Internet of Things", Apress., United States ,2015.
7. Christoph Jan Bartodziej, “The Concept Industry 4.0 An Empirical Analysis of Technologies and Applications in Production Logistics”, Springer Gambler., Germany, 2017.

MF23E02	ADVANCED COMPOSITE MATERIALS AND MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES:

To impart knowledge of various manufacturing methods of different composite materials, their properties, machining characteristics and their applications.

UNIT I INTRODUCTION 9

Introduction to Composites, function of the matrix and reinforcement in composites. Classification: polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon- carbon composites, fiber reinforced composites, particulate reinforced composites and nature-made composites. Reinforcement types: Fiber Glass, Silica, Kevlar, carbon, boron, silicon carbide, and boron carbide.

UNIT II MANUFACTURING METHODS: PMC 9

Polymer Matrix Composites-Thermoset Composite manufacturing- Lay-up processes, Sprayup process, Fiber placement process, Resin transfer moulding, Vaccum assisted resin transfer moulding, Compression moulding process, Filament winding. Thermoplastic Composite manufacturing- Sheet moulding, Injection moulding, sheet moulding, Calendaring, Extrusion, Blow moulding, rotational moulding, Thermoforming.

UNIT III MANUFACTURING METHODS: MMC 9

Metal Matrix Composites- Solid state methods- hot isostatic pressing (HIP), Foil diffusion bonding. Liquid state methods- Stir casting, Squeeze casting, Pressure infiltration.

UNIT IV MANUFACTURING METHODS: CMC 9

Introduction – Types – Toughening Mechanism- Processing of CMCs: Cold pressing, sintering,reaction bonding, liquid infiltration, lanxide process – In-situ chemical reaction techniques: Chemical vapour deposition, Chemical vapour impregnation, Sol-gel, C-C Composites. Interface in CMCs. Mechanical Properties and Applications of CMCs

UNIT V COMPOSITES DESIGN AND TEST 9

Laminate theory, Rule of mixtures, symmetry and balance. Non- destructive testing of Composites- Visual inspection, Tap testing, Ultrasonic inspection, X-ray inspection, Thermography. Manufacturing process selection: Cost, performance, size shape, rate of production. Steps for process selection

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

CO1: Analyze the role of matrix and reinforcement in composites across various types including polymer matrix composites, metal matrix composites, and ceramic matrix composites.

CO2: Synthesize advanced manufacturing techniques like resin transfer molding and filament winding to optimize the production of polymer matrix composites.

CO3: Evaluate the effectiveness of advanced manufacturing processes such as hot isostatic pressing and squeeze casting in enhancing the properties of metal matrix composites.

CO4: Critically appraise the design considerations and processing methodologies used in ceramic matrix composites for optimal performance.

CO5: Design innovative composite structures using advanced theories like laminate theory and employ sophisticated non-destructive testing methods such as ultrasonic inspection and thermography for quality assessment.

CO - PO MAPPING :

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	1	3	2	1	1	2	1	1	2	2		
2	2	3	3	2	2	3	1	1	3	2	1	2		3	
3	3	2	3	2	3	3	1	2	2	2	1	3		3	
4	2	3	2	3	2	2	1	2	3	1	2	3		3	
5	3	3	3	3	3	3	2	3	3	3	3	3	3		
Avg	2.6	2.6	2.6	2.2	2.6	2.6	1.2	1.8	2.6	1.8	1.6	2.6	2.5	3	

REFERENCES

1. Chawla, K.K., "Composite Materials: Science and Engineering", Springer, New York, ISBN: 978-0-387-74364-6, 2012.
2. Jahanmir, S., Ramulu, M. and Koshy, P., "Machining of Ceramics and Composites", Marcel Dekker Inc, New York, 1999.
3. Sheikh-Ahmad, J.Y., "Machining of Polymer Composites", Springer, USA, ISBN: 978-0-387-35539-9,2009.
4. Mallick, P.K., "Fiber Reinforced Composites: Materials, Manufacturing and Design", CRC Press,New Delhi, ISBN: 0849342058, 2010.
5. Hull, D. and Clyne, T.W., "An Introduction to Composite Materials", Cambridge University Press,ISBN: 0-521-38190-8, 1988.
6. American Society of Metals, "Composites - ASM Handbook", Volume -21, ISBN: 978-0-87170-703, 2001.
7. Vasiliev, V.V. and Morozov, E.V., "Advanced Mechanics of Composite Materials", Elsevier Ltd.,New Delhi, 2011.
8. Lubin , "Hand Book of Composite Materials",. Springer, ISBN-10 : 1461571413,2014.
9. Composite Materials Science and Applications – Deborah D.L. Chung. Softcover ISBN978-1-4471-2547-1, 2012.
10. Danial Gay, Suong V. Hoa, and Stephen W. "Composite Materials Design and Applications",eBook ISBN9780429134968,2002

WEB REFERENCES:

1. http://nptel.ac.in/courses/103107125/
2. http://nptel.ac.in/courses/103107125/14
3. https://link.springer.com/content/pdf/bfm%3A978-3-642-54634-1%2F1.pdf

MF23E03 **ELCTRONICS CHIP MANUFACTURING** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

To impart knowledge on wafer preparation, PCB fabrication, including Through Hole Technology; elaborate on various steps in oxidation technologies; and familiarize students with various deposition methods and etching techniques.

UNIT I INTRODUCTION TO IC TECHNOLOGY **9**

Definition of a system and history of semiconductors- Introduction to IC Technology: Basic fabrication steps and their Importance. Environment of IC Technology: Concepts of Clean room and safety requirements, Concepts of Wafer cleaning processes and wet chemical etching techniques. Wafer fabrication- inspection and testing Wafer packaging-Packaging evolution-Chip connection choices.

UNIT II IMPURITY INCORPORATION **9**

Solid State diffusion modeling and technology; Ion Implantation modeling, technology and damage annealing, characterization of Impurity profiles.

UNIT III OXIDATION **9**

Kinetics of Silicon dioxide growth both for thick, thin and ultra thin films, Oxidation technologies in VLSI and ULSI,Characterization of oxide films, High k and low k dielectrics for ULS. Thermal Oxidation of Silicon-

UNIT IV LITHOGRAPHY AND DEPOSITION TECHNIQUES **9**

Photolithography, E-beam lithography and newer lithography techniques for VLSI/ULSI, Mask generation. Chemical Vapour Deposition Techniques: CVD techniques for deposition of polysilicon, silicon dioxide, silicon nitride and metal films; Epitaxial growth of silicon: modeling and technology.

UNIT V METAL FILM DEPOSITION **9**

Evaporation and sputtering techniques, Failure mechanisms in metal interconnects Multi-level metallization schemes. Plasma and Rapid Thermal Processing: PECVD, Wet and Dry Etching-Plasma etching and RIE techniques; RTP techniques for annealing, growth and deposition of various films for use in ULSI.-Future trends and Challenges: Challenges for integration, system on chip.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students should be able to:

CO1: Perceive wafer preparation and IC fabrication
CO2: Recognize the importance of impurity incorporation.

CO3: Demonstrate various steps in oxidation technologies.
CO4: Identify various types of lithography and CVD techniques
CO5: Discuss various film deposition techniques

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	-	-	-	-	-	-	-	-	-	-	2	1	1	2
2	3	-	-	-	-	-	-	-	-	-	-	2	1	1	1
3	3	-	1	-	-		-	-	-	-	-	2	2	2	2
4	3	-	1	-	-	1	-	-	-	-	-	2	2	2	2
5	3	-	1	-	-	2	1	-	-	-	-	2	2	3	3
Avg	3		1			1.5	1					2	1.6	1.8	2

TEXT BOOKS:

1. S.M.Sze(2nd Edition)"VLSI Technology", McGraw Hill Companies Inc.
2. C.Y. Chang and S.M.Sze (Ed), "ULSI Technology", McGraw Hill Companies Inc.
3. Rao R. Tummala, Fundamentals of Microsystems Packaging, McGraw Hill, NY, 2001

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1. Stephena, Campbell, "The Science and Engineering of Microelectronic Fabrication", Second Edition, Oxford University Press.
2. James D.Plummer, Michael D.Deal, "Silicon VLSI Technology" Pearson Education
3. William D.Brown,Advanced Electronic Packaging, IEEE Press, 1999.
4. A. Campbell, *The Science and Engineering of Microelectronic* Fabrication, Oxford University Press, 1996.

MF23E04 NANO MANUFACTURING AND CHARACTERIZATION L T P C
4 0 0 4

COURSE OBJECTIVES:

Introduce fundamental concepts of nano manufacturing and material characterization, explore techniques used in nano manufacturing, cover advanced material characterization methods, study latest advancements and applications, and analyze real-world case studies for practical insights.

UNIT I INTRODUCTION TO NANO MANUFACTURING 9

Basics of Nanotechnology and Nano Manufacturing- Top-Down vs. Bottom-Up Approaches- Nanolithography Techniques (e.g., Photolithography, E-beam Lithography)- Self-Assembly and Template-Based Methods- Applications of Nano Manufacturing in Industry

Case Study:

Application of nanolithography in semiconductor manufacturing

UNIT II ADVANCED NANO MANUFACTURING TECHNIQUES 9

Atomic Layer Deposition (ALD) and Chemical Vapor Deposition (CVD)- Nanoimprint Lithography- Focused Ion Beam (FIB) Techniques-Molecular Beam Epitaxy (MBE)- Nano 3D Printing and Additive Manufacturing

Case Study:

Use of Atomic Layer Deposition in fabricating high-k dielectrics

UNIT III FUNDAMENTALS OF MATERIAL CHARACTERIZATION 9

Principles of Material Characterization- Microscopy Techniques: SEM, TEM, AFM**-** Spectroscopy Techniques: Raman, XPS, FTIR**-** X-ray Diffraction (XRD)**-** Mechanical and Thermal Analysis: Nanoindentation, DSC, TGA

Case Study:

Characterization of graphene using Raman spectroscopy and TEM

UNIT IV ADVANCED MATERIAL CHARACTERIZATION TECHNIQUES 9

Electron Energy Loss Spectroscopy (EELS)- Scanning Tunneling Microscopy (STM)- Dynamic Light Scattering (DLS)-Synchrotron Radiation Techniques- In-situ Characterization Methods

Case Study:

In-situ TEM analysis of nanomaterial behavior under stress

UNIT V APPLICATIONS AND LATEST ADVANCEMENTS 9

Nanomaterials in Electronics and Photonics- Biomedical Applications: Drug Delivery, Imaging, and Diagnostics- Energy Applications: Nanostructured Solar Cells and Batteries- Environmental Applications: Nano Catalysts and Sensors- Future Trends and Innovations in Nano Manufacturing and Characterization

Case Study:

Development and characterization of nanostructured solar cells for enhanced efficiency

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course the students shall be able to:

1. Explain the fundamental principles and techniques of nano manufacturing.
2. Apply advanced nano manufacturing methods such as ALD, CVD, and nano 3D printing.
3. Utilize various material characterization techniques including SEM, TEM, and XRD.
4. Analyze the latest advancements in material characterization methods like EELS and STM.
5. Evaluate the applications of nanomaterials in electronics, biomedicine, energy, and environmental sectors.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	-	-	-	-	-	-	-	-	1	3	2	
2	3	2	1	-	-	-	-	-	-	-	-	1	3	2	
3	3	2	1	-	-	-	-	-	-	-	-	1	3	2	
4	3	2	1	-	-	-	-	-	-	-	-	1	3	2	
5	3	2	1	-	-	-	-	-	-	-	-	1	3	2	
Avg	3	2	1									1	3	2	

REFERENCES

- "Nanotechnology: Principles and Practices" by Sulabha K. Kulkarni
- "Characterization of Nanomaterials" by Wolfgang Unger
- "Nano Manufacturing: Principles and Practices" by Anand Subramaniam
- Various journal articles and white papers on recent advancements in nano manufacturing and material characterization

ADDITIONAL RESOURCES

- Access to online databases and journals (ScienceDirect, IEEE Xplore)
- Industry visits and guest lectures from experts in nanotechnology and material characterization

PROFESSIONAL ELECTIVE COURSES

MF23001 INDUSTRIAL ROBOTICS and AUTOMATION L T P C

3 0 0 3

COURSE OBJECTIVES

- Familiarize students with robot components and their functions, including sensors and machine vision.
- Study the selection and design of end effectors for different robot applications.
- Provide knowledge in robot kinematics, dynamics, and basic robotic intelligence, considering economic analysis.

UNIT I FUNDAMENTALS OF ROBOT 9

Robot - Definition - Laws of Robot- Robot Anatomy –Manipulators, Coordinate Systems, Work Envelope, Types and Classification-Specifications - Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load - Robot Parts and their Functions - Need for Robots-Different Applications - Material Handling, Processing and Assembly

UNIT II END EFFECTOR 9

Robot Drive systems-End Effectors - Grippers - Mechanical Grippers, Pneumatic and Hydraulic - Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations-End effector commands -Design of end effector

UNIT III SENSORS AND ROBOT MACHINE VISION 9

Requirements of a sensor, Principles and Applications of various types of sensors - contact sensors - touch sensors, position & displacement sensors - potentiometers, encoders, LVDT, pneumatic sensors, force & torque sensors, wrist sensors, joint sensors, tactile array sensors, slip sensors for robot grippers, Proximity & Range sensors, optical sensors, Electro-optical imaging sensors – Advanced sensors for robot-Sensor commands-Robot Machine vision- Training of vision system-Case study

UNIT IV ROBOT KINEMATICS AND DYNAMICS 9

Forward Kinematics and Inverse Kinematics, Forward Kinematics and Reverse Kinematics of manipulators with Two, Three Degrees of Freedom (in 2 & 3 Dimension)- D-H Parameters Co-ordinate reference frame, Velocity and Forces - Manipulator Dynamics, Trajectory Generator, Manipulator Mechanism Design - Derivations and problems.

UNIT V MANUFACTURING AUTOMATION 9

Automation in production systems, principles and strategies, Product/production relationships, Production concepts and mathematical models, manufacturing economics. Automated systems – elements, functions, levels, Continuous Vs discrete control, Computer process control,

Programmable logic controllers – ladder logic diagrams. Automated guided vehicle systems, AS/RS, Carousel storage, Automatic data capture - Bar code technology

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students should be able to:

CO1: Describe the basic concepts in a robotic system

CO2: Design an end effector considering the selection and design criteria

CO3: Recognize the use of sensors and machine vision for robots

CO4: Acquire knowledge on robot kinematic and dynamic system

CO5: Discuss the applications of robot intelligence

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	2	2	2	-	-	-	-	1	3	3	3
2	2	2	2	2	2	2	2	-	-	-	-	1	3	3	3
3	2	2	3	3	3	3	2	-	-	-	-	1	3	3	3
4	2	2	3	3	3	3	2	-	-	-	-	1	3	3	3
5	2	2	3	3	3	3	2	-	-	-	-	1	3	3	3
Avg	2.2	2.2	2.6	2.6	2.6	2.6	2					1	3	3	3

TEXT BOOKS:

1. King-Sun Fu , C.S.George Lee and Ralph Gonzalez , "Robotics Control, Sensing, Vision and Intelligence", International Edition, McGraw Hill., United States, 1987. ISBN-10: 0071004211
2. Groover M.P., "Industrial Robotics (SIE): Technology, Programming and Applications", 2nd edition, McGraw Hill., United States, 2012. ISBN: 9781259006210.
3. 3.Mikell P.Groover, Automation, "Production Systems and Computer Integrated Manufacturing" PHI, 2008.

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1. Abbeel P., "Machine Learning for Robotics".In: Flach P.A., De Bie T., Cristianini N. (eds) Machine Learning and Knowledge Discovery in Databases. ECML PKDD 2012, Lecture Notes in Computer Science, vol. 7523, Springer, Berlin, Heidelberg, 2012. ISBN: 978-3-642-33459-7, 978-3-642-33460-3.
2. Craig J.J., "Introduction to Robotics Mechanics and Control", 3rd Edition, Pearson Education, India, 2008, ISBN: 8131718360, 978-8131718360.
3. Deb S.R., "Robotics Technology and Flexible Automation", 4th Edition, Tata Mc Graw Hill Book Co., United States, 2009, ISBN: 9788120308428
4. Klafter R.D., Chmielewski T.A and Negin M., "Robotic Engineering - An Integrated Approach", Prentice Hall, United States, 2010. ISBN: 0134687523, 978-0134687520.
5. Koren Y., "Robotics for Engineers", Mc Graw Hill Book Co., United States, 1992

PR23C05 **MACHINE VISION**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students to

1. Understand the fundamental principles and concepts of machine vision technology.
2. Learn about various image acquisition techniques and their applications in machine vision systems.
3. Develop proficiency in image processing algorithms and techniques for image enhancement, segmentation, and feature extraction.
4. Gain knowledge of pattern recognition methods and classifiers used in machine vision.
5. Explore real-world applications of machine vision in different industries and understand the implementation challenges.

UNIT – I INTRODUCTION TO MACHINE VISION 9

Machine Vision use of machine vision – tasks for a vision system – relation to other fields – place of vision in CIM.

UNIT – II IMAGE ACQUISITION AND CONVERSION 9

Colour systems – light sources – lighting techniques – image formation by lensing – image scanning – television cameras – sensors, charge coupled devices – camera and system interface – frame buffers and frame grabbers – digital and smart cameras.

UNIT – III IMAGE PROCESSING DECISION MAKING 9

Processing of binary images – thresholding, geometrical properties, topological properties – processing of grey scale images, statistical operations, spatial operations, segmentation edge detection, morphological operations – image analysis – factors extraction – decision making.

UNIT – IV PATTERN RECOGNITION 9

Fundamentals – parametric classifiers – nonparametric, classifiers nearest neighbor CART, neural networks, generic classifiers.

UNIT – V MACHINE VISION APPLICATIONS 9

Applications in user industries automotive, semiconductor, electronic manufacturing, printing industries etc. – generic applications founding manufacturing metrology, inspection,assembly verification – application analysis and implementation.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to

1. Demonstrate a clear understanding of the principles and components of machine vision systems.
2. Acquire hands-on skills in image acquisition, conversion, and processing using appropriate software tools.
3. Apply image processing techniques to enhance, segment, and extract features from digital images.

4. Implement pattern recognition algorithms and classifiers for object detection and recognition tasks.
5. Analyze and evaluate the effectiveness of machine vision applications in various industries, considering factors such as accuracy, speed, and reliability.

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	-	-	-	-	-	-	-	-	1	-	1	2	-	1
CO2	2	-	-	-	-	-	-	-	-	1	-	1	2	-	1
CO3	3	1	-	1	1	-	-	-	-	1	-	1	2	-	1
CO4	3	1	-	1	-	-	-	-	-	1	-	1	2	-	1
CO5	2	-	-	-	-	-	-	-	-	1	-	1	2	-	2
CO/PO & PSO Average	2.4	1.0	-	1.0	1.0	-	-	-	-	1.0	-	1.0	2.0	-	1.2
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1.Davies, E. R., “Computer and Machine Vision: Theory, Algorithms, Practicalities”, Elsevier Science, 2018.
2. Woods, R. E., Gonzalez, R. C, “Digital Image Processing”, Pearson, 2018.

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1.Carsten Steger, Markus Ulrich, and Christian Wiedemann, "Machine Vision Algorithms and Applications", Wiley, 2018.
2. Beyerer, J., Frese, C., Puente León, F., “Machine Vision: Automated Visual Inspection: Theory, Practice and Applications”, Springer, 2015.
3. Waszkewitz, P., Streicher-Abel, B., Demant, C., “Industrial Image Processing: Visual Quality Control in Manufacturing”, Springer, 2014.
4. Valliappa Lakshmanan, Martin Görner, Ryan Gillard, "Practical Machine Learning for Computer Vision", O'Reilly Media, 2021
5. Joseph Howse, Joe Minichino, "Learning OpenCV 4 Computer Vision with Python 3", Packt Publishing Ltd, 2020.

MF23002 **DRIVES AND ACTUATORS** **L T P C**

3 0 0 3

COURSE OBJECTIVE

Provide students with a comprehensive understanding of drives and actuators used in manufacturing engineering, familiarize them with different types, principles of operation, and selection criteria, and develop their skills in designing, implementing, and controlling drives and actuators for diverse manufacturing applications.

UNIT I MECHANICAL ACTUATORS 9

Linear and rotary motion systems - Mechanical Actuators: Hydraulic and Pneumatic Systems - Actuator Types, Principles, and Control - Sensors for Actuator Control and Feedback - Transmission Systems in Drives and Actuators - Gears, Belts, Chains, and Couplings - Mechanical Power Transmission Calculations

UNIT II ELECTRICAL ACTUATORS 9

Principles of Electromechanical Systems - Electrical Motors and Motor Control - DC Motors: Principles, Characteristics, and Control and speed regulation - AC Motors: Induction Motors, Synchronous Motors, and Control and speed regulation Techniques - BLDC Principles, Characteristics, and Control - H Bridge Circuits - Stepper Motors: Principles, Types, and Control - Servo Motors: Principles, Types, and Control - Selection and sizing of electric motors for specific applications - Linear Electrical Motors

UNIT III DRIVES AND CONTROLLERS 9

Study of Switching Devices – Relay and Types, Switching characteristics -BJT, SCR, TRIAC, GTO, MOSFET, IGBT and IGCT-: SCR, MOSFET and IGBT - Triggering and commutation circuit - Control Systems for Drives and Actuators - Closed-loop control: feedback and feedforward control techniques - P, I, D, PI, PD, and PID control Controllers

UNIT IV MONITORING AND MAINTENANCE OF ACTUATORS 9

Control Interfaces and Communication Protocols - Human-Machine Interfaces (HMIs) - Industrial Networking and Fieldbus Systems - Fault Diagnosis and Maintenance of Drives and Actuators - Condition Monitoring and Failure Analysis - Troubleshooting Techniques and Maintenance Strategies

UNIT V EMERGING TRENDS IN DRIVES AND ACTUATORS 9

Piezoelectric Actuators - Shape Memory Alloy (SMA) Actuators - Electroactive Polymer (EAP) Actuator - Magnetic Actuators – Magnetostrictive Actuator - Energy Efficiency in Drives and Actuators - Energy Conservation Techniques and Strategies - Power Factor Correction and Energy Management - Industry 4.0 and Smart Manufacturing Applications - Factors influencing drive and actuator selection - Design considerations and specifications for different applications - Case studies and real-world examples of drives and actuators in manufacturing.

TOTAL: 45 PERIODS

COURSE OUTCOME

Upon completing of the course students will be able to:

CO1: Understand the principles, types, and control techniques of mechanical actuators, including hydraulic and pneumatic systems, and apply them to design and control linear and rotary motion systems.

CO2: Gain knowledge of electrical actuators, including DC motors, AC motors, stepper motors, and servo motors, and develop the ability to select and size electric motors for specific applications.

CO3: Apply the principles of power electronics and control systems to analyze and design circuits for switching devices, control systems, and closed-loop control techniques for drives and actuators.

CO4: Develop skills in the monitoring, maintenance, and fault diagnosis of drives and actuators by learning about control interfaces, communication protocols, condition monitoring, failure analysis, and troubleshooting techniques.

CO5: Explore emerging trends in drives and actuators and their applications in manufacturing.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	-	-	-	-	-	-	-	-	-	-	2	1	1	2
2	3	-	-	-	-	-	-	-	-	-	-	2	1	1	1
3	3	-	1	-	-		-	-	-	-	-	2	2	2	2
4	3	-	1	-	-	1	-	-	-	-	-	2	2	2	2
5	3	-	1	-	-	2	1	-	-	-	-	2	2	3	3
Avg	3		1			1.5	1					2	1.6	1.8	2

TEXT BOOKS:

1. Godfrey Onwubolu, "Mechatronics Principles and Applications", 1st Edition,Butterworth-Heinemann, 2005. ISBN: 9780750663793
2. Bimbhra B.S., "Power Electronics", 6th Edition, Kanna Publishers, New Delhi, 2018.
3. Mehta V.K. & Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S. Chand& Co. Ltd., New Delhi, 2016.

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1. Gopal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House, New Delhi, 2005.
2. Theraja B.L. & Theraja A.K., "A Text Book of Electrical Technology", 2nd Edition, S.Chand & Co. Ltd., New Delhi, 2012.
3. Singh M.D. & Kanchandhani K.B., "Power Electronics", McGraw Hill, New Delhi, 2011.
4. Bimal K.Bose. Modern Power Electronics and AC Drives, Pearson Education, 2015.
5. R. Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Pearson, 2001.

MF23003 **SENSORS FOR CONDITION MONITORING AND INTELLIGENT SYSTEMS** **L T P C**

3 0 0 3

COURSE OBJECTIVE:

To gain a thorough understanding of sensors and their role in monitoring manufacturing systems, learn about different sensor technologies used and their practical applications in condition monitoring, and explore signal processing techniques to extract valuable information from sensor data.

UNIT I SENSORS FOR CONDITION MONITORING **9**

Basics of sensors and their role in condition monitoring - Principles and working of commonly used sensors: Vibration sensors and analysis techniques, Temperature sensors and thermal monitoring, Pressure sensors and monitoring systems, Flow sensors for fluid condition monitoring, Proximity and displacement sensors, Optical and imaging sensors for condition monitoring - Introduction to condition monitoring techniques and their importance in manufacturing systems

UNIT II SIGNAL PROCESSING AND ANALYSIS TECHNIQUES **9**

Preprocessing techniques for sensor data - Feature extraction and selection methods - Statistical analysis and pattern recognition - Machine learning techniques for condition monitoring - Data fusion - Software tools for sensor data analysis

UNIT III SENSOR DATA ACQUISITION **9**

Data acquisition and transmission techniques - Integration of wireless sensor networks for intelligent condition monitoring systems - Sensor networks and wireless communication in condition monitoring

UNIT IV INTELLIGENT SYSTEMS **9**

Introduction to intelligent systems in condition monitoring - Predictive maintenance strategies and methodologies -Fault diagnosis and prognosis using sensor data - Real-time monitoring and control systems - Case studies and applications of intelligent condition monitoring systems

UNIT V APPLICATIONS OF CONDITION MONITORING **9**

Sensor selection, installation, and troubleshooting - Sensor reliability and maintenance considerations - Implementation of sensors in specific manufacturing processes - Case studies and examples of sensor-based condition monitoring in manufacturing industries

TOTAL: 45 PERIODS

COURSE OUTCOME:

At the end of the course,

CO1: Describe the principles and working of sensors used in condition monitoring and Identify suitable sensor technologies for different types of condition monitoring in manufacturing systems.

CO2: Apply signal processing and analysis techniques to extract useful information from sensor

data.

CO3: Design and develop intelligent systems for condition monitoring using sensor data.

CO4: Analyze and interpret sensor data to diagnose and predict the condition of manufacturing systems.

CO5: Demonstrate effective problem-solving skills in real-world applications of sensors for condition monitoring.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	-	-	-	-	-	-	-	1	2	3
2	3	3	3	1	2	-	-	-	-	-	-	-	1	2	3
3	3	1	2	1	2	-	-	-	-	-	-	-	1	2	3
4	3	3	3	3	3	-	-	-	-	-	-	-	1	2	3
5	3	3	3	3	3	-	-	-	-	-	-	-	1	2	3
Avg	3	2.4	2.4	1.8	2.2								1	2	3

TEXT BOOKS

1. Tönshoff H.K. and Inasaki I., "Sensors in Manufacturing: Sensors Applications- Volume1", Wiley-VCH Verlag GmbH, Weinheim, 2001, ISBN (13) :9783527295586
2. Wang L. and Gao, R.X., "Condition Monitoring and Control for Intelligent Manufacturing", Springer-Verlog London Limited, United Kingdom,2006, ISBN (13): 978-1-84628-268-3.

REFERENCE BOOKS

1. Considine D.M. and Glenn D., "Standard Handbook of Industrial Automation: Advanced Industrial Technology", Chapman and Hall, New York, 1987, ISBN (13): 978-0-412-00831-3.
2. Mohanty A. R., "Machinery Condition Monitoring: Principles and Practices", CRC Press, U.S.A, 2017, ISBN (13): 9781138748255.
3. Sinclair I.,"Sensors and Transducers",Elsevier, Newnes, Reprint2012,ISBN: 9780750649322.
4. Fatos Xhafa, Fang-Yie Leu, Li-Ling Hung (2017). Smart Sensors Networks: Communication Technologies and Intelligent Applications,Academic Press, ISBN: 9780128098592
5. Sami S.H and Kisheen Rao G, "The Internet of Mechanical Things: The IoT Framework for Mechanical Engineers", CRC Press, 2022.

MF23004 FLEXIBLE MANUFACTURING SYSTEMS L T P C

3 0 0 3

COURSE OBJECTIVES:

- To introduce the concepts application of computer control in simulation, with proper data base technologies computer control of hardware's in controlling of Manufacturing Systems elements.
- To familiarize the principles of group technology and Just in Time concept in the implementation of FMS and Factories of Future.

UNIT I INTRODUCTION AND FMS COMPONENTS 9

Manufacturing system types and principles- Components & classifications, Automation in manufacturing systems, principles and strategies-Flexible Manufacturing Systems (FMS)- system components-Types of FMS-FMS Layouts-FMC and FMS- - Programmable Logic Controllers - Cell Controllers - Communication Networks- JIT and KANBAN System-FMS planning and Scheduling-Single product, Single batch, n-product, n-batch Scheduling Problem

UNIT II FMS SOFTWARE STRUCTURE, FUNCTIONS AND DESCRIPTION 9

Introduction-General Structure and Requirements-Advantages of Modular Software Design and Development-Activities and Functions to be Performed-FMS Software-Requirements of FMS Software-Types of FMS Software Modules- Software Specification and Selection- General Phases of Simulation Analysis-Reasons to Integrate FMS Computer System to a Central Host Computers-Functions of an FMS Host Computer-The Major FMS Host Functions-FMS Master Host Tasks-Subordinate FMS Host Tasks-Area Controller Host Tasks - Manufacturing Data Systems - Data Flow - FMS Database Systems - Planning for FMS Database.

UNIT III AUTOMATED MATERIAL MOVEMENT AND STORAGE SYSTEM 9

Introduction - Types of AGVS --Analysis of AGV Systems- Automated Storage and Retrieval Systems (AS/RS) - Advanced Automated Storage and Retrieval System-Analysis of AS/RS-Quantitative Analysis--Industrial Robots- Applications of Industrial Robots

UNIT IV GROUP TECHNOLOGY AND JIT 9

Definition-Reasons for Adopting Group Technology- Visual Inspection- Part Classification and Coding-Production Flow Analysis-Benefits of Group Technology- Obstacles to Application of GT-Definition-JIT Concept-Goals of JIT- Objectives-Ingredients of JIT-Quality and Quantity Principles-The Primary Quantity JIT Principles- Benefits of JIT -JIT Implementation- Kanban/Card System-Push vs. Pull System -Types of Kanban

UNIT V FMS INSTALLATION, IMPLEMENTATION AND FUTURE 9

FMS Installation - FMS Implementation- Economic Justification of FMS - Application of Possibility Distributions in FMS Systems -Justification. Acceptance Testing-Case Studies-- Factories of the Future - Artificial Intelligence and Expert Systems in FMS

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Be familiarized with concepts of Flexible Manufacturing Systems and its components
CO2: Perceive Computer Control, Software for Flexible Manufacturing Systems and be acquainted with Flexible Manufacturing System Simulation using Database
CO3: Be familiarised with AS and RS systems and selection of robot for the requirements
CO4: Evaluate principles of Group Technology and justify Flexible Manufacturing Systems
CO5: Describe various flexible manufacturing systems and their applications.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		3	3	3		2				1	2	3	3	3	3
2		3	3	3		2				1	2	3	3	3	3
3		3	3	3		2				1	2	3	3	3	3
4		3	3	3		2				1	2	3	3	3	3
5		3	3	3		2				1	2	3	3	3	3
Avg		3	3	3		2				1	2	3	3	3	3

TEXT BOOK

1. Jha.N.K., "Handbook of flexible manufacturing systems", Academic Press Inc., United States of America, 2012, ISBN-13: 978-03-231-3935-9.
2. Shivanand H.K., Benal MM, Koti V, "Flexible Manufacturing System", Second Edition, New age international (P) Limited, New Delhi, 2021

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1. Groover M.P., "Automation, production systems and computer integrated manufacturing", Prentice Hall of India Pvt., New Delhi, 2016, ISBN-13: 978-93-325-7249-
2. Kalpakjian S., "Manufacturing Engineering and Technology", Addison-Wesley Publishing Co., United States of America, 2013, ISBN-13: 978-01-331-2874-1.
3. Ohno T., "Toyota production system: Beyond large-scale production", Productivity Press (India) Pvt. Ltd., 1992, ISBN-13: 978-09-152-9914-0.
4. Radhakrishnan P. and Subramanyan S., "CAD/CAM/CIM", Wiley Eastern Ltd., New Age International Ltd., India, 2009, ISBN-13: 978-81-224-2236-8.
5. Raouf A. and Daya B.M., "Flexible manufacturing systems: recent development", Elsevier Science, Netherlands, 2005, ISBN-13 978-04-448-9798-5.
6. S.R.Deb, "Robotics Technology and Flexible Automation", McGraw Hill Education (India) Private Limited, 2010, ISBN: 9780070077911.

ME23C16	DRONE TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

To understand the basics of drone concepts, fundamentals of design, fabrication and programming of drone

UNIT – I INTRODUCTION TO DRONE TECHNOLOGY 9

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

UNIT – II DRONE DESIGN, FABRICATION AND PROGRAMMING 9

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program -Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

UNIT – III DRONE FLYING AND OPERATION 9

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone Controls Flight operations –management tool –Sensors-Onboard storage capacity - Removable storage devices- Linked mobile devices and applications

UNIT – IV DRONE COMMERCIAL APPLICATIONS 9

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

UNIT – V FUTURE DRONES AND SAFETY 9

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:
CO1: Know about a various type of drone technology, drone fabrication and programming.
CO2: Execute the suitable operating procedures for functioning a drone
CO3: Select appropriate sensors and actuators for Drones
CO4: Develop a drone mechanism for specific applications
CO5: Create the programs for various drones

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

TEXTBOOKS:

1. Daniel Tal and John Altschuld, “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, 2021 John Wiley & Sons, Inc.
2. Terry Kilby and Belinda Kilby, “Make:Getting Started with Drones “,Maker Media, Inc, 2016

REFERENCES

1. John Baichtal, “Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs”, Que Publishing, 2016
2. Zavrsnik, “Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance”, Springer, 2018.

IE23C06 **OPERATIONS RESEARCH** **L T P C**
3 0 0 3

COURSEOBJECTIVES:

1. To provide knowledge of optimization techniques and approaches.
2. To enable students to formulate real-world problems as mathematical programming models
3. To develop students' mathematical, computational, and communication skills required for the practical application of Operations Research
4. To educate students on solving networking problems
5. To impart knowledge on Project Management.
6. To gain knowledge and skills in solving decision-making and game theory models

UNIT I LINEAR PROGRAMMING 9

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method. Solutions to LPP using simplex algorithm – Two phase method – Big M method

UNIT II ADVANCES IN LINEAR PROGRAMMING 9

Revised simplex method - primal dual relationships – Dual simplex algorithm – Sensitivity analysis – changes in RHS value – changes in Coefficient of constraint – Adding new constraint – Adding new variable.

UNIT III NETWORK ANALYSIS I 9

Transportation problems: Northwest corner rule, least cost method, Vogel’s approximation method - stepping stone method - MODI method – Unbalanced transportation – Assignment problem – Hungarian algorithm. TSP- Solving using Hungarian Algorithm- Applications of TSP to other engineering problems

UNIT IV NETWORK ANALYSIS II 9

Project Management CPM & PERT. Minimum spanning tree problem, shortest path problem, Maximal flow problem-Maximal-flow minimum cut theorem - Maximal flow algorithm

UNIT V DECISION THEORY AND GAME THEORY 9

Decision Theory- Decision under certainty-Decision under Risk-Decision under uncertainty – Decision Tree- Game theory – Two-person zero sum games – Graphical solution Algebraic solution – Linear Programming solution

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Convert an abstract real-world problem to an optimization model.

CO2. Perform sensitivity analysis for an optimization problem

CO3. Build and solve Transportation Models, Assignment Models and TSP models

CO4. Handle issues in Project Management and other network problems.

CO5. Make decision under risk and uncertainty

CO's - PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	-	1	2	-	-	-	-	-	3	1	3	1	2
2	3	3	3	2	2	-	-	-	-	-	3	1	3	1	2
3	3	3	3	3	2	-	-	-	-	-	3	1	3	1	2
4	3	3	3	2	2	-	--	-	-	-	3	1	3	1	2
5	3	3	3	2	2	-	-	-	-	-	3	1	3	1	2
Avg.	3	2.8	3	2	2	-	-	-	-	-	3	1	3	1	2

TEXTBOOKS:

1. Panneerselvam R, "Operations Research", PHI, 2009
2. Srinivasan G., "Operations Research Principles and Applications", PHI, 2017

REFERENCES:

1. Hamdy A Taha, "Operations Research – An Introduction", Pearson, 2017.
2. Philips, Ravindran and Solberg, "Operations Research principle and practise", John Wiley, 2007.
3. Ronald L Rardin, "Optimisation in Operations Research", Pearson, 2018.

MF23C04 **TOTAL PRODUCTIVE MAINTENANCE** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

- To familiarize students with the major concepts on maintenance concepts followed in industries
- To introduce the models , tools and techniques used in TPM

UNIT I MAINTENANCE CONCEPTS **9**

Introduction - History of TPM - The TPM Paradigm Shift -TPM pillars -Objectives and functions – Productivity, Quality, Reliability and Maintainability (PQRM) - Terotechnology - Reliability Centered Maintenance - Predictive Maintenance - Condition Based Maintenance - maintainability prediction - availability and system effectiveness-maintenance costs - maintenance organization- Benefits of TPM- TPM and Lean- TPM and Six Sigma

UNIT II MAINTENANCE MODELS **9**

Minimal repair - As Good As New policy - maintenance types -Autonomous Maintenance- Breakdown Maintenance- -Planned Maintenance-Upstream Maintenance- steps to maintenance excellence. - PM schedules: deviations on both sides of target values - PM schedules: functional characteristics - replacement models.

UNIT III TOTAL PRODUCTIVE MAINTENANCE **9**

Zero breakdowns - Zero Defects and TPM - maximizing equipment effectiveness – Autonomous maintenance program - Steps to autonomous maintenance-- - Establishment of basic policies and goals - Formation of master plan - TPM implementation- Difficulty in implementation of TPM. Online Monitoring -Condition monitoring - Infrared Thermography, Oil Analysis, acoustic emissions testing, Motor Current Analysis, Vibration Measurement and Analysis, Wear Debris Monitoring, Visual checks - corrosion control - Maintenance Management Information System - Expert system applications.

UNIT IV MAINTENANCE LOGISTICS **9**

Management Decision -The new role for the maintenance department- TPM organization -Creation of Organizations -TPM is a team effort- - TPM small group activities - maintenance staffing methods - Roles and Responsibilities in TPM-The Operators role-The Specialists role-Improvement teams role TPM Education & Training-GEMBA Workshops-Key indicators-Strive workshop and “7S” Initiatives One-Point lessons - -Pre-TPM checklist- maintenance manuals- queuing applications - simulation - Tools management - spare parts management - maintenance planning and scheduling.

UNIT V MEASURING TPM EFFECTIVENESS **9**

Definition of losses-Causes of losses-6 Big losses of TPM-Basic quality management tools from TPM-Zero Accident-Definition of zero accidents-Steps in zero accidents-- - The philosophy of setting goals-Types of indicators-Evaluating TPM-Overall Equipment efficiency- Definitions of AR, QR, PR & OEE - OEE Factors-The Role of OEE in Total Productive Maintenance-Calculation of OEE- Improvement in OEE-Direct & Indirect benefits of TPM.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Differentiate maintenance methods employed in industries

CO2: Recognize various models used in maintenance

CO3: Gain knowledge on TPM, inspection and monitoring methods used.

CO4: Able to do maintenance management

CO5: Calculate OEE, understand losses, able to set goal for productivity.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		3	3	3	3	1	3	3	3		3	3	3	3	3
2		3	3	3	3	1	3	3	3		3	3	3	3	3
3	1	3	3	3	3	1	3	3	3		3	3	3	3	3
4		3	3	3	3	3	3	3	3		3	3	3	3	3
5	1	3	3	3	3	1	3	3	3		3	3	3	3	3
Avg	1	3	3	3	3	1	3	3	3		3	3	3	3	3

TEXT BOOKS:

1. Nakajima S., "Introduction to TPM", Productivity Press, Chennai, 1992.
2. Srivastava S.K., "Maintenance Engineering (Principle, Practices & Management)", S. Chand Group, 2011.
3. Tina Kanti Agustiady Elizabeth A. Cudney, "Total Productive Maintenance Strategies and Implementation Guide", CRC Press,2016 ISBN:13: 978-1-4822-5540-9

REFERENCES:

1. Goto F.,"Equipment planning for TPM Maintenance Prevention Design", Productivity Press., United States,1992.
2. Kelly A., "Maintenance planning and control", Butterworths, London, 1991.
3. Shirose K., "Total Productive Maintenance for Workshop Leaders", Productivity Press., United States.
4. Shirose K., "TPM for Operators", Productivity Press, United States, 1996.
5. Suzuki T., "New Directions for TPM", Productivity Press, United States,1992
6. Wireman T., "Total Productive Maintenance", Industrial Press Inc., New york, 2004.

IE23C07 **TOTAL QUALITY MANAGEMENT** **L T P C**
3 0 0 3

COURSE OBJECTIVES:
Understand and apply the basic principles and tools of quality management in work.

UNIT I INTRODUCTION TO TQM **9**
Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality – Definition of TQM - Basic concepts of TQM - Gurus of TQM (Brief introduction) -- TQM Framework - Barriers to TQM – Benefits of TQM.

UNIT II TQM PRINCIPLES **9**
Leadership - Deming Philosophy, Quality Council, Quality statements and Strategic planning Customer Satisfaction – Service Quality - Kano Model and Customer retention Employee involvement – Motivation, Empowerment, Teamwork, Recognition and Reward - Performance Appraisal Continuous process improvement – Juran Trilogy - PDSA cycle - 5S - Kaizen.

UNIT III TQM TOOLS & TECHNIQUES I **9**
The seven traditional tools of quality - new management tools - Six-sigma - Process Capability

Bench marking - Reasons to benchmark, benchmarking process, understanding current performance, Planning, studying others, Learning from the data, Using the findings, Pitfalls and Criticisms of benchmarking FMEA - Design FMEA and Process FMEA – Steps in performing FMEA

UNIT IV TQM TOOLS & TECHNIQUES II **9**
Quality circles – Quality function deployment (QFD) - Total Productive Maintenance – Concepts, improvement needs – Performance measures Cost of Quality – Taguchi quality loss function Business Process Re-engineering

UNIT V QUALITY MANAGEMENT SYSTEM **9**
Introduction - Benefits of ISO Registration - ISO 9000 Series of Standards – ISO 9001 Requirements implementation – Documentation - Internal Audits – Registration Environmental Management System: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001 - Benefits of EMS.
Supplier partnership – Partnering, Supplier selection, Supplier Rating and Relationship development.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:
CO1: Explain the evolution of Quality Management and its impact on organizations.
CO2: Apply TQM concepts and principles in an enterprise.
CO3: Understand and apply TQM tools and techniques in each situation.
CO4: Understand how to operationalise the concept of quality using QFD and TPM.
CO5: Understand the challenges and benefits of applying QMS and EMS in an organization.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	-	3	-	-	-	-	-	-	-	-	-	3	2	-	3
2	-	-		-	-	3	-	-	-	-	-	3	-	2	-
3	-	-		-	3	-	-	-	3	-	-	-	-	2	3
4	-	2		-	3	2	**2**	3	-	-	-	3	3	2	-
5	-	**-**	**3**	-	**-**	--	3	3	-	-	-	-	-	-	-
Avg	-	**2.5**	**3**	-	**3**	-	**2.6**	3	3	-	-	3	2.5	2	3

REFERENCES:

1. Joel. E. Ross, *Total Quality Management – Text and Cases*, Routledge, 2017
2. Dale H. Besterfiled, Carol B. Michna, Glen H. Besterfield, Mary B. Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, *Total Quality Management*, Pearson Education Asia, Revised 3rd Edition, Indian Reprint, 2013.
3. Kiran. D. R, *Total Quality Management: Key concepts and case studies*, Butterworth – Heinemann Ltd, 2016.
4. Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, Third Edition, 2003.
5. Suganthi,L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.

IE23C10	SUPPLY CHAIN ANALYTICS	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To expose about the role of analytics in supply chain network design
2. To apply the analytical tools in supplier selection, transportation and warehousing
3. To demonstrate the application of analytics in inventory
4. To evaluate the performance improvement strategies in supply chain
5. To understand the application of analytics in coordination and risk assessment in supply chain

UNIT I INTRODUCTION TO ANALYTICS IN SUPPLY NETWORKS 9

Introduction to Supply Network, Performance Measures for Efficiency and Effectiveness, SCOR model, Strategic Fit and Scope, Types of Distribution Networks, Analytics in Management, Design of Distribution Networks.

UNIT II SUPPLIER SELECTION, TRANSPORTATION AND WAREHOUSE ANALYTICS 9

Linear Programming, Rating method, Ranking method, Borda Count, Clustering, Goal Programming and related multi-criterion decision making (MCDM) techniques. Transportation models, Route planning, Transshipment, Shipment schedule, Flow path optimization, Warehouse location problem, MILP formulation, Location with foreign exchange risks, space calculation for warehouse, Non-linear optimization for warehouse space allocation.

UNIT III INVENTORY ANALYTICS 9

Elementary Concepts related to Inventory Management, Economic Order Quantity (Instantaneous Replenishment), Inventory Management under Uncertainty – Concept of Safety Stock, Continuous Review System, Periodic Review System. Newsvendor Model, Performance Measures: Expected Lost Sales, Expected Sales, Expected Leftover Inventory, Expected Profit, Fill Rate, In-Stock Probability, and Stock-Out Probability Choosing an Order-up-to Level to Meet a Target Service Level, In-Stock Probability, and Desired Fill-Rate. Assemble-to-Order, Make-to-Order and Quick Response with Reactive Capacity, Reducing Mismatch Costs with Make-To-Order

UNIT IV STRATEGIC PERFORMANCE IMPROVEMENT IN SUPPLY CHAIN 9

Data Envelopment Analysis for competitive comparisons among multiple warehouses and service units and formulation of strategic action plans for improving the efficiencies of non-performing DMUs, Stochastic Frontier Analysis.

UNIT V **MODELLING COORDINATION AND RISK ANALYTICS IN SUPPLY CHAIN NETWORK** **9**

Information Distortion in Supply Network and Bull-Whip Effect, Coordination and collaboration modelling in supply networks. Mapping the riskiness profile of a country, taxation, Mapping the riskiness profile of possible international routes and designing the route plan based on riskiness profile. Design and optimization of global supply chain networks, Multi-period supply chain network design

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Apprise about the role of analytics in supply chain network design

CO2. Investigate the supplier selection, transportation and warehousing issues using analytical tools

CO3. Perform the analytics in the inventory system

CO4. Examine the strategies for performance improvement in supply chain

CO5. Support to the decision making in coordination and risk in supply chain by using analytics

TEXT BOOK:

1. Liu, Kurt Y. 2022. Supply Chain Analytics: Concepts, Techniques and Applications. 1st ed. Cham, Switzerland: Springer Nature.
2. Peter W. Robertson, 2020, Supply Chain Analytics (Mastering Business Analytics) 1st Edition, Routledge

REFERENCES:

1. Supply Chain Management: Strategy & Analysis, Chopra, Meindl& Kalra, Pearson Education, Asia.
2. Supply Chain Management, Janat Shah, Pearson education, Asia
3. Designing & Managing the Supply Chain, Simchi-Levi, & Kaminsky, McGraw-Hill Publication.

CO's-PO's&PSO'sMAPPING

CO's	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	1	2	1	-	3	-	-	-	-	-	-	-	3	3
2	3	3	1	1	3	-	-	-	-	-	-	-	3	3
3	3	3	1	1	3	-	-	-	-	-	-	-	2	3
4	3	3	1	1	3	-	-	-	-	-	-	-	3	3
5	3	3	1	1	3	-	-	-	-	-	-	-	3	3
Avg.	3	3	1	1	3	-	-	-	-	-	-	-	3	3

IE23C01 **ENGINEERING QUALITY CONTROL** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

- To develop a clear knowledge in the basics of various quality concepts.
- To understand the student's application of control charts and their techniques.
- To develop the special control procedures for service and process-oriented industries.
- To analyse and understand the process capability study.
- To illustrate the acceptance sampling procedures for incoming raw material.

UNIT I QUALITY FUNDAMENTALS **9**

Importance of quality- evolution of quality- definitions of quality- dimensions of quality- quality control quality assurance- areas of quality- quality planning- quality objectives and policies- quality costs economics of quality- quality loss function-three cases and problems- quality Vs productivity- Quality Vs reliability- Quality Standards.

UNIT II CONTROL CHARTS FOR VARIABLES **9**

Process variation- preliminary decisions- control limits and their computation- construction and application of X bar, R and S charts- warning and modified control limits- process adjustment for trend - Comparison of process variation with specification limits- O.C. curve for X bar chart- individual measurement charts- X-chart, moving average and moving range chart, multi-vari chart.

UNIT III CONTROL CHARTS FOR ATTRIBUTES **9**

Limitations of variable control charts- Control charts for fraction non-conforming- p and np charts, variable sample size, operating characteristic function, run length- Control chart for nonconformities(defects)- c, u, ku charts, demerits control chart- applications.

UNIT IV STATISTICAL PROCESS CONTROL **9**

Process stability- process capability study using control charts- capability evaluation- Cp, Cpk and Cpm – capability analysis using histogram and normal probability plot- machine capability study gauge capability study- setting statistical tolerances for components and assemblies.

UNIT V ACCEPTANCE SAMPLING **9**

Need- economics of sampling- sampling procedure- single and double sampling- O.C. Curves- Average outgoing quality- Average sample number- Average total inspection- Multiple and sequential sampling- Standard sampling plans-Variable sampling plans- Military, Dodge-Roming, IS 2500.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Control the quality of processes using control charts for variables in manufacturing industries.

CO2: Control the occurrence of defective product and the defects in manufacturing companies.

CO3: Control the occurrence of defects in services.

CO4: Analyzing and understanding the process capability study.

CO5: Developing the acceptance sampling procedures for incoming raw material.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	1	1	1	1	1	2	2	1	1	2	1	2	2	2
2	2	3	1	2	1	1	2	1	2	2	3	2	2	2	2
3	2	2	3	3	3	2	2	2	2	2	3	2	2	2	2
4	2	3	3	2	2	2	2	2	1	2	2	2	1	1	1
5	3	2	3	3	2	2	2	2	1	2	2	2	1	1	1
Avg	2	2.2	2	2.2	1.8	1.6	2	1.8	1.4	1.8	2.4	1.8	1.6	1.6	1.6

TEXT BOOK:

1. Douglus C. Montgomery, "Introduction to Statistical Quality Control", Wiley-India, Eighth Edition, 2019.
2. Krishnaiah K.," Applied Statistical Quality Control and Improvement", PHI, 2014.

REFERENCES:

1. AmitavaMitra, "Fundamentals of Quality Control and Improvement", Wiley, Fourth Edition, 2015.
2. Dale H. Besterfield, Quality Control, Pearson Education Asia, 10th Edition, 2018.
3. Eugene L. Grant and Richard S. Leaven Worth, "Statistical Quality Control", McGraw-Hill Education, Seventh Edition, 2000.

IE23C02 **FUNDAMENTALS OF LEAN SIX SIGMA** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

- To know the basics of Lean and Six Sigma.
- To analyse the process of integrating Lean and Six sigma
- To identify and select the resources required for LSS Projects and selection of projects including Team building.
- To infer the DMAIC process and study the various tools for undertaking LSS projects.
- To relate how to institutionalize the LSS efforts.

UNIT I INTRODUCTION TO LEAN AND SIX SIGMA 9

Introduction to Lean- Definition, Purpose, Features of Lean ; Top seven wastes, Need for Lean management, The philosophy of lean management, Creating a lean enterprise, Elements of Lean, Lean principles, the lean metric, Hidden time traps. Introduction to quality, Definition of six sigma, origin of six sigma, Six sigma concept and Critical success factors for six sigma; Case analysis.

UNIT II INTEGRATION OF LEAN AND SIX SIGMA 9

Evolution of lean six sigma, the synergy of Lean and six sigma, Definition of lean six sigma, the principles of lean six sigma, Scope for lean six sigma, Features of lean six sigma. The laws of lean six sigma, Key elements of LSS, the LSS model and the benefits of lean six sigma. Initiation - Top management commitment – Infrastructure and deployment planning, Process focus, organizational structures, Measures – Rewards and recognition, Infrastructure tools, structure of transforming event and Launch preparation; Case study presentations.

UNIT III PROJECT SELECTION AND TEAM BUILDING 9

Resource and project selection, Selection of Black belts, Training of Black belts and Champions, Identification of potential projects, top down (Balanced score card) and Bottom up approach – Methods of selecting projects – Benefit/Effort graph, Process mapping, value stream mapping, Predicting and improving team performance, Nine team roles and Team leadership; Case study presentations.

UNIT IV THE DMAIC PROCESS AND TOOLS 9

The DMAIC process – Toll gate reviews; The DMAIC tools; Define tools – Project definition form, SIPOC diagram; Measure tools – Process mapping, Lead time/cycle time, Pareto chart, Cause and Effect matrix, FMEA; Idea – generating and organizing tools – Brainstorming, Nominal group technique, Multi-voting and Cause and effect diagram, Data collection and accuracy tools- Check sheet, Gauge R&R; Understanding and eliminating variation- run charts, control charts and process capability analysis; Analyze tools - Scatter plots, ANOVA, Regression analysis, Time trap analysis; Improve tools – Mistake proofing, Kaizen, set up time reduction (SMED), TPM, DOE and the pull system. Control tools – statistical process control.

UNIT V INSTITUTIONALIZING AND DESIGN FOR LSS 9

Institutionalizing lean six sigma – improving design velocity, creating cycle time base line, valuing projects, gating the projects, reducing product line complexity, Design for lean six sigma, QFD, Theory of Inventive Problem solving (TRIZ), Robust design; Case study presentations.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. understand what is Lean and Six sigma and their importance in the globalised competitive world.

CO2. Understand the importance of integrating Lean and Six sigma and also the process of their integration.

CO3. Plan the Resources required to undertake the LSS projects and also acquire how to select the suitable projects and the teams.

CO4. Apply DMAIC methodology to execute LSS projects and in this regard they will be acquainted with various LSS tools

CO5. Understand the process of institutionalizing the LSS effort and also understand the Design for LSS.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3	3	1	1	-	-	-	-	2	2	2	2
2	3	3	3	3	3	2	2	-	-	-	-	3	2	2	2
3	3	3	3	3	3	2	2	-	-	-	-	2	3	3	3
4	3	3	3	3	3	2	2	-	-	-	-	2	3	3	3
5	3	3	3	3	3	3	3	-	-	-	-	3	3	3	3
Avg	3	3	3	3	3	2	2	-	-	-	-	2.4	2.6	2.6	2.6

TEXT BOOK:

1. Michael L.George, David Rownalds, Bill Kastle, What is Lean Six Sigma, McGraw – Hill 2003
2. James P. Womack, Daniel T.Jones, Lean Thinking, Free Press Business, 2003

REFERENCES:

1. Thomas Pyzdek, The Six Sigma Handbook, McGraw-Hill,2000
2. Fred Soleimannejed , Six Sigma, Basic Steps and Implementation, AuthorHouse, 2004
3. Forrest W. Breyfogle, III, James M. Cupello, Becki Meadows, Managing Six Sigma:A Practical Guide to Understanding, Assessing, and Implementing the Strategy That Yields Bottom-Line Success, John Wiley & Sons, 2000

PR23C03 DESIGN OF JIGS, FIXTURES AND GUAGES

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students:

1. Use the fundamental ideas behind work holding and clamping systems.
2. Identify the locating techniques and guiding concepts followed in jigs and fixtures.
3. To understand the construction of various types of Jigs and Fixtures
4. Understand the uses of various jigs and fixtures
5. Design of gauges.

UNIT – I WORKHOLDING DEVICES 9

Introduction-Work holding Concepts –purpose and function -General considerations. Jigs and Fixtures– Advantages – Economy, cost, elements–materials- Fool Proofing – Locating and supporting principles, Degrees of freedom. Principle of location - Location methods - 3-2-1 principle - Concentric and Radial methods – Basic rules, position and number of locators, Redundant locators, Locational Tolerances. Various types of Locator - Spring stop buttons. Design of location systems for industrial applications.

UNIT – II PRINCIPLES OF CLAMPING 9

Clamping - Clamping principles – Tool forces, clamping forces, positioning clamps. Rigid Vs Elastic work holders. Various types of Clamps – Operations, Nomenclature. Lathe chucks – Solid Arbor's and Mandrels. Split collet and bushing work holders, axial location, self-actuating wedge cam and wedge roller work holders. Vises – Special jaws, independent jaws. Various types of Non-Mechanical Clamping. Washers - 'C' washer – spherical and flat washers. Design of clamping system for industrial applications.

UNIT – III TOOL GUIDING ELEMENTS AND PRINCIPLES OF JIG DESIGN 9

Tool Guiding Elements - jig bushings and liners – Selection, Bushing / liner installation, fits and tolerances, chip clearance, accuracy and life. Drill bush – types, materials and manufacture. Bushings and liners for polymers, castable and soft material tooling. Template bushings, Rotary bushings. Drill bushing tips and accessories - Bushing specifications. Introduction – Principles of Jig Design - General considerations – Machine considerations – Process considerations. Basic requirements of Drill jigs. Various types of drill jigs-Design of Jigs for industrial applications.

UNIT – IV PRINCIPLES OF FIXTURE DESIGN 9

Introduction – Principles of fixture design – element of fixtures - General Considerations, fixture cost, production capabilities, Production process, part considerations. Design consideration of locators and clamps for fixtures –various types of fixtures. Fixture characteristics - Standard fixture mounting, Relationship between fixture and cutting tool, Tool positioning, Relationship to locators, Cutter-setting devices, Fixture design for computer numerically controlled machine Tools. Design of fixtures system for industrial applications.

UNIT – V GAUGES 9

Introduction – limit gauges –Taylor's principle of limit gauging – Application of limit gauges – Gauging principles – Allocation of Gauge Tolerance – Bilateral system, Unilateral system, Gauge design - Design of various gauges, Gauge wear allowance, Gauge materials, Gauging policy.

Types of Gauges – Commercial Gauges – Screw pitch gauges, Plug gauges, Ring gauges, Snap gauges, Flush pin gauges – IS specifications for gauges.

TOTAL: 45 PERIODS

Note: (Use of standard Design Data Book is permitted in the University examination)

COURSE OUTCOMES

Upon successful completion of the course, students should be able to

1. Classify and explain the needs towards the requirements of Jigs and Fixtures for Manufacturing, Testing and Assembly.
2. Understand the design, material and manufacturing process for Jigs, Fixtures and Gauges.
3. Design and drafting of various Jigs and Fixtures using appropriate software package.
4. Thorough knowledge on the principles, construction and working principle of various Work holding devices and gauges
5. Analyze problems related to Jigs and fixtures in Manufacturing, Testing and Assembly

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	1	2	-	-	-	-	-	1	-	1	2	-	1
CO2	2	2	1	2	-	-	-	-	-	1	-	1	2	-	1
CO3	2	2	1	2	-	-	-	-	-	1	-	1	2	-	1
CO4	2	2	1	2	-	-	-	-	-	1	-	1	2	-	1
CO5	2	2	1	2	-	-	-	-	-	1	-	1	2	-	1
CO/PO & PSO Average	2.0	2.0	1.0	2.0	-	-	-	-	-	1.0	-	1.0	2.0	-	1.0
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. ASTME, Fundamentals of Tool Design, 6th Edition, 2010, SME Publication.
2. Cyril Donaldson, H. LeCain George, V. C. Goold and Joyjeet Ghose, Tool Design, 2017, Tata McGraw Hill.
3. Sharma. P.C, A Text Book of Production Engineering, 2013, S.Chand & Co.,
4. Joshi, P.H. “Jigs and Fixtures”, Third Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2017.
5. Edward G. Hoffman, “Jig and Fixture Design”, Delmar, Cengage Learning, Fifth Edition, 2004 ISBN-13:9781401811075.
6. PSG Design Data Handbook - Data Book of Engineers - by PSG College of Technology, Coimbtore - 2024.

REFERENCES

1. Venkataraman. K., “Design of Jigs Fixtures & Press Tools”, Tata McGraw Hill, New Delhi, 2005.
2. Design Data Hand Book, PSG College of Technology, Coimbatore.
3. Hoffman “Jigs and Fixture Design”, Thomson Delmar Learning, Singapore, 2004.

4. Kempster, “Jigs and Fixture Design”, Third Edition, Hoddes and Stoughton, 1974.
5. William E Boyes, “Jigs. & Fixtures & Gauge”, Michigan SME 1st Ed., 1986, ISBN: 0872633659.
6. Kempster M. H. A, “An Introduction to Jig and Tool Design”, Butterworth-Heinemann Ltd. 3rdEd.1974, ISBN-13: 9780340182215.

ME23C09 **FINITE ELEMENT ANALYSIS** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

The main learning objective of this course is to

Understand basic concepts of finite element methods, formulate models for 1D and 2D problems, and apply them to analyze solid mechanics and heat transfer scenarios.

UNIT I INTRODUCTION **9**

Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique

UNIT II ONE-DIMENSIONAL PROBLEMS **9**

Element types- Linear and higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors - Assembly of Matrices - Solution of problems from solid mechanics including thermal stresses-heat transfer. Natural frequencies of longitudinal vibration and mode shapes

UNIT III TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS **9**

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements and Quadrilateral elements- Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Torsion of Non circular shafts

UNIT IV TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS **9**

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Constitutive matrices and Strain displacement matrices – Stiffness matrix – Stress calculations - Plate and shell elements.

UNIT V ISOPARAMETRIC FORMULATION AND ADVANCED TOPICS **9**

Natural co-ordinate systems – Isoparametric elements – Shape functions for isoparametric elements – One and two dimensions – Serendipity elements – Numerical integration - Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software- Introduction to Non Linearity.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Develop mathematical models for Boundary Value Problems and their numerical solution
CO2: Apply concepts of Finite Element Analysis to solve one dimensional problems
CO3: Develop field variables for two dimensional scalar variable problems
CO4: Determine field variables for two dimensional vector variable problems
CO5: Apply the need for Isoparametric transformation and the use of numerical integration

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	2	2							1	3	3	3
2	3	3	3	2	2							1	3	3	3
3	3	3	3	2	2							1	3	3	3
4	3	3	3	2	2							1	3	3	3
5	3	3	3	2	2							1	3	3	3
Avg	3	3	3	2	2							1	3	3	3

TEXT BOOKS:

1. Rao, S.S., "The Finite Element Method in Engineering", 6th Edition, ButterworthHeinemann, 2018.
2. Reddy,J.N. "Introduction to the Finite Element Method", 4thEdition, McGrawHill, 2018.

REFERENCES:

1. Hutton, "Fundamentals of Finite Element Analysis", McGrawHill, 2005
2. Dhanaraj. R and Prabhakaran Nair. K, "Finite Element Analysis", Oxford Publications, 2015.
3. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, "Concepts and Applications of Finite Element Analysis", 4th Edition, Wiley Student Edition, 2004.
4. Seshu.P, "Text Book of Finite Element Analysis", PHI Learning Pvt. Ltd., NewDelhi, 2012.
5. Tirupathi R. Chandrupatla and Ashok D. Belegundu, "Introduction to Finite Elements in Engineering", International Edition, Pearson Education Limited, 2014

MF23005 **DESIGN FOR MANUFACTURING** **L T P C**

3 0 0 3

COURSE OBJECTIVE

To Apply economic process selection and general design principles for manufacturability in the design and development of engineering products, and incorporate assembly constraints during their design and development phase.

UNIT I DFM PRINCIPLES AND DESIGN FOR CASTING 9

Introduction - Economics of process selection - General design principles for manufacturability; Design considerations for: Sand cast –Pattern, mould, and parting line. Cored holes and machined holes. Identifying the possible and probable parting lines. Castings requiring special sand cores. Designing to obviates and cores- Case Studies- Die cast – Permanent mold castparts- Case Studies

UNIT II DESIGN FOR FORMING 9

Forging considerations -requirements and rules-redesign of components for forging and case studies. Design of components for powder metallurgy- requirements and rules-case studies. Design of components for injection moulding- requirements and rules-case studies. Design considerations for: Metal extruded parts – requirements and rules-case studies -Impact/Cold extruded parts – requirements and rules-case studies Stamped parts requirements and rules-case studies

UNIT III DESIGN FOR WELDING 9

Arc welding – Design considerations for: Cost reduction – Minimizing distortion – Weld strength – Weldment & heat treatment. Resistance welding – Design considerations for: Spot – Seam – Projection – Flash & Upset weldment-case studies.

UNIT IV DESIGN FOR MACHINING 9

Design considerations for: Turned parts – Drilled parts – Milled, planed, shaped and slotted parts– Ground parts. –Case Studies

UNIT V DESIGN FOR ASSEMBLY 9

Design of Manual Assembly: Design for assembly fits in the design process, general design guidelines for manual assembly, development of the systematic DFA methodology, assembly efficiency, classification system for manual handling, classification system for manual insertion and fastening, effect of part symmetry on handling time, effect of part thickness and size on handling time, effect of weight on handling time, parts requiring two hands for manipulation, effects of combinations of factors, effect of symmetry effect of chamfer design on insertion operations, estimation of insertion time. Design considerations for: Rivets – Screw fasteners – Gasket & Seals – Press fits – Snap fits – Automatic assembly.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Apply economic process selection principles and general design principles for manufacturability in the development and design of products for various engineering applications. Also, apply design consideration principles of casting in the design of cast products.
CO2: Apply design consideration principles of forming in the design of extruded, stamped, and forged products.
CO3: Apply design consideration principles of welding in the design of welded products.
CO4: Apply design consideration principles of machining in the design of turned, drilled, milled, planed, shaped, slotted, and ground products.
CO5: Apply design consideration principles of assembly in the design of assembled products

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3	3	2	3				3	3	3	3	3
2	3	3	3	3	3	2	3				3	3	3	3	3
3	3	3	3	3	3	2	3				3	3	3	3	3
4	3	3	3	3	3	2	3				3	3	3	3	3
5	3	3	3	3	3	2	3				3	3	3	3	3
Avg	3	3	3	3	3	2	3				3	3	3	3	3

TEXT BOOK:

1. James G. Bralla, "Handbook of Product Design for Manufacture", McGraw Hill Book Co., 2004.
2. Boothroyd, G., Dewhurst, P., & Knight, A. W., "Product Design for Manufacture and Assembly", 3rd Edition, CRC Press – Taylor Francis Group, 2011.

REFERENCES:

1. Harry Peck, "Designing for Manufacture", Sir Isaac Pitman & Sons Ltd., 1973
2. Anderson, D.M., "Design for manufacturability & concurrent engineering: how to design for low cost, design in high quality, design for lean manufacture, and design quickly for fast production," ISBN-10 1878072234 : ,ISBN-13 : 978-1878072238, CIM press, 2nd Edition, 2010.
3. C W Allen, "Simultaneous Engineering -Integrating Manufacturing and Design", . ISBN 10: 0872633829 / ISBN 13: 9780872633827, Society of Manufacturing, Dearborn MI, 1990
4. Alan Redford , Jan Chal Design for Assembly: Principles and Practice, ISBN-10 : 0077078381,ISBN-13 : 978-0077078386, McGraw-Hill Education ,1994
5. K. G. Swift , Knowledge-Based Design for Manufacture (New Technological Modular), ISBN-10 : 1850912319,ISBN-13 : 978-1850912316, Kluwer Academic Publishers ,1986

MF23006 NEW PRODUCT DEVELOPMENT L T P C

3 0 0 3

COURSE OBJECTIVE

To prepare the students on generic development processes and new product development.

UNIT I INTRODUCTION TO PRODUCT DEVELOPMENT 9

Introduction – Characteristics of Successful Product Development – Product Development Team – Challenges of Product Development – Duration and Cost of Product Development – Product Development Process – Concept Development: The Front-End Process – Adapting the Generic Product Development Process – Product Development Process Flows – Product Development Organizations – Tournament Structure of Opportunity Identification – Opportunity Identification Process.

UNIT II PRODUCT PLANNING, CUSTOMER NEEDS IDENTIFICATION & PRODUCT SPECIFICATION 9

Product Planning Process – Identifying Customer Needs – Importance of Latent Needs – Process of Identifying Customer Needs – Definition of Specifications – Time to Establish Specification – Establishing Target Specifications – Setting the Final Specifications.

UNIT III PRODUCT CONCEPT GENERATION, SELECTION & TESTING 9

Activity of Concept Generation – Concept Selection – Concept Screening – Concept Scoring – Caveats – Concept Testing.

UNIT IV PRODUCT ARCHITECTURE & INDUSTRIAL DESIGN, 9

Product Architecture – Definition – Implications – Establishing the Architecture – Delayed Differentiation – Platform Planning – Related System-Level Design Issues – Industrial Design – Assessing the Need for Industrial Design – Impact of Industrial Design – Industrial Design Process – Management of the Industrial Design Process – Assessing the Quality of Industrial Design.

UNIT V DESIGN FOR MANUFACTURING & PROTOTYPING 9

Design for Manufacturing – DFM Process: Estimate the Manufacturing Costs – Reduce the Costs of Components – Reduce the Costs of Assembly – Reduce the Costs of Supporting Production – Consider the Impact of DFM Decisions on Other Factors – Prototyping – Principles of Prototyping – Prototyping Technologies – Planning for Prototypes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Apply the principles of generic development process; and understanding the organization structure for new product development. identify the opportunity and planning for new product development.

CO2 Conduct customer need analysis; and to design and set product specification for new product development.

CO3 Generate, select, and test the concepts for new product development

CO4 Apply principles of product architecture and industrial design for new product development.

CO5 Apply the principles in design for manufacturing and prototyping for new product development.

CO's- PO's & PSO's MAPPING

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2
2	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2
4	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2
5	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2
Avg	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2

TEXT BOOKS:

1. Ulrich K.T., Eppinger S. D. and Anita Goyal, "Product Design and Development "McGraw-HillEducation; 7edition,2020.

REFERNCES:

1. Belz A., 36-Hour Course: "Product Development" McGraw-Hill, 2010.
2. Rosenthal S.,"Effective Product Design and Development", Business One Orwin, Homewood,1992,ISBN1-55623-603-4.
3. Pugh.S,"Total Design Integrated Methods for Successful Product Engineering", Addison Wesley Publishing,1991,ISBN0-202-41639-5.
4. Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.
5. Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press, 2018.

MF23007 DESIGN FOR SUSTAINABILITY L T P C

3 0 0 3

COURSE OBJECTIVE

- To understand about life cycle requirement of engineering product with environment concern.
- To understand the aspects in the forms of resource reduction, recycling and reuses possibilities.

UNIT I LIFE CYCLE DESIGN 9

Introduction - The Roadmap and the State of the Art -Evolution of Sustainability in Design Research and Practice -Low Impact Resources-Selection-Product Life Cycle Design - System Design for Eco-efficiency -Design for Social Equity and Cohesion-State of the Art-Environmental Requirements of Industrial Products-Product Life Cycle- Pre-production-Production – DSollribution-Use - Disposal - Additional Life Cycles- Functional Approach - Life Cycle Design : Objectives- Implications - Current State of Life Cycle Design -The Design Approach- Strategies- Interrelations and Priorities- - Design for Disposal - Environmental Priorities and Disposal Costs.

UNIT II MINIMISING RESOURCE CONSUMPTION 9

Introduction - Minimising Material Consumption-Minimising Material Content.- Minimising Scraps and Discards- Minimising Packaging - Minimising Materials Consumption: During Usage ,During the Product Development Phase - Minimising Energy Consumption:Selecting Low Impact Resources and Processes, Selection of Non-toxic and Harmless Resources, Select Non-toxic and Harmless Materials, Selecting Non-toxic and Harmless Energy Resources- Renewable and Bio-compatible Resources: Select Renewable and Bio-compatible Materials, Select Renewable and Bio-compatible Energy Resources.

UNIT III PRODUCT LIFETIME OPTIMISATION 9

Useful Lifetime- Design Long-lasting Goods- Design Intensely -Utilised Goods- Social and Economic Dimensions of Changes - Optimization Services-Guidelines-Designing for Appropriate Lifespan -- Designing for Reliability-- Facilitating : Upgrading and Adaptability, Maintenance, Repairs, Re-use, Re-manufacturing - Intensifying Use -Extending the Lifespan of Materials – Guidelines- Adopting the Cascade Approach- Selecting Materials with the Most Efficient-Recycling Technologies-Facilitating End-of-life Collection and Transportation - Identifying Materials- Minimizing the Overall Number of Different-Incompatible Materials – Facilitating: Cleaning, Composting, Combustion.

UNIT IV FACILITATING DISASSEMBLY 9

Introduction –Guidelines- Reducing and Facilitating Operations of Disassembly-and Separation- Engaging: Reversible Joining Systems, Permanent Joining Systems -Co-designing Special Technologies and Features for Crushing Separation -Using Easily Separable Materials-Using Additional Parts that Are Easily Separable -System Design for Eco-efficiency- Economic Restrictions in Traditional Supply-and Demand System -System Innovation for New Interactions between Socio-economic actors.

UNIT V ESTIMATING THE ENVIRONMENTAL IMPACT OF PRODUCTS **9**

Methods and Support Tools for Environmental-Sustainability analysis and Design - Environmental Complexity and Designing Activity- Methods and Tools for Design for Environmental-Sustainability –The Environmental Impact-of Our Production–Consumption System-Exhaustion of Natural Resources - Global Warming- Ozone Layer Depletion -Toxic Air, Soil and Water Pollution -- Waste -Other Effects -- Quantitative Methods for Estimating and Analysing Product-Environmental Impact -Life Cycle Assessment.- Stages of LCA- LCA and Design: Importance and Limitations -Power to Choose: Discriminant Power-Versus Scientific Reliability -Incisive Decisions: First Stages of Development-Versus LCA Applicability -Developing LCA-Environmentally Sustainable Design-orienting Tools - Tools Developed for Certain Environmental Goals-Limitations of Tools that Are Developed-for Certain Environmental Goals-Tools for Product LCD- Tools for Design for Eco-efficiency

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Understand the environment aspects of life cycle design
CO2: Apply reduced resource usage during design of engineering components
CO3: Apply life cycle optimization of engineering products
CO4: Consider recycle and reuse requirements during design.
CO5: Assessing the design impact on environment

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3	2	3	3	3		3	3	3	3	3
2	3	3	3	3	3	2	3	3	3		3	3	3	3	3
3	3	3	3	3	3	2	3	3	3		3	3	3	3	3
4	3	3	3	3	3	2	3	3	3		3	3	3	3	3
5	3	3	3	3	3	2	3	3	3		3	3	3	3	3
Avg	3	3	3	3	3	2	3	3	3		3	3	3	3	3

TEXT BOOK:

1. Carlo Vezzoli, Ezio Manzini, "Design for Environmental Sustainability" Springer-Verlag London Limited, 2008, ISBN 978-1-84800-162-6 e-ISBN 978-1-84800-163-3.
2. Jane Penty "Product Design and Sustainability Strategies, Tools and Practice", 1st Edition, ISBN 9781138301986, Routledge ,2020.

REFERENCES:

1. Gerald Jonker And Jan Harmsen, " Engineering For Sustainability A Practical Guide For Sustainable Design" Elsevier, 2012, ISBN: 978-0-444-53846-8.
2. Tracy Bhamra, Vicky Lofthouse, "Design for Sustainability", Gower Publishing Limited, Hampshire,2007, ISBN–13: 9780566087042.
3. Tim Frick, "Designing for Sustainability", ISBN: 9781491935729, O'Reilly Media, Inc. 2016,
4. Fabrizio Ceschin, İdil Gaziulusoy " Design for SustainabilityA Multi-level Framework from Products to Socio-technical Systems", 1st Edition, ISBN 9781032089959, Routledge, 2020.
5. S M Sapuan, Muhd Mansor, "Design for Sustainability Green Materials and Processes"1st Edition , Paperback ISBN: 9780128194829,9 7 8 - 0 - 1 2 - 8 1 9 4 8 2 – 9 eBook ISBN: 9780128194423, Elsevier 2021.

MF23C03 ERGONOMICS AND HUMAN FACTORS ENGINEERING L T P C

3 0 0 3

COURSE OBJECTIVES:

Familiarize students with ergonomics and human anatomy interactions in workplaces, train them in workplace design concepts, and enable them to identify various work environments, conduct method and work studies, and develop sustainable workplace designs.

UNIT I INTRODUCTION TO ERGONOMICS AND HUMAN FACTORS 9

Introduction to Ergonomics- History, Needs and importance- Scientific Management and work study- Human relations and occupational psychology, socio technical systems theory- Industrial ergonomics programs.

UNIT II HUMAN BODY AND WORKPLACE 9

Human body mechanics, Human Sensorimotor systems, stimulus dimensions, human information processing, noise and theory of signal detection (TSD); Quantitative and qualitative visual displays;

human factors associated with speech communication; Introduction to biomechanics and engineering aspects of human motor activity, human decision making- Tolerances for human interactions, measurement of muscular forces in work place.

UNIT III ANTHROPOMETRY, WORK STATION AND FACILITIES DESIGN 9

Anthropometry-definition, types and surveys – scaling techniques- constraints on product dimensions Performance of body members in making different types of movements; Energy expenditure in physical activities; Spatial movements and conceptual relationships of stimuli and responses; Continuous control systems; Types of control functions, tools and related control devices. Design of work place and work components; Applied anthropometry, activity analysis; -effective workstation design for various works (standing, sitting etc..)- static and dynamic work postures- repetitive jobs, risks assessment and task design- Understanding organizational work- system integration, workers involvement in Human factors improvement

UNIT IV WORK PLACE DESIGN AND WORK STUDY 9

Design of Work Place- Visual environment-lighting design considerations, Human performance under heat, cold, illumination, vibration, noise, pollution, static and dynamic conditions. Application of results from human factors data and analysis in work study; Work design; method Study and Work Measurement Techniques, Designing displays and controls- Tools and techniques for ergonomics- Cognitive Ergonomics- Interactive devices- Accident prevention and safety management.

UNIT V WORK SYSTEM STABILITY AND SUSTAINABILITY 9

System stability, evolution, surveying, levels of sustainability, Assessing reality and validity- Design of experiments in field surveys- survey design - Economic growth and environmental concerns

TOTAL: 45 PERIODS

COURSE OUTCOMES:

By the end of the course, students will be able to:

CO1: Explain the various aspects of human sensory, motor, and cognitive attributes that influence human performance in the operation of aviation and space systems.
CO2: Identify and analyze sources of human and organizational error in aviation and space accidents.
CO3: Formulate principled hypotheses for human-system design improvement.
CO4: Test hypotheses in human settings and assess the validity of proposed designs on human workload, situation awareness, and mission performance.
CO5: Communicate interpretation of statistical analysis and design results, both written and orally

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	2	2	2	2		-	-	-	-	1	2	2	2
2	2	2	2	2	2	2		-	-	-	-	1	3	2	2
3	2	2	2	3	3	3		-	-	-	-	1	3	2	3
4	2	2	2	3	3	3		-	-	-	-	1	2	2	3
5	2	2	2	3	3	3		-	-	-	-	1	3	2	3
Avg	2	2	2	2.6	2.6	2.6						1	2.6	2	2.6

TEXT BOOKS:

1. Bridger, Robert S. (2009). Introduction to Ergonomics, 3rd edition, CRC Press, Taylor & Francis Group (ISBN- 978-0849373060).
2. Phillips, C. A. (1999). Human Factors Engineering, 1st edition, Wiley (ISBN-9780471240891)
3. Human Factors Engineering by M S Sanders and McCormick, TMH

REFERENCES:

1. Proctor, R. W., and T. Van Zandt. Human Factors in Simple and Complex Systems. 2nd ed. CRC Press, 2008.
2. Dismukes, R. K., B. A. Berman, and L. D. Loukopoulous. The Limits of Expertise: Rethinking Pilot Error and the Causes of Airline Accidents. Ashgate Publishing, 2007. ISBN: 9780754649656. [Preview with Google Books]
3. Bluman, A. G. Elementary Statistics: A Step-by-Step Approach. 5th ed. McGraw-Hill, 2004. ISBN: 9780072549072.
4. Handbook of Human Factors and Ergonomics Methods, Alan Hedge, Hal W. Hendrick, Karel Anton Brookhuis, Neville A. Stanton, CRC Press
5. A Guide to Human Factors and Ergonomics, Martin Helander, 2nd edition, CRC Press

MF23008 ADVANCES IN CONVENTIONAL MANUFACTURING TECHNOLOGIES **L T P C**

3 0 0 3

COURSE OBJECTIVES:

To understand the advances in conventional manufacturing techniques such as casting, powder metal processing, Ceramics and glass processing and welding process.

UNIT I ADVANCES IN CASTING DESIGN **9**

Solidification of Metals-pure metals and alloys, Surface property relationships, Fluid flow-Sprue Design, Modeling of mold filling, Fluidity of molten metal, Heat transfer- Solidification time calculation for various casting shapes. Design Considerations in Casting- Designing gates- Runner Design- Pouring basin design- Riser design, Establishing good practices with desirable casting designs, Casting Alloys, Economics of Casting.

UNIT II ADVANCES IN POWDER-METAL PROCESSING **9**

Production of Metal Powders Atomization, Electrolytic Deposition, Reduction from oxide, Carbonyl process, Comminution & Mechanical Alloying Nano powders & Microencapsulated powders. Particle Size, Shape and Distribution Blending Metal Powders Precautions during blending, storage and handling - Case studies. Compaction of Metal Powders: Cold Isostatic, Hot Isostatic & Pseudo Isostatic Pressing, Powder Injection Molding- Sintering-solid-state transport, vapour-phase transport,Mechanical properties of Sintered alloys. Secondary and Finishing Operations, Design Considerations, Process Capabilities Economics of Powder Metallurgy, Case studies.

UNIT III ADVANCES IN PROCESSING OF CERAMICS & GLASS **9**

Structure of Ceramics: Oxide ceramics, Carbides, Nitrides, Cermets, Silica & Nano Ceramics-Mechanical Properties, Physical Properties, Applications. Structure of Glass, Types of Glasses Mechanical & Physical Properties of Glass, Glass Ceramics Applications. Shaping Ceramics-Forming and Shaping of Glass-Techniques for Strengthening and Annealing Glass- Design Considerations for Ceramics and Glasses- Processing of Superconductors Case studies

UNIT IV ADVANCES IN CONVENTIONAL MACHINING OPERATIONS **9**

Machining Centers, Machine-tool Structures, Vibration and Chatter in Machining Operations, High speed Machining, Hard Machining, Ultra precision Machining, Machining Economics, Design Considerations for Grinding, Design consideration of Mechanical micromachining (micro milling, micro turning, micro EDM).

UNIT V ADVANCES IN CONVENTIONAL WELDING PROCESS **9**

Solidification of weld metal: Principle of solidification of weld metal, modes of solidification, effect of welding parameters on weld structure, grain refinement principle of weld metal, method of weld metal refinement, inoculation, arc pulsation, external excitation. **Heat affected zone and weld metal:** Transformations in HAZ of steel, factors affecting changes in microstructure and mechanical properties of HAZ, reactions in weld pool- gas metal

reaction, slag metal reaction. **Metallurgical issue in weld joint:** Mechanisms, causes and remedy of cold cracking, solidification cracking, non-metallic inclusions, lamellar tearing, hydrogen damage, banding, segregation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Understand the advances in casting design.

CO2: Acquire the knowledge of Powder Metallurgy and powder processing

CO3: Identify the properties & processing of ceramics & glass

CO4: Be familiarized with advances in conventional machining techniques

CO5: Understand the metallurgical aspects of welding.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	2	2	2	2	-	-	-	-	1	3	3	3
2	2	2	2	2	2	2	2	-	-	-	-	1	3	3	3
3	2	2	3	3	3	3	2	-	-	-	-	1	3	3	3
4	2	2	3	3	3	3	2	-	-	-	-	1	3	3	3
5	2	2	3	3	3	3	2	-	-	-	-	1	3	3	3
Avg	2.2	2.2	2.6	2.6	2.6	2.6	2					1	3	3	3

TEXT BOOKS

1. Serope Kalpakjian, "Manufacturing Engineering and Technology", Pearson Education, seventh edition, 2018.
2. Ostwald, Phillip F., and Jairo Munoz. Manufacturing processes and systems. John Wiley & Sons, 2008.

REFERENCES

1. Groover, Mikell P. Fundamentals of modern manufacturing: materials, processes, and systems. John Wiley & Sons, 2020.
2. Black, J. Temple, and Ronald A. Kohser. DeGarmo's materials and processes in manufacturing. John Wiley & Sons, 2017.
3. Rajput, R. K. A textbook of manufacturing technology: Manufacturing processes. Firewall Media, 2007. Bar-Cohen, Yoseph, ed. Advances in manufacturing and processing of materials and structures. CRC Press, 2018.

4. Krar, Stephen F., and Arthur Gill. Exploring advanced manufacturing technologies. Industrial Press Inc., 2003.

5. Kalpakjian, Serope. Manufacturing processes for engineering materials. Pearson Education India, 1984.

MF23C06 **PRECISION MANUFACTURING AND NANO TECHNOLOGY** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

To introduce students to precision manufacturing and nano manufacturing principles and techniques, emphasizing the importance of precision in manufacturing processes and addressing challenges unique to nano manufacturing, while providing hands-on experience with precision machining and nanofabrication techniques.

UNIT I INTRODUCTION TO PRECISION MANUFACTURING 9

Introduction to precision manufacturing and its significance in various industries - Principles of precision machining processes, including turning, milling, and grinding - Tolerance, surface finish, and geometric dimensioning and tolerancing (GD&T) - Need - Development of overall machining precision-Classes of achievable machining Accuracy - Precision machining - High precision - Machining-Ultra precision Machining-application of precision machining - Materials for tools and machine elements - carbides - ceramic, CBN & diamond - Tool and work material compatibility

UNIT II PRECISION MACHINING COMPONENTS & TECHNIQUES 9

Guide ways - Drive systems - Spindle drive - preferred numbers - Rolling elements - hydrodynamic & hydrostatic bearings - Hybrid fluid bearings - Aero static and aero dynamic bearings - Hybrid gas bearings - materials for bearings - Advanced machining processes for precision manufacturing, such as electrical discharge machining (EDM) and laser machining - Computer Numerical Control (CNC) machining and programming - Tooling and fixturing considerations for precision machining.

UNIT III METROLOGY AND QUALITY CONTROL IN PRECISION MANUFACTURING 9

Measurement techniques and instruments for dimensional accuracy and surface quality assessment - Statistical process control and quality assurance in precision manufacturing - Inspection and verification of precision components - Error - Sources - Static stiffness - Variation of the cutting force - total compliance - Different machining methods - Thermal effects - heat source - heat dissipation - Stabilization - decreasing thermal effects - forced vibration on accuracy - clamping & setting errors - Control - errors due to locations - principle of constant location surfaces.

UNIT IV NANO MANUFACTURING & TECHNIQUES 9

Fundamentals of nanotechnology and its applications in manufacturing - Nanoscale fabrication techniques, including top-down and bottom-up approaches - Nanomaterials and their properties for advanced manufacturing - Lithography techniques for nanostructure patterning, such as electron beam lithography and nanoimprint lithography - Thin film

deposition methods, including physical vapor deposition (PVD) and chemical vapor deposition (CVD) - Nanoscale metrology and characterization techniques

UNIT V EMERGING TOPICS IN PRECISION AND NANO MANUFACTURING **9**

Micro machining processes - diamond machining - micro engraving - Micro replication techniques - forming - casting - injection moulding - micro embossing - Energy assisted processes - LBM, EBM, FIB, Micro electro discharge machining-photolithography - LIGA process- Silicon micro machining - MEMS - microfluidics - Wet and dry etching-thin film deposition - characteristics- principle - Design - Application: automobile, defence, health care, Industrial, aerospace etc. Case studies and real-world applications of precision and nano manufacturing - Future trends and challenges in the field

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Understand the principles and techniques of precision manufacturing and nano manufacturing, and apply them to solve manufacturing challenges.
CO2: Demonstrate proficiency in using precision machining techniques and tools, and apply them to produce high-quality components with tight tolerances and surface finishes.
CO3: Apply metrology techniques and quality control methods to assess and ensure the dimensional accuracy and surface quality of precision components.
CO4: Demonstrate knowledge of nanofabrication techniques and materials, and apply them to fabricate nanostructures and nanoscale devices.
CO5: Analyze and evaluate emerging trends and applications in precision and nano manufacturing, and identify potential areas for future research and development.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	2	2	2	-	-	-	-	1	3	3	3
2	2	2	2	2	2	2	2	-	-	-	-	1	3	3	3
3	2	2	3	3	3	3	2	-	-	-	-	1	3	3	3
4	2	2	3	3	3	3	2	-	-	-	-	1	3	3	3
5	2	2	3	3	3	3	2	-	-	-	-	1	3	3	3
Avg	2.2	2.2	2.6	2.6	2.6	2.6	2					1	3	3	3

TEXT BOOKS

1. Murthy R.L., "Precision Engineering", 3rd Edition, New Age International, India, 2009. ISBN: 9788122407501
2. Venkatesh V.C. and Izman S., "Precision Engineering", Tata McGraw Hill., India, 2007. ISBN: 0070620903, 978-0070620902.

3. Ahmed Busnaina, "Nanomanufacturing Handbook", 1st edition, CRC Press, 2007. ISBN: 9780849333262

REFERENCES

1. James, D. and Meadow, S., “Geometric Dimensioning and Tolerancing”,1st Edition, Marcel Dekker Inc., United States, 1995.ISBN: 0824793099, 9780824793098
2. Juliar W.Gardner and Vijay K. Varadan, “Micro Sensors, MEMS and Smart Devices”,1st Edition, John Wiley and Sonsb., 2001. ISBN: 9780471861096, 9780470846087.
3. Nakazawa H., “Principles of Precision Engineering”, Oxford University Press., Institute of Physics Publishing, Bristol and Philadelphia, Bristol, BSI 6BE United kingdom, 1994.ISBN:0198562667, 978-0198562665.
4. Paulo Davim, "Microfabrication and Precision Engineering: Research and Development", 1st Edition, Woodhead publishing., United Kingdom , 2017. ISBN: 0857094866, 9780857094865
5. Raady Frank, “Understanding Smart Sensors”, 1st Edition, Artech. House., Boston, 1996. ISBN: 0890068240, 9780890068243.
6. Stephen A.Campbell, “The Science And Engineering Of Micro Electronic Fabrication”,1st Edition, Oxford

MF23009 MICROMACHINING AND MICROFABRICATION TECHNOLOGY **L T P C**

3 0 0 3

COURSE OBJECTIVE:

To introduce Meso, Micro, and Nano manufacturing and their applications, acquaint students with advanced micro machining and microfabrication processes, and provide knowledge on metrology and characterization techniques used for micromachining and microfabrication.

UNIT I INTRODUCTION **9**

Introduction to Meso, Micro and Nano manufacturing, Miniaturization and applications, classification-subtractive, additive, mass containing processes- Microfabrication- MEMS - Applications of Micro products in IT and telecommunications, Automotive, Medicine.

UNIT II MICROMACHINING PROCESSES **9**

Theory of micromachining, micro turning, micro drilling, micro milling- Micro stereo lithography - micro forming, micro moulding, micro casting- micro joining - Introduction to mechanical and beam energy based micro machining processes- Ultrasonic micro machining-Focused Ion Beam machining, Laser Beam micro machining, Micro/ Nano finishing processes- Electro-discharge diamond grinding-Hybrid micro/nano machining – Electro Chemical Spark Micro Machining, Electro Discharge Grinding, Electrolytic In Process Dressing Grinding.

UNIT III MICROFABRICATION **9**

Evolution of Micro fabrication, Microsystems and Microelectronics, Microsystems and miniaturization- Working principles of Microsystems: micro sensors, micro actuation, MEMS with micro actuators, Micro accelerometers, micro fluidics, Applications of Microsystems in various industries.

UNIT IV MICROFABRICATION PROCESSES **9**

Introduction- Photolithography- Ion implantation- Chemical Vapor deposition-Physical Vapor deposition - clean room- Bulk micromachining :etching, isotropic and anisotropic etching, wet and dry etching- Surface micro machining :process, mechanical problems associated with surface micro machining- LIGA process :general description, materials for substrates and photo resists-SLIGA process- Epitaxy-Pattern generation- Polymer and glass microprocessing- MEMS process integration-special processes and materials- Microfabrication at large- Economics of Microfabrication.

UNIT V CHARACTERISATION TECHNIQUES **9**

Metrology for micro machined Components-Optical Microscopy, White Light Interferometry, Molecular Measuring Machine, Micro CMM- Atomic Force Microscopy- Scanning Probe Microscopy (SPM) – Scanning Electron Microscope, Transmission Electron Microscope, Scanning Thermal Microscopy, Tribological characteristics -Micro abrasion wear - Nano indentation- Surface integrity of micro and nano machined surfaces.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Recognize the importance of Meso, Micro and Nano manufacturing and their respectiveapplications.

CO2: Elaborate on types of micromachining processes.

CO3: Describe the MEMS and microsystem.

CO4: Acquire knowledge on different types of microfabrication processes.

CO5: Identify the type of metrology and characterization techniques to be used for microfabrication.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	3	2	1	1	3	1	2	1	3	2	3	2	1
2	2	3	2	3	2	1	1	1	1	1	2	3	2	3	2
3	1	1	1	2	2	1	1	1	1	1	1	1	1	2	2
4	3	3	1	1	1	1	1	1	1	1	3	3	1	1	1
5	3	3	3	3	3	2	3	1	1	1	3	3	3	3	3
Avg	2.4	2.4	2	2.2	1.8	1.2	1.8	1	1.2	1	2.4	2.4	2	2.2	1.8

TEXT BOOKS

1. Jain V.K., "Introduction to Micromachining", Narosa Publishing House, New Delhi, India,2018.
2. Sami Franssila "Introduction to Microfabrication", John Wiley, 2010.

REFERENCE BOOKS

1. Madou M.F. "Fundamentals of Micro fabrication", CRC Press, 2002, 2nd Edition.
2. Jain V.K., "Micro manufacturing Processes", CRC Press, Florida, USA, 2017.
3. P. Raichoudhury, Handbook of Microlithography, Micromachining and Microfabrication, 1997.
4. Jackson M.J., "Microfabrication and Nanomanufacturing" Taylor and Francis 2006.
5. Davis, H.E., Hauck, G. and Troxell, G.E., "The Testing of engineering Materials", (4th Edition), McGraw Hill 1982.

MF23C05 **SUSTAINABLE MANUFACTURING** **L T P C**

3 0 0 3

COURSE OBJECTIVE:

To enable the students to gain an understanding of sustainable manufacturing and its significance in modern engineering, explore principles and strategies such as eco-design, energy efficiency, waste management, and life cycle assessment, and familiarize students with their application across diverse industries like automotive, electronics, and textiles.

UNIT I **INTRODUCTION TO SUSTAINABLE MANUFACTURING, DESIGN AND PRODUCT DEVELOPMENT** **9**

Definition and scope of sustainable manufacturing - Environmental, social, and economic aspects of sustainability - Sustainability performance indicators - - Eco-design principles and strategies - Design for disassembly and recycling - Life cycle assessment and eco-labeling - Sustainable building design and construction - Energy-efficient lighting and HVAC systems - Green Buildings and Facilities

UNIT II **ENERGY EFFICIENCY IN MANUFACTURING, WASTE MANAGEMENT AND CIRCULAR ECONOMY** **9**

Energy management and optimization - Renewable energy applications in manufacturing - Energy-efficient process design - Waste management in manufacturing facilities - Waste reduction and recycling strategies - Industrial symbiosis and resource sharing - Closed-loop and cradle-to-cradle approaches - carbon footprint: calculation, need to reduce the carbon footprint of manufacturing Operations, Carbon trading and offsetting

UNIT III **SOCIAL RESPONSIBILITY IN MANUFACTURING** **9**

Worker safety and well-being - Human rights and labor standards - Community engagement and social impact assessment - Corporate Social Responsibility (CSR)

UNIT IV **SUSTAINABLE MANUFACTURING PRACTICES IN INDUSTRY SECTORS** **9**

Case studies and best practices in automotive manufacturing, electronics manufacturing and textiles and apparel manufacturing - Clean and green manufacturing technologies - Advanced process monitoring and control systems - Digitalization and Industry 4.0 in sustainable manufacturing - Sustainable material selection - Green supply chain management - Responsible sourcing and ethical considerations

UNIT V **REGULATORY AND POLICY FRAMEWORKS, FUTURE TRENDS AND CHALLENGES IN SUSTAINABLE MANUFACTURING** **9**

Environmental regulations and compliance - International standards for sustainable manufacturing - Governmental regulations for Sustainability:GRI, ISO 26000, ISO 14001-Government policies and incentives - Emerging technologies and innovations - Circular economy and zero waste concepts - Sustainable manufacturing in the era of climate change

TOTAL: 45 PERIODS

Course Outcome:

At the end of the course, the students shall be able to

CO1: Demonstrate a deep understanding of the concepts and principles of sustainable manufacturing and their significance in modern industrial practices.

CO2: Analyze and interpret data related to carbon footprint, water consumption, and ecological impact, to support decision-making in manufacturing operations.

CO3: Apply knowledge of sustainable manufacturing tools and techniques to evaluate and improve the social performance of manufacturing systems.

CO4: Design sustainable manufacturing processes by considering factors like green supply chain, material selection through case studies

CO5: Understand the sustainability regulations and circular economy

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2										3	3	3
2	3	3	3										3	3	3
3	3	3	2										3	3	3
4	3	3	3										3	3	3
5	3	3	3										3	3	3
Avg	3	3	2.6										3	3	3

TEXT BOOKS

1. Joseph Fiksel, Design for Environment, Second Edition: A Guide to Sustainable Product Development, McGraw-Hill Education, 2018
2. Fahimnia, B. & Bell, Michael & Hensher, David & Sarkis, Joseph. (2015). Green Logistics and Transportation: A Sustainable Supply Chain Perspective

REFERENCE BOOKS

1. Davim J.P., "Sustainable Manufacturing", John Wiley & Sons., United States, 2010, ISBN: 978-1-848-21212-1.
2. Ibrahim Garbie, "Sustainability in Manufacturing Enterprises Concepts, Analyses and Assessments for Industry 4.0", Springer International Publishing., United States, 2016, ISBN-13: 978-3319293042.

3. Jovane F., Ęmper, W.E. and Williams, D.J., “The ManuFuture Road: Towards Competitive and Sustainable High-Adding-Value Manufacturing”, Springer,2009, United States, ISBN 978-3-540-77011-4.
4. Kutz M., “Environmentally Conscious Mechanical Design”, John Wiley & Sons., United States, 2007, ISBN: 978-0-471-72636-
5. Seliger G., “Sustainable Manufacturing: Shaping Global Value Creation”, Springer, United States, 2012, ISBN 978-3-642-27289-9.

MF23010 ELECTRONICS MANUFACTURING TECHNOLOGY L T P C

3 0 0 3

COURSE OBJECTIVES:

To impart knowledge on wafer preparation, PCB fabrication, Through Hole Technology (THT), and Surface Mount Technology (SMT), elaborate on Surface Mount Technology (SMT) steps, and acquaint with testing, inspection, repair, rework, and quality aspects of electronic assemblies.

UNIT I INTRODUCTION TO ELECTRONICS MANUFACTURING 9

History, definition, wafer preparation by growing, machining, and polishing, diffusion, microlithography, etching and cleaning, Printed circuit board –fabrication, types, single sided, double sided, multi-layer and flexible printed circuit board.

UNIT II COMPONENTS AND PACKAGING 9

Introduction to packaging, types-Through hole technology(THT), Surface mount technology (SMT) and mixed technology. Through hole components – axial, radial, multi leaded, odd form.

Surface-mount components- active, passive. Interconnections - chip to lead interconnection, die bonding, wire bonding, TAB, flip chip, chip on board, Chip and chip carrier, lead frame, Interconnection types and methods, Flip-Chip bonding, area arrays, multi chip module, direct chip array module, leaded, leadless, area array and embedded packaging, miniaturization and trends. Specialized packages (RF, MEMS, Sensors, Harsh Environments, Wearable/Flexible)

UNIT III SURFACE MOUNT TECHNOLOGY 9

SMT Process, SMT equipment and material handling systems, handling of components and assemblies - moisture sensitivity and ESD, safety and precautions needed, IPC and other standards, stencil printing process - solder paste material, storage and handling, stencils and squeegees, process parameters, quality control. Component placement- equipment type, flexibility, accuracy of placement, throughput, packaging of components for automated assembly, soldering- wave soldering, reflow process, process parameters, profile generation and control, adhesive, underfill and encapsulation process.

UNIT IV INSPECTION AND TESTING 9

Inspection techniques, equipment and principle- AOI, X-ray. Defects and Corrective action - stencil printing process, component placement process, reflow soldering process, electrical testing of PCB assemblies- In circuit test, functional testing, fixtures and jigs.

UNIT V REPAIR, REWORK, QUALITY AND RELIABILITY OF ELECTRONICS ASSEMBLIES **9**

Repair and rework of PCB- Coating removal, base board repair, conductor repair, thermo-mechanical effects and thermal management, Reliability fundamentals, reliability testing, failure analysis, design for manufacturability, assembly, reworkability, testing, reliability, and environment, e-waste management. Repair Reuse Recycling (RRR) of electronic packaging.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students should be able to:

CO6: Perceive wafer preparation and PCB fabrication
CO7: Recognize the importance of Through Hole Technology (THT) and Surface Mount Technology (SMT)
CO8: Demonstrate various steps in Surface Mount Technology (SMT)
CO9: Identify various testing and inspection methods of populated PCBS
CO10: Discuss various techniques in repair, rework, quality and reliability of electronic Assemblies

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	-	-	-	-	-	-	-	-	-	-	2	1	1	2
2	3	-	-	-	-	-	-	-	-	-	-	2	1	1	1
3	3	-	1	-	-		-	-	-	-	-	2	2	2	2
4	3	-	1	-	-	1	-	-	-	-	-	2	2	2	2
5	3	-	1	-	-	2	1	-	-	-	-	2	2	3	3
Avg	3		1			1.5	1					2	1.6	1.8	2

TEXT BOOKS:

1. Prasad R., "Surface Mount Technology – Principles and practice",2nd Edition, Chapman and Hall., New York, 1997, ISBN 0-41-12921-3.
2. Tummala R.R., "Fundamentals of microsystem packaging", Tata McGraw Hill Co. Ltd., New Delhi, 2001, ISBN 00-71-37169-9.

REFERENCES:

1. Harper C.A., "Electronic Packaging and Interconnection Handbook" 2nd Edition, McGraw Hill Inc., New York, N.Y., 1997, ISBN 0-07-026694-8.
2. Lee N.C., "Reflow Soldering Process and Trouble Shooting SMT, BGA, CSP and Flip Chip Technologies", Elsevier Science. United Kingdom, 2001.
3. Puligandla Viswanadham and Pratap Singh., "Failure Modes and Mechanisms in Electronic Packages", Chapman and Hall., New York, 1997, N.Y. ISBN 0-412-105591-8. Science and Technology, United Kingdom, 1997, ISBN 0750698756.

4. Totta P., Puttlitz K. and Stalter K., “Area Array Interconnection Handbook”, Kluwer Academic Publishers, Norwell, MA, United States, 2001, ISBN 0-7923-7919-5.
5. Zarrow P. and Kopp D., “Surface Mount Technology Terms and Concepts”, Elsevier, 1997.

MF23011 **LASER BASED MANUFACTURING** **L T P C**

3 0 0 3

COURSE OBJECTIVE:

To impart knowledge on

the basic components and working principles of lasers, and explore the mechanisms involved in all laser-assisted processing operations.

UNIT I BACKGROUND TO LASER DESIGN AND GENERAL APPLICATIONS **9**

Basic Principles of Lasers-Stimulated Emission Phenomenon, Basic Components of a Laser, Physics of the Generation of Laser Light, Relationship Between the Einstein Coefficients, Lifetime Broadening, Transition Rates for Monochromatic Waves, Amplification by an Atomic System, The Laser: Oscillation and Amplification; Laser Construction Concepts-Overall Design; Types of Laser-Gas Lasers, Solid-state Lasers, Dye Lasers, Free-electron Lasers, Applications of Lasers

UNIT II LASER CUTTING, DRILLING AND PIERCING **9**

Introduction; Basics of Laser machining process; Laser Drilling and Piercing; Methods of Cutting- Vaporisation Cutting/Drilling, Fusion Cutting –Melt and Blow, Reactive Fusion Cutting, Controlled Fracture; Theoretical Models of Cutting; Examples of Applications of Laser Cutting.

UNIT III LASER WELDING **9**

Introduction; Process Arrangement; Process Mechanisms – Keyholes and Plasmas; Operating Characteristics- Power, Spot Size and Mode, Polarisation, Wavelength, Speed, Focal Position, Joint Geometries, Gas Shroud and Gas Pressure, Effect of Gas Pressure – Due to Velocity and Environment, Effect of Material Properties, Gravity: Process Variations; Applications for Laser Welding in General.

UNIT IV LASER SURFACE TREATMENT **9**

Introduction; Laser Heat Treatment; Laser Surface Melting-Solidification Mechanisms, Style of Solidification; Laser Surface Alloying; Laser Cladding; Particle Injection; Laser-assisted Cold Spray Process; Surface Texturing; Enhanced Electroplating; Laser Chemical Vapour Deposition; Laser Physical Vapour Deposition; Noncontact Bending: Laser Cleaning and Paint Stripping; Surface Roughening; Micromachining; Shock Hardening.

UNIT V LASER FORMING AND CLEANING **9**

LASER FORMING: Introduction; The Process Mechanisms- The Thermal Gradient Mechanism, The Point Source Mechanism, The Buckling Mechanism, The Upsetting Mechanism, Laser-induced Shock Bending; Theoretical Models; Operating Characteristics; Applications.

LASER CLEANING: Introduction; Mechanisms of Laser Cleaning; An Overview of the Laser Cleaning Process; Practical Applications

TOTAL: 45 PERIODS

COURSE OUTCOME:

At the end of the course,

CO1: The students will be able to understand the fundamentals of laser and its types

CO2: The students will be able to explain the laser assisted machining operations

CO3: The students will be able to describe laser assisted welding process.

CO4: The students will be able to elucidate the various laser assisted surface treatment techniques.

CO5: The students will be able to expound the laser assisted forming and surface cleaning process.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	2	2	2	2	3	-	-	-	-	2	2	2	2
2	3	3	3	2	2	2	3	-	-	-	-	2	2	2	2
3	2	2	2	2	2	2	3	-	-	-	-	2	2	2	2
4	3	3	2	2	2	2	3	-	-	-	-	2	2	2	2
5	2	3	2	2	2	2	3	-	-	-	-	2	2	2	2
Avg	2.6	2.6	2.2	2	2	2	3					2	2	2	2

TEXT BOOKS

1. Steen, William M., and Jyotirmoy Mazumder. Laser material processing. springer science & business media, 2010.
2. Snopiński, Przemysław, and Tomasz Tański. "Advances in Laser and Surface Material Processing." (2020

REFERENCE BOOKS

1. Yilbas, Bekir Sami, Sohail Akhtar, and Shahzada Zaman Shuja. Laser forming and welding processes. Heidelberg: Springer International Publishing, 2013.
2. Dahotre, Narendra B., and Sandip Harimkar. Laser fabrication and machining of materials. Springer Science & Business Media, 2008.

3. Migliore, Leonard R. Laser materials processing. CRC Press, 2018.
4. Crafer, Roger, and Peter J. Oakley. Laser processing in manufacturing. Springer Science & Business Media, 1992.
5. Akinlabi, Esther Titilayo, Rasheedat Modupe Mahamood, and Stephen Akinwale Akinlabi, eds. Advanced manufacturing techniques using laser material processing. IGI Global, 2016.

MF23012 DESIGN OF MECHATRONICS SYSTEM L T PC

3 0 0 3

Course Objective

Gain understanding of integration concepts and elements in mechatronics, develop system models, become familiar with mechatronics design processes, and apply real-time integration techniques, including data acquisition, for analyzing mechatronic systems, including micro mechatronics systems.

UNIT I INTRODUCTION TO DESIGN OF MECHATRONICS SYSTEM 9

Key elements – Mechatronics design process – design parameters – mechatronics and traditional design – Advanced approaches in mechatronics design – Introduction to industrial design, modelling, simulation and analysis – Ergonomics and safety

UNIT II BASIC SYSTEM MODELLING 9

Introduction – model categories – model development – Simulation using softwares – verification and validation – Mathematical modelling: Basic system modelling – mechanical electrical, fluid and thermal

UNIT III MECHATRONIC SYSTEM MODELLING 9

Engineering systems: Rotational – translational, electro-mechanical, pneumatic-mechanical, hydraulic-mechanical, micro electro mechanical system – Dynamic responses of system: first order, second order system – Performance measures

UNIT IV REAL TIME INTERFACING 9

Introduction – Selection of interfacing standards- elements of data acquisition and control systems – Overview of I/O process – general purpose I/O cards and its installation – Data conversion process – Application software – Man machine interface

UNIT V CASE STUDIES ON DESIGN OF MECHATRONICS SYSTEM 9

Motion control using DC Motor, AC Motor and Servomotor - Temperature control of hot/cold reservoir – Pick and place robot – Car parking barriers – Motion and temperature control of washing machine – Auto focus camera, exposure control

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Gain a comprehensive understanding of integration concepts and become acquainted with the fundamental elements of mechatronics.

CO2: Acquire proficiency in developing system models and gain familiarity with the design process specific to mechatronics.

CO3: Apply real-time integration techniques to effectively integrate mechatronics systems in real-world applications.

CO4: Master the techniques and methods of data acquisition for real-time applications in mechatronics.

CO5: Develop the skills to analyze diverse mechatronics systems, including micro mechatronics systems, in terms of their functionality and performance

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	1	1	1	1	1	1	1	1	1	2	3	1	1	1
2	3	2	2	1	2	1	3	1	1	1	1	3	2	3	2
3	3	1	1	1	1	1	2	1	1	1	1	3	2	2	1
4	3	1	1	1	1	1	2	1	1	1	1	3	2	2	1
5	3	3	2	1	1	1	2	3	1	1	2	3	3	3	3
Avg	3	1.6	1.4	1	1.2	1	2	1.4	1	1	1.4	3	2	2.2	1.6

TEXT BOOKS:

1. Devdas Shetty, Richard A. Kolk, "Mechatronics System Design", 2nd EDITION, SI, Cengage Learning, 2011. ISBN-13: 978-1-4390-6199-2
2. Georg pelz, "Mechatronic Systems: Modeling and simulation" with HDL's, John wiley and sons Ltd, 2003.

REFERENCES

1. Bishop, Robert H, "Mechatronics Hand book", CRC Press, 2002.
2. Bradley, D.Dawson, N.C. Burd and A.J. Loader, "Mechatronics: Electronics in Products and Processes", CRC Press 1991, First Indian print 2010.
3. De Silva,"Mechatronics: A Foundation Course", Taylor & Francis, Indian Reprint, 2013.
4. W. Bolton, Mechatronics: Electronic Control Systems in Mechanical Engineering - 6th Edition, Pearson Higher Educations, 2019. ISBN: 13: 9780273742890.
5. David Alciatore, Introduction to Mechatronics and Measurement Systems, 5th Edition, 2019. ISBN13: 9781259892349.

MF23013 **IIOT IN MANUFACTURING** **L T P C**

3 0 0 3

COURSE OBJECTIVE:

Provide students with a comprehensive understanding of Industrial Internet of Things (IIoT) concepts and their applications in manufacturing, familiarize them with IIoT system technologies, protocols, and architectures used in manufacturing, and develop their skills in designing, implementing, and managing IIoT-enabled solutions to enhance productivity, efficiency, and safety in manufacturing processes.

UNIT I CONCEPTS OF IIoT IN MANUFACTURING **9**

Introduction to IoT in Manufacturing: Concepts, applications, and benefits - IoT platforms and frameworks for manufacturing - Industrial IoT (IIoT) and Industrial Control Systems (ICS)

UNIT II COMMUNICATION PROTOCOLS AND COMPUTING IN IIoT **9**

Overview of IoT architecture and protocols - Industrial Communication Systems: OPC UA, MQTT, CoAP - Wireless Communication Technologies in IoT: Wi-Fi, Bluetooth, LoRaWAN, NB-IoT - Edge Computing and Fog Computing in IoT - Edge devices and gateways in manufacturing - Data preprocessing and analytics at the edge - Cloud Computing and Storage for IoT in manufacturing - Cloud-based data management and analytics - Integration of cloud services with manufacturing processes

UNIT III IIoT BASED SOLUTIONS **9**

Data acquisition and sensor integration in manufacturing - Predictive Maintenance and Condition Monitoring with IoT - Sensor data analysis for fault detection and predictive maintenance - RFID and barcode technologies for inventory management - Tracking and tracing of products using IoT- IoT-enabled Quality Control and Assurance in manufacturing - Real-time monitoring and inspection of production processes - Integration of IoT with quality management systems - Case studies and real-world examples

UNIT IV SECURITY CONCERNS IN IIoT **9**

Cybersecurity and Privacy in IoT-enabled manufacturing systems - Threats, vulnerabilities, and risk management - Security protocols and best practices

UNIT V RECENT TRENDS OF IIoT IN MANUFACTURING **9**

Future Trends and Emerging Technologies in IoT for manufacturing - Control and automation of manufacturing systems using IoT - Remote monitoring and control in smart factories - Smart Manufacturing and IoT-enabled supply chain - IoT-enabled Energy Efficiency and Sustainability in manufacturing - Energy monitoring and optimization in smart factories - Environmental monitoring and waste reduction using IoT - Case studies and real-world examples

TOTAL: 45 PERIODS

COURSE OUTCOME:

At the end of the course the students shall be able to

CO1: Demonstrate a deep understanding of IIoT concepts, architectures, and standards in the context of manufacturing engineering.

CO2: Apply knowledge of IIoT technologies, communication protocols, and computing methods to monitor and control manufacturing systems.

CO3: Design and implement IIoT solutions for real-time monitoring, predictive maintenance, and optimization of manufacturing processes.

CO4: Understand the security concerns of the big data generated by IIoT systems

CO5: Collaborate effectively in multidisciplinary teams to design and implement IIoT-enabled systems for manufacturing applications.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2										3	3	3
2	3	3	3										3	3	3
3	3	3	2										3	3	3
4	3	3	3										3	3	3
5	3	3	3										3	3	3
Avg	3	3	2.6										3	3	3

TEXT BOOKS

1. Sharma, A. and Jangir, S.K. and Kumar, M. and Choubey, D.K. and Shrivastava, T. and Balamurugan, S., Industrial Internet of Things: Technologies and Research Directions, CRC Press, 2022 ISBN: 9781000545289
2. Sanjeev J. Wagh, Manisha Sunil Bhende, Anuradha D. Thakare, Energy Optimization Protocol Design for Sensor Networks in IoT Domains, CRC Press, 2022 ISBN: 9781032305592

REFERENCE BOOKS

1. Mahmood, Z. (2019) The internet of things in the industrial sector: Security and device connectivity, smart environments, and Industry 4.0. Springer.
2. Butun, I. (2020) Industrial Iot Challenges, design principles, applications, and security, Springer.
3. Manoj Kumar Tiwari, Nachiappan Subramanian, Sivalinga Govinda Ponnambalam, Wan Azhar Wan Yusoff, Industry 4.0 and Hyper-Customized Smart Manufacturing Supply Chains. United States, IGI Global, 2019.
4. Christian Brecher, Danda B. Rawat, Houbing Song, Sabina Jeschke, Industrial

Internet of Things: Cybermanufacturing Systems. Germany, Springer International Publishing, 2016.
5. Bhattacharjee, S. (2018). Practical Industrial Internet of Things Security: A Practitioner's Guide to Securing Connected Industries. United Kingdom: Packt Publishing.

RA23C01	ENGINEERING DATA ANALYTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students to:

Master data analytics using Microsoft Excel, from fundamental concepts and descriptive statistics to advanced statistical analysis, data visualization, and big data

UNIT – I INTRODUCTION TO DATA ANALYTICS 9

Introduction to data analytics: concepts, importance, and applications -Introduction to Microsoft Excel: basic operations, functions, and data manipulation- Data types and formats in Excel - importing data into Excel: text files, CSV, databases. Data cleaning techniques: handling missing data, duplicate records, and outliers. Text functions and data transformation,

Database Functions, Web Functions

UNIT – II DESCRIPTIVE STATISTICS 9

Calculating descriptive statistics: mean, median, mode, variance, standard deviation – ANOVA,

MANOVA, T-test, Statistical Distributions - Statistical Analysis Functions

UNIT – III DATA VISUALIZATION AND REPORTING 9

Creating and interpreting charts and graphs: histograms, bar charts, scatter plots.Advanced charting techniques: sparklines, trendlines, and conditional formatting. Creating interactive dashboards in Excel - introduction to Excel VBA for automation in data analysis tasks - PivotTables and PivotCharts for data summarization and visualization - Excel's built-in data analysis tools: Solver, Data Tables, Scenario Manager -Power Query for data transformation

and integration

UNIT – IV ADVANCED STATISTICAL ANALYSIS 9

Multivariate statistical techniques: factor analysis, cluster analysis - Time series analysis and

forecasting methods -Bayesian statistics and its applications.

UNIT – V BIG DATA ANALYTICS 9

Introduction to big data concepts and technologies (Hadoop, Spark) - Data mining in large- scale datasets - Real-time analytics and streaming data processing - Data Visualization and Communication - Advanced data visualization techniques: interactive dashboards, geospatial

visualization.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to

1. Understand foundational concepts and importance of data analytics
2. Proficiency in data manipulation and cleaning techniques using Excel
3. Apply descriptive statistical techniques and interpret results using Excel
4. Design and create effective data visualizations and reports in Excel
5. Apply advanced statistical techniques and tools for data analysis in Excel

Mapping of COs with POs and PSOs															
COs/POs & PSOs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	1	2	1	2	-	-	-		1	-	1	1	1	2
CO2	2	2	2	1	2	-	-	-	-	1	-	1	1	1	2
CO3	1	1	3	1	2	-	-	-	-	1	-	1	1	1	2
CO4	2	2	2	2	3	-	-	-	-	1	-	1	1	1	2
CO5	1	1	2	1	2	-	-	-	-	1	-	1	1	1	2
CO/PO & PSO Average	**1.6**	**1.4**	**2.2**	**1.2**	**2.2**	**-**	**-**		**-**	**1**	**-**	**1**	**1**	**1**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Michael Alexander and Richard Kusleika, Excel 2019 Bible, 2019, 5th Edition Wiley.

REFERENCES

1. Michael Alexander and Richard Kusleika, Excel 2019 Power Programming with VBA,Willey.
2. Gordon S. Linoff, Data Analysis Using SQL and Excel, 2016, Willey.
3. Denise Etheridge, Excel Data Analysis, Visual publisher; 3rd edition, 2 July 2010.
4. Frank J. Ohlhorst, "Big Data Analytics: Turning Big Data into Big Money, 2015,Wiley andSAS Business Series

ME23C10 HAPTICS AND IMMERSIVE TECHNOLOGIES L T P C

3 0 0 3

COURSE OBJECTIVES:

To familiarize students with the concepts and applications of virtual reality, augmented reality, mixed reality, and extended reality.

UNIT – I INTRODUCTION TO IMMERSIVE TECHNOLOGIES 9

Introduction on Virtual reality – Augmented reality – Mixed reality – Extended reality – VR Devices – AR Devices – Applications

Suggested activities:

- Flipped Classroom: Analysis of Immersive Technology Adoption
- External learning: Explore the advancements in Augmented reality

Suggested evaluation methods:

- Tutorial: discussion on immersive technology and its application
- Group discussion on advancements in immersive technology

UNIT – II BUILDING AR AND VR APPLICATION WITH UNITY 9

AR SDKs for unity and unreal engine – Working with SDKs for unity – Developing AR/VR application in unity – Building AR and VR application

Suggested activities:

- Flipped Classroom: Working with AR SDKs for Unity
- External learning: Hands-on Exploration of Haptic Devices

Suggested evaluation methods:

- Tutorial: AR application developed using Unity and the AR SDK
- Assignment on AR/VR application in different domains

UNIT – III HAPTIC PERCEPTION AND VIRTUAL REALITY 9

Virtual Reality – Display Technologies - Input devices to Virtual Reality Systems - Interaction with Virtual Environment - Introduction to Haptics - Human haptic system - Haptic Displays

Suggested activities:

- Flipped Classroom: Explore Haptic Displays and their Role in Virtual Reality Systems
- External Learning: Study and Analyze Case Studies on the Integration of Haptic System in Virtual Reality Applications

Suggested evaluation methods:

- Tutorial: Discuss on Impact of Haptic Displays on Virtual Reality Experiences

- Assignment Summarizing the Importance and Functionality of Haptic Systems in Virtual Reality Applications.

UNIT – IV COLLISION DETECTION IN HAPTICS 9

Collision Detection for Teleoperation: Force and Torque Sensors-Tactile Sensors-Collision Detection in Virtual Environment-Representational Models for Virtual Objects- Collision Detection for Polygonal Models-Collisions Detection between Simple Geometric Shapes- Teleoperation - Virtual Fixtures

Suggested activities:

- Flipped Classroom: Explore Haptic Interaction frameworks
- External learning: Haptic interface and display devices

Suggested evaluation methods:

- Tutorial: Haptic Interaction Techniques in AR/VR
- Quiz on haptic interaction design, working principles and functionalities of haptic interfaces

UNIT – V INTERACTION DESIGN IN IMMERSION TECHNOLOGIES 9

Mixed Reality Applications – Interactive AR models – User Interface Design in AR/VR environment – Virtual Agent Interaction Framework - Gestures and Haptic Interaction

Suggested activities:

- Flipped Classroom: User Interface Design in AR/VR Environment
- External learning: Explore gestures and haptic based interaction

Suggested evaluation methods:

- Tutorial: Designing immersive and user-friendly interfaces for practical applications
- Assignment on design concepts and prototype that incorporates gestures and haptic-based interaction

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, students should be able to:

1. Understand immersive technologies such as VR, AR, MR, and XR.
2. Build AR and VR applications using Unity and AR SDKs.
3. Gain knowledge of haptic perception and explore haptic devices and custom development.
4. Familiarize with haptic interfaces, immersion techniques, and haptic interaction in AR/VR.
5. Demonstrate proficiency in integrating haptic feedback into AR/VR experiences.

CO's- PO's & PSO's MAPPING

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	2	-	2	-	-	-	1	-	-	1	1	2	2
2	2	2	2	-	2	-	-	-	1	-	-	1	1	2	2
3	2	2	2	-	2	-	-	-	1	-	-	1	1	2	2
4	2	2	2	-	2	-	-	-	1	-	-	1	1	2	2
5	2	2	2	-	2	-	-	-	1	-	-	1	1	2	2
Avg	2	2	2	-	2	-	-	-	1	-	-	1	1	2	2

TEXT BOOKS:

1. Immersive Multimodal Interactive Presence, by Angelika Peer (Editor), Christos D. Giachritsis (Editor), Springer; 2012th edition (13 April 2014), ISBN-10: 1447162137
2. XR Haptics, Implementation & Design Guidelines, by Eric Vezzoli , Chris Ullrich , Gijs den Butter, RafalPijewski, March 13, 2022
3. Arnaldi, Bruno, Pascal Guitton, and Guillaume Moreau, eds. Virtual reality and augmented reality: Myths and realities. John Wiley & Sons, 2018.

MF23014	BLOCKCHAIN IN MANUFACTURING	L T P C
		3 0 0 3

OBJECTIVE

This course equips future engineers with the knowledge to revolutionize the industry. Discover how blockchain can improve transparency in supply chains, ensure product quality, safeguard intellectual property, and optimize manufacturing processes. Get ready to drive innovation and efficiency!

UNIT I INTRODUCTION TO BLOCKCHAIN 9

History of Blockchain – Blockchain Architecture - Distributed Ledger Technology (DLT); Blocks and Chain Structure; Types of Blockchain – Consensus – Consensus algorithms- Decentralization using Blockchain – Blockchain and Full Ecosystem Decentralization – Platforms for Decentralization.

UNIT II BLOCKCHAIN ARCHITECTURE AND COMPONENTS 9

Structure and components of a blockchain network - Public vs. private blockchains - Smart contracts and their role in manufacturing - Security challenges in blockchain technology - Privacy considerations in manufacturing blockchain applications - Cryptography and encryption techniques in blockchain

UNIT III WEB3 AND HYPERLEDGER 9

Web3 – Web3 concepts and Architecture- Benefits and Features of Web3- Web3 Development Tools and Frameworks – Hyperledger Projects and Frameworks - Hyperledger Fabric, Hyperledger Sawtooth, Hyperledger Indy, Hyperledger Iroha, Hyperledger Besu- Hyperledger Tools

UNIT IV BLOCKCHAIN FOR QUALITY ASSURANCE AND COUNTERFEIT PREVENTION 9

Blockchain applications in quality assurance processes - Use of blockchain for product authentication and anti-counterfeiting measures - Case studies on blockchain implementation in quality control - Role of blockchain in protecting intellectual property rights - Blockchain-based solutions for patent tracking and copyright management - Blockchain in digital rights management for manufacturing

UNIT V FUTURE TRENDS IN BLOCKCHAIN FOR MANUFACTURING 9

Real-world examples of blockchain adoption in the manufacturing sector - Challenges and future directions for blockchain in manufacturing - Need, Role, and Impact of Blockchain in the Manufacturing and Logistics Industries - Blockchain Technology in the Manufacturing Firms - Blockchain in Logistics and Supply Chain Monitoring - Asset Management Systems Through Blockchain

TOTAL: 45 PERIODS

OUTCOME

Upon completing of the course students will be able to:

CO1: Understand the technology components of Blockchain and how it works.

CO2: Familiarize with blockchain architecture and components

CO3: Understand the concepts of WEB3 and Hyperledger

CO4: Apply the blockchain in quality assurance and counterfeit prevention

CO5: Implement blockchain technology in various manufacturing operations.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	1	1	3										
2	3	1	1	1	3										
3	3	1	1	1	3										
4	3	1	1	1	3									1	1
5	3	1	1	1	3									1	1
Avg	3	1	1	1	3									1	1

TEXT BOOKS

1. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained", Second Edition, Packt Publishing.
2. Arshdeep Bahga, Vijay Madisetti, "Blockchain Applications: A Hands-On Approach", VPT, 2017.
3. S. B. Goyal, Nijalingappa Pradeep, "Utilizing Blockchain Technologies in Manufacturing and Logistics Management", IGI Global, ISBN 9781799886976

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1. Om Prakash Jena, Sabyasachi Pramanik, Ahmed A. Elngar, "Machine Learning Adoption in Blockchain-Based Intelligent Manufacturing Theoretical Basics, Applications, and Challenges", CRC Press, ISBN: 978-1-032-17153-1
2. Lakshmana Kumar Ramasamy, Seifedine Kadry, "Blockchain in the Industrial Internet of Things", IOP Publishing, ISBN 978-0-7503-3661-1.
3. Andreas Antonopoulos, Satoshi Nakamoto, "Mastering Bitcoin", O'Reilly Publishing, 2014. Roger Wattenhofer, "The Science of the Blockchain" CreateSpace Independent Publishing Platform, 2016.
4. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Princeton University Press, 2016.
5. Alex Leverington, "Ethereum Programming", Packt Publishing, 2017.

ME23C13 **MODERN ROBOTICS** **L T P C**

3 0 0 3

OBJECTIVE

To impart knowledge on anatomy of robots, kinematics, different end effector, mobile robots and its societal applications

UNIT I INTRODUCTION **9**

Robot: Definition, History of Robotics, Robot Anatomy, Co-ordinate systems, types and classification, Configuration space and degrees of freedom of rigid bodies and robots, Configuration space topology and representation; configuration and velocity constraints; task space and workspace, Rigid-body motions, rotation matrices, angular velocities, and exponential coordinates of rotation, Homogeneous transformation matrices.

UNIT II SIMULATION OF ROBOT KINEMATICS **9**

Robot kinematics, Forward and inverse kinematics (two three four degrees of freedom), Forward and inverse kinematics of velocity, Homogeneous transformation matrices, translation, and rotation matrices Dennavit and Hartenberg (D-H) transformation, Dynamics of Open Chains, Trajectory Generation, motion planning, robot control: First- and second-order linear error dynamics, stability of a feedback control system.

UNIT III GRASPING AND MANIPULATION OF ROBOTS **9**

Kinematics of contact, contact types (rolling, sliding, and breaking), graphical methods for representing kinematic constraints in the plane, and form-closure grasping, Coulomb friction, friction cones, graphical methods for representing forces and torques in the plane, End effectors, grippers, types of gripper, gripper force analysis, and examples of manipulation and grasping.

UNIT IV MOBILE ROBOTS **9**

Mobile robot, Wheeled Mobile Robots: Kinematic models of omnidirectional and non-holonomic wheeled mobile robots, Controllability, motion planning, feedback control of non-holonomic wheeled mobile robots; odometry for wheeled mobile robots; and mobile manipulation. Reference Trajectory generation, feed forward control

UNIT V APPLICATIONS OF ROBOTS **9**

Application of robotic: industrial robots, Service robots, domestic and household robots, medical robots, defence robots, agricultural robots, space robots, Aerial robotics Role of robots in inspection, assembly, material handling, underwater, space and healthcare

TOTAL: 45 PERIODS

OUTCOME

At the end of the course the students would be able to

CO1: Explain the definition, history of robotics and robot anatomy.
CO2: Develop the solutions for robot kinematics
CO3: Describe the grasping and manipulation of robots.
CO4: Explain mobile robot and manipulation.
CO5: Summarise the applications of robots in industry, defence, domestic & household and medical field

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	3	-	-	-	-	-	-	2	1	2	3
2	3	3	3	3	3	-	-	-	-	-	-	2	1	2	3
3	3	3	3	3	3	-	-	-	-	-	-	2	1	2	3
4	3	3	1	-	3	-	-	-	-	-	-	2	1	2	3
5	3	1	1	-	-	3	3	-	-	-	-	2	1	2	3
Avg	3	2.6	2.2	3	3	3	3	-	-	-	-	2	1	1	3

TEXT BOOKS

1. Modern Robotics: Mechanics, Planning, and Control, by Kevin M. Lynch , Frank C. Park , Cambridge University Press; 1st edition (25 May 2017), ISBN-10 : 110715
2. Modern Robotics: Mechanics, Systems and Control, by Julian Evans, Larsen and Keller Education (27 June 2019), ISBN-10 : 1641720751

REFERENCES

1. Modern Robotics: Designs, Systems and Control, by Jared Kroff, Willford Press (18 June 2019)ISBN-10 : 1682856763
2. Advanced Technologies in Modern Robotic Applications, by Chenguang Yang , Hongbin Ma , Mengyin Fu, Springer; Softcover reprint of the original 1st ed. 2016 edition (30 May 2018), ISBN-10 : 981109263X
3. Modern Robotics: Building Versatile Machines, by Harry Henderson, Facts On File Inc; Illustrated edition (1 August 2006), ISBN-10 : 0816057451
4. Artificial Intelligence for Robotics, by Francis X. Govers, Packt Publishing Limited; Standard Edition (30 August 2018), ISBN-10 : 1788835441
5. Modern Robotics Hardcover by Lauren Barrett (Editor), Murphy & Moore Publishing (1 March 2022), ISBN-10 : 1639873732

MF23015 AN INTRODUCTION TO REVERSE ENGINEERING L T P C

3 0 0 3

Course Objective:

To impart knowledge on

- the basics of reverse engineering and additive manufacturing
- the barriers in reverse engineering

UNIT I REVERSE ENGINEERING METHODOLOGIES AND TECHNIQUES 9

Introduction – Use of Reverse Engineering – The Generic Process – Scanning – Point Processing – Application Geometric Model Development – Computer-aided Reverse Engineering – Computer Vision and Reverse Engineering – Structured-light Range Imaging – Scanner Pipeline.

UNIT II SELECTION PROCESS OF REVERSE ENGINEERING SYSTEMS 9

Devices – Triangulation Approaches – Ranging Systems – Structured-light and Stereoscopic Imaging Systems – Tracking Systems – X-ray Tomography – Probe positioning – Post processing the Captured Data – Handling Data Points – Inspection Applications.

UNIT III REVERSE ENGINEERING AND RAPID PROTOTYPING 9

Modeling Cloud Data in Reverse Engineering – Data Processing for Rapid Prototyping – Integration of RE and AM for Layer-based Model Generation – Adaptive Slicing Approach for Cloud Data Modeling – Planar Polygon Curve Construction – Determination of Adaptive Layer Thickness – Application Examples.

UNIT IV APPLICATION AREAS 9

Reverse Engineering-Workflow for Automotive Body Design – Virtual NASCAR Engine Block – Ferrari reverse engineering CFD simulations – Reverse Engineering for Better Quality. Reverse Engineering in the Aerospace Industry – Reducing Costs of Hard Tooling – Digitizing a NASA Space Vehicle – Inspection in Half the Time. Reverse Engineering in Medical Industry – Orthodontics – Improving the Scanning Process- The Six-stage Process -Digital Dentistry – Hearing Instruments – Knee Replacement – Total Artificial Heart – Mass Customization.

UNIT V BARRIERS FOR REVERSE ENGINEERING 9

Copyright Law- Reverse Engineering – Case studies – Fair Use Statutory Defense – Barriers to adopting reverse engineering technology – Understanding the user needs for reverse engineering – Challenges in reverse Engineering.

TOTAL: 45 PERIODS

Course Outcome:

At the end of the course

CO1: the students will be able to understand the basics of reverse engineering.

CO2: the students will be able to select a suitable reverse engineering system for a given

application.

CO3: the students will be able to describe the relation between of reverse engineering and additive manufacturing.

CO4: the students will be able to demonstrate the key application areas of reverse engineering.

CO5: the students will be able to illustrate the legal issues and the barriers to reverse engineering

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	3	2	3	-	-	-	-	1	2	2	2	2
2	3	2	2	3	2	3	-	-	-	-	1	2	2	2	2
3	3	2	2	3	2	3	-	-	-	-	1	2	2	2	2
4	3	2	2	3	2	3	-	-	-	-	1	2	2	2	2
5	3	2	2	3	2	3	-	-	-	-	1	2	2	2	2
Avg	3	2.2	2	3	2	3					1	2	2	2	2

Text Books

1. Vinesh Raja, Kiran J. Fernandes, "Reverse Engineering, An Industrial Perspective", Springer, London, 2008.
2. Wang W, "Reverse Engineering: Technology of Reinvention", CRC Press, 2010.

Reference books

1. Ian Gibson, "Advanced Manufacturing Technology for Medical Applications: Reverse Engineering, Software Conversion and Rapid Prototyping", Wiley, 2006.
2. David Kadavy, "Design for Hackers: Reverse Engineering Beauty", Wiley, 1st edition, 2011.
3. Kumar, Kaushik, Divya Zindani, and J. Paulo Davim. "Rapid Prototyping, Rapid Tooling and Reverse Engineering." Rapid Prototyping, Rapid Tooling and Reverse Engineering. De Gruyter, 2020.
4. Eilam, Eldad. Reversing: secrets of reverse engineering. John Wiley & Sons, 2011.
5. Sirinterlikci, Arif, and Yalcin Ertekin. A Comprehensive Approach to Digital Manufacturing. Springer Nature, 2023.

MF23016 INDUSTRIAL STANDARDS AND QUALITY CONTROL FOR ADDITIVE MANUFACTURING **L T P C**

3 0 0 3

COURSE OBJECTIVE:

To impart knowledge on

- Standard in additive manufacturing
- quality management in additive manufacturing

UNIT I AN INTRODUCTION TO ADDITIVE MANUFACTURING STANDARDS **9**

Basics of standards for Additive Manufacturing, Importance of standardization, History of formation of committee for standards. Work plan and roadmap of Joint Committee between ASTM, ISO. Priority areas on Additive Manufacturing Standards, List of Standards and summary for Additive manufacturing (ASTM Standards).

UNIT II AN INTRODUCTION TO MEASUREMENT SCIENCE AND NEW DEVELOPMENTS IN DATA FORMAT **9**

Measurement science in Additive manufacturing, challenges of Measurement science, Additive Manufacturing Materials and Uncertainties, Additive Manufacturing Process and Uncertainties, Additive Manufacturing Materials parts and Uncertainties, Potentials of Measurement science, typical applications, Data format in Additive Manufacturing – New Developments in Data formats- Various Scanning Technology

UNIT III CHARACTERIZATION FOR ADDITIVE MANUFACTURING PROCESS **9**

Introduction to Material Characterization in Additive manufacturing –Liquid, solid and powder based. Liquid Materials Characterization Techniques-rheology and wetting behavior- Solid materials characterization techniques- Filament Diameter Consistency, density, porosity, Moisture content, Thermal properties. Micro structure of composite filament- Mechanical properties of Filament. Powder material characterization Techniques-powder size measurements-Morphology- chemical composition, Flow characteristics, density and laser absorption based characterization.

UNIT IV EQUIPMENT QUALIFICATION, PROCESS CONTROL AND MODELING **9**

Introduction to qualification-Definition and Terms, equipment qualification and general test, Four stages for qualification. Motivation for process control, Monitoring sensors, visual imaging, Thermal sensing, Displacement sensing. Measurand of In-Process Control Research. Commercial solutions on process modelling, simufact additive, ESI-Additive Manufacturing, Netfabb Simulation, Current Commercial Process Control Solutions.

UNIT V QUALITY MANAGEMENT IN ADDITIVE MANUFACTURING **9**

Need for Quality management frame work, Leader ship and commitment, planning, Additive Manufacturing support, Additive manufacturing operation, performance Evaluation, PDCA

Frame work cycle, Roles of regulatory and certification bodies, Proposed Framework For Additive Manufacturing Implementation-User inputs, product knowledge, Equipment qualification, process knowledge, continuous process verification.

TOTAL: 45 PERIODS

Course Outcome:

At the end of the course,

CO1: The students will be able to understand the basic additive manufacturing standards

CO2: The students will be able to explain measurement science with additive manufacturing.

CO3: The students will be able to describe characterization in additive manufacturing.

CO4: The students will be able to elucidate the process control and sensing techniques in additive manufacturing.

CO5: The students will be able to expound the quality management in additive manufacturing.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	2	3	3	2	-	-	-	2	3	3	3
2	3	3	2	2	2	3	3	2	-	-	-	2	3	3	3
3	3	3	2	2	2	3	3	2	-	-	-	2	3	3	3
4	3	3	2	2	2	3	3	2	-	-	-	2	3	3	3
5	3	3	2	2	2	3	3	2	-	-	-	2	3	3	3
Avg	3	3	2	2	2	3	3	2	-	-	-	2	3	3	3

TEXT BOOKS

1. Chee Kai Chua , Chee How Wong and Wai Yee Yeong," Standards, Quality Control, and Measurement Sciences in 3D Printing and Additive Manufacturing", Singapore Centre for 3D Printing, Academic press, Singapore, 1st Edition, 2017
2. Killi, Steinar Westhrin. Additive manufacturing: design, methods, and processes. CRC Press, 2017.

REFERENCE BOOKS

1. Chee Kai Chua, "3D Printing and Additive Manufacturing: Principles and Applications", World Scientific, 5th edition, 2017.
2. Olaf Diegel, Axel Nordin, Damien Motte "A Practical Guide to Design for Additive Manufacturing", Springer, 2019.
3. Ben Redwood, Filemon Schöffer, Brian Garret, "The 3D Printing Handbook: Technologies, Design and Applications", 3D Hubs, 2017.
4. Yang, Li, et al. Additive manufacturing of metals: the technology, materials, design

and production. Cham: Springer, 2017.
5. John O.. Milewski. Additive Manufacturing of Metals: From Fundamental Technology to Rocket Nozzles, Medical Implants, and Custom Jewelry. Springer., 2017.

MF23017 BUSINESS IMPROVEMENT STRATEGIES WITH ADDITIVE MANUFACTURING **L T P C**

3 0 0 3

Course Objective:

To impart knowledge on

- various aspects of sustainability in additive manufacturing process
- the business competitiveness, challenges and business strategies in additive manufacturing process

UNIT I CONCEPT OF SUSTAINABILITY WITH ADDITIVE MANUFACTURING **9**

Basics of Sustainable manufacturing – Economic Sustainability– Environmental Sustainability – Impacts on Energy Consumption resources and pollution – Societal Sustainability– Destructive implications of AM and counter measures.

UNIT II BUSINESS VALUE IMPROVEMENT AND OPERATION STRATEGY **9**

AM as a Driver for Business Competitiveness, creativity and Innovation, new services – Impact on Manufacturing Paradigms, Product Lifecycle and Operational Costs and Supply Chain Management – From Mass Customization to the new Entrepreneurial Role of Prosumers– Challenges Ahead of AM Technology Suppliers-Challenges Facing the AM Community.

UNIT III THE VALUE FOR OPERATIONS **9**

AM for the Product Development Process – AM as a Driver For Evolution In Design Methodologies – Design Freedom – Impact of AM on Production Process, Product Quality, Manufacturing Costs and Material Waste – Impact of AM on Inventory Turnover, Spare Part Supply Chain and 3DP Online Platforms Supply Chain.

UNIT IV STRATEGIC ALIGNMENT AND IMPLEMENTATION OF ADDITIVE MANUFACTURING **9**

Strategic Alignment Framework– Contingency Factors Driving AM Performance – Organizational Factors, Operational Factors and Product Characteristics – Economic Analysis of AM – Technology Analysis of AM– Selecting AM Technology –implementation of AM.

UNIT V BUSINESS IMPROVEMENT STRATEGIES IN INDUSTRIAL SECTORS **9**

The Role of Additive Manufacturing and business value In Future Industries – Industrial Diffusion – Business improvement strategies in medical, transportation, aerospace, energy and customer goods industries

TOTAL: 45 PERIODS

Course Outcome:

At the end of the course,

CO1: The students will be able to understand the sustainability concepts pertaining to additive manufacturing

CO2: The students will be able to explain Business value enhancement with additive manufacturing.

CO3: The students will be able to describe value addition in terms of design and product quality with additive manufacturing.

CO4: The students will be able to elucidate the strategic alignment framework of additive manufacturing.

CO5: The students will be able to enlist the applications of additive manufacturing.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	3	3	2	2	-	-	-	-	2	2	2	2
2	3	2	2	3	3	2	2	-	-	-	-	2	2	2	2
3	3	2	2	3	3	2	2	-	-	-	-	2	2	2	2
4	3	2	2	3	3	2	2	-	-	-	-	2	2	2	2
5	3	2	2	3	3	2	2	-	-	-	-	2	2	2	2
Avg	3	2	2	3	3	2	2	-	-	-	-	2	2	2	2

Text Books

1. Mojtaba Khorram Niaki, Fabio Nonino, "The Management of Additive Manufacturing: Enhancing Business Value", (Springer Series in Advanced Manufacturing), Springer, 2018.
2. Subramanian Senthilkannan," Handbook of Sustainability in Additive Manufacturing", Springer, 2016.

Reference books

1. Diegel, Olaf, Axel Nordin, and Damien Motte. A practical guide to design for additive manufacturing. Singapore: Springer Singapore, 2019.
2. Kamalpreet Sandhu; Sunpreet Singh; Chander Prakash; Karupppasamy Subburaj; Seeram Ramakrishna, "Sustainability for 3D Printing", (Springer Tracts in Additive Manufacturing), Springer, 2021.
3. Gibson, Ian, David W. Rosen, and Brent Stucker. "Additive manufacturing technologies: rapid prototyping to direct digital manufacturing." (2009).
4. Gebhardt, Andreas. "Understanding additive manufacturing." (2011).
5. Srivatsan, T. S., and T. S. Sudarshan, eds. "Additive manufacturing: innovations, advances, and applications." (2015).

MF23018 **METALLURGICAL ASPECTS OF ADDITIVE MANUFACTURING** **L T P C**

3 0 0 3

COURSE OBJECTIVE:

Impart knowledge on the

microstructure analysis of laser-assisted powder bed fusion processes, the evaluation of structural integrity and static mechanical properties of printer materials, and non-destructive testing techniques for parts produced via additive manufacturing.

UNIT I METAL MATERIALS FOR ADDITIVE MANUFACTURING 9

Additive manufacturing technologies for metal materials and principles- Selective laser melting, Wire arc additive manufacturing; Formation mechanisms of metal materials- Laser energy transfer, Absorption of laser energy by metal; Absorption of laser energy by metal powder; Temperature stress and strain fields in selective laser melting forming process; Dynamics and stability of melt pool

UNIT II A STEP-BY-STEP GUIDE TO THE L-PBF PROCESS 9

Single track formation-Melt-pool dynamics and track formation, Process stability, Influence of process parameters on single track characteristics; Single layer formation- Morphology of a single layer: Scanning strategies and hatching, Contouring, offset, and skywriting, Characterization of a single layer; Thin wall formation L-PBF object formation; Optimization of L-PBF process parameters-Numerical simulations of single tracks, Optimal process parameters for single tracks, Optimal process parameters for single layers Optimal process parameters for 3D parts

UNIT III MICROSTRUCTURE OF L-PBF ALLOYS 9

Introduction; Basic principles of solidification of the melt pool in L-PBF; Microstructure of L-PBF materials that do not have solid-state transformation upon cooling; Influence of manufacturing strategy and process parameters on texture in L-PBF materials; Thermal cycling in L-PBF materials during manufacturing; Microstructure of L-PBF materials that have solid-state transformation upon cooling; Effect of post heat treatment on microstructure of key L-PBF materials.

UNIT IV STRUCTURAL INTEGRITY AND STATIC MECHANICAL PROPERTIES OF VARIOUS METALS AND ALLOYS 9

Correlation between mechanical properties and microstructure of the L-PBF Materials; Mechanical properties of key L-PBF materials in as-built condition- Mechanical properties of steels; Mechanical properties of titanium-based alloys; Mechanical properties of aluminum-based alloys; Mechanical properties of nickel-based alloys; Influence of heat treatments on mechanical properties of key L-PBF materials- Steels 360,Titanium-based alloys, Aluminum- and nickel-based alloys; Fracture analysis-L-PBF steels High strength/low ductility materials e L-PBF titanium-based alloys, Low strength/high ductility materials e L-PBF aluminum-based alloys

UNIT V 9

Introduction- Traditional NDT, NDT requirements for metal additive manufacturing; NDT for L-PBF-X-ray and neutron radiography, X-ray computed tomography,Optical and tactile measurement, Dye penetrant, Ultrasonic testing, Eddy current, X-ray and neutron diffraction, Archimedes bulk density measurement, Optical and electron microscopy, Process compensated resonance testing (PCRT),

X-ray fluorescence, Thermography, Quality control and NDT considerations; Emerging areas and outlook

TOTAL: 45 PERIODS

Course Outcome:

At the end of the course,

CO1: The students will be able to understand laser-matter interaction phenomenon in additive manufacturing
CO2: The students will be able to explain the morphology and melt pool dynamics of depositing layers
CO3: The students will be able to describe the microstructure of the additively made metal parts
CO4: The students will be able to elucidate the Structural Integrity and Static Mechanical Properties of metal parts made by additive manufacturing
CO5: The students will be able to understand the various NDT requirements in additive manufacturing.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	3	2	2	2	-	-	-	-	2	3	3	3
2	3	3	3	3	2	3	3	-	-	-	-	2	3	3	3
3	3	3	2	3	2	3	3	-	-	-	-	2	3	3	3
4	3	3	3	2	3	3	3	-	-	-	-	2	3	3	3
5	3	3	3	2	3	3	3	-	-	-	-	2	3	3	3
Avg	3	3	2.6	2.6	2.4	2.8	2.8					2	3	3	3

TEXT BOOKS

1. Yadroitsev, I., Yadroitsava, I., Du Plessis, A., & MacDonald, E. (Eds.). (2021). Fundamentals of laser powder bed fusion of metals. Elsevier.
2. Gu, Dongdong. Laser additive manufacturing of high-performance materials. Springer, 2015.

REFERENCE BOOKS

1. Froes, F. H., & Dutta, B. (2014). The additive manufacturing (AM) of titanium alloys (Vol. 1019, pp. 19-25). Trans Tech Publications Ltd.
2. Olaf Diegel, Axel Nordin, Damien Motte "A Practical Guide to Design for Additive Manufacturing", Springer, a 2019.
3. Killi, Steinar Westhrin. Additive manufacturing: design, methods, and processes. CRC Press, 2017.
4. Pei, Eujin, Mario Monzón, and Alain Bernard, eds. Additive manufacturing-Developments in training and education. London: Springer International Publishing, 2019.
5. Prashanth, Konda Gokuldoss. "Selective laser melting: materials and applications." Journal of Manufacturing and Materials Processing 4.1 (2020): 13.

MF23019 DESIGN FOR ADDITIVE MANUFACTURING L T P C

3 0 0 3

COURSE OBJECTIVES:

Gain knowledge of different design strategies in additive manufacturing, study various design optimization techniques and tools to enhance product development using additive manufacturing, and learn polymer and metal additive manufacturing design guidelines for industrial applications.

UNIT I INTRODUCTION TO DESIGN FOR ADDITIVE MANUFACTURING (DfAM) 9

Introduction-Design freedom with AM-Need for Design for Additive Manufacturing (DfAM)-CAD tools vs. DfAM tools-Requirements of DfAM methods-General Guidelines for DfAM- Design to Minimize Print Time- Design to Minimize Post-processing- Economic of Additive Manufacturing - AM Part Standardization and Certification-Case Studies.

UNIT II DESIGN CONSIDERATION IN ADDITIVE MANUFACTURING 9

Part Consolidation- Design Guidelines for Part Consolidation - Design for Function- Material Considerations -Number of Fasteners- Use Knowledge from Conventional DFM/DFA-Assembly Considerations- Moving Parts- Opportunities for part consolidation - challenges with part consolidation. Guidelines for AM Tooling Design- Design of support structures- Case studies.

UNIT III COMPUTATIONAL TOOLS FOR DESIGN ANALYSIS 9

Considerations for Analysis of AM Parts- Topology Optimization - Objective and Constraints- Opportunities for TO applied to AM- Shape optimisation- Size optimization - Generative design - Generative design opportunities for mass customization -Case studies.

UNIT IV DESIGN FOR POLYMER AM 9

Designing for Material Extrusion-Print Orientation- Wall Thicknesses-Overhangs- Support Material- Tolerances- Layer Thickness- Warpage-Hollowing Parts-Horizontal Bridges- Connections- Fill Style- Holes- fillets- Ribs- font sizes and small details- Designing for Polymer Powder Bed Fusion- Designing for Vat Photopolymerization.

UNIT V DESIGN FOR METAL AM 9

Powder Morphology- Part orientation- Overhangs- shrinkage- warpage and Support Material- Design Guidelines for Wall Thickness- Clearance Between Moving Parts- Vertical Slots- Circular Holes- fillets- channels- Vertical Bosses- circular pins-External Screw Threads and part positioning.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course students shall be able to:

CO1: Gain a comprehensive understanding on design in additive manufacturing.

CO2: Acquire the ability to effectively apply design for additive manufacturing guidelines across various domains.

CO3: Develop the capability to optimize products and achieve optimal design outcomes.

CO4: Gain a comprehensive understanding of design guidelines for polymer AM, to maximize the potential applications and benefits.

CO5: Gain a comprehensive understanding of design guidelines for Metal AM, to maximize the potential applications and benefits.

CO's	PO's												PSO's		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	2	1	2	1	1	1	1	1	2	1	3	2	1	1
2	2	2	2	2	2	1	2	1	1	2	1	3	2	2	3
3	2	3	3	3	3	1	3	1	1	3	1	3	1	3	3
4	2	3	3	2	2	1	3	1	1	2	1	3	1	2	3
5	2	3	3	2	2	1	3	1	1	2	1	3	1	2	3
Avg	1.8	2.6	2.4	2.2	2	1	2.4	1	1	2.2	1	3	1.4	2	2.6

TEXT BOOKS:

1. A Practical Guide to Design for Additive Manufacturing, Diegel, Olaf, Axel Nordin, and Damien Motte, Springer, 2020.
2. The 3D Printing Handbook: Technologies, Design and Applications, Redwood, Ben, Filemon Schoffer, and Brian Garret, 3D Hubs, 2017.

REFERENCE BOOKS:

1. Design for Additive Manufacturing, Martin Leary, Elsevier, 2020.
2. Design for Advanced Manufacturing: Technologies and Process, Laroux K, Gillespie, McGrawHill, 2017.
3. Additive Manufacturing Technologies, Gibson, Ian, David W. Rosen, Brent Stucker, and Mahyar Khorasani, Springer, 2021.
4. Laser-Induced Materials and Processes for Rapid Prototyping, L.Lu, J. Y. H. Fuh and Y.S. Wong, Springer, 2001.
5. Design for Additive Manufacturing: Methods and Tools, Macro Mandolini, Patrick Pradel, Paolo Cicconi, Applied Sciences (ISSN 2076-3417), 2022.

MF23020	MODELING AND SIMULATION IN ADDITIVE MANUFACTURING	L T P C
		3 0 0 3

COURSE OBJECTIVE:

Impart knowledge on the challenges of finite element modeling in additive manufacturing, the physics and modeling possibilities of laser metal and electron beam additive manufacturing processes, and thermo-hydrodynamic and thermo-mechanical simulations in additive manufacturing.

UNIT I MODELING CHALLENGES IN ADDITIVE MANUFACTURING 9

Motivation, Additive Manufacturing Processes; Challenges in the Finite Element Modeling of AM Processes- Material Addition- Heat Input, Thermal Losses, Distortion and Residual Stress, Temperature Dependent Material Properties; Microstructural Changes; Reducing Simulation Time

UNIT II THE PHYSICS OF LASER METAL ADDITIVE MANUFACTURING PROCESSES 9

Motivation, Additive Manufacturing Processes; Challenges in the Finite Element Modeling of AM Processes- Material Addition- Heat Input, Thermal Losses, Distortion and Residual Stress, Temperature Dependent Material Properties; Microstructural Changes; Reducing Simulation Time

UNIT III THE PHYSICS OF THE ELECTRON BEAM PBF PROCESS 9

Introduction, Reminder of the essential physical variables characteristic of the electron–matter interaction, The phenomena induced during the electron–matter Interaction Energy absorption in the powder in E-PBF, Description of the fusion zone in E-PBF and associated defects, Partial conclusion regarding E-PBF

UNIT IV THERMO-HYDRODYNAMIC SIMULATION OF ADDITIVE MANUFACTURING 9

Description of physical phenomena, Modeling of heat source, Modeling of material input, Numerical methods for deposition modelling, Modeling of heat and mass transfer in the melt-pool, Examples of thermo-hydrodynamic simulations

UNIT V THERMO-MECHANICAL SIMULATION OF ADDITIVE MANUFACTURING 9

Whole-part simulation: different techniques, Heat transfer resolution, Metallurgical resolution, Mechanical resolution, Coupling, Application at the mesoscopic scale: local manufacturing Stresses, Application at the macroscopic scale, Software and calculation codes dedicated to additive manufacturing.

TOTAL: 45 PERIODS

Course Outcome:

At the end of the course,

CO1: The students will be able to understand the challenges in FEM.

CO2: The students will be able to explain the physics of laser interaction with metals.

CO3: The students will be able to describe physics of Electron Beam powder bed fusion process.

CO4: The students will be able to understand the Thermo-hydrodynamic simulation in AM

CO5: The students will be able to expound the Thermo-Mechanical simulation in AM.

CO's- PO's & PSO's MAPPING

CO's	**PO's**												**PSO's**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	2	2	2	2	3	-	-	-	-	2	3	3	3
2	2	3	3	2	2	2	3	-	-	-	-	2	3	3	3
3	2	3	2	2	2	2	3	-	-	-	-	2	3	3	3
4	3	3	2	2	2	2	3	-	-	-	-	2	3	3	3
5	2	3	2	2	2	2	3	-	-	-	-	2	3	3	3
Avg	**2.2**	**3**	**2.2**	**2**	**2**	**2**	**3**	**-**	**-**	**-**	**-**	**2**	**3**	**3**	**3**

TEXT BOOKS

1. Peyre, P., & Charkaluk, E. (Eds.). (2022). Additive Manufacturing of Metal Alloys 1: Processes, Raw Materials and Numerical Simulation. John Wiley & Sons.
2. Gouge, M., & Michaleris, P. (Eds.). (2017). Thermo-mechanical modeling of additive manufacturing. Butterworth-Heinemann.

REFERENCE BOOKS

1. Froes, F. H., & Dutta, B. (2014). The additive manufacturing (AM) of titanium alloys (Vol. 1019, pp. 19-25). Trans Tech Publications Ltd.
2. Olaf Diegel, Axel Nordin, Damien Motte "A Practical Guide to Design for Additive Manufacturing", Springer, a 2019.
3. Killi, Steinar Westhrin. Additive manufacturing: design, methods, and processes. CRC Press, 2017.
4. Schmidt, Michael, et al. "Laser-based additive manufacturing: Processes and materials." Optics Laser Technology 139 (2021): 106999.
5. Zohdi, Tarek I. Modeling and simulation of functionalized materials for additive manufacturing and 3d printing: continuous and discrete media: continuum and discrete element methods. Vol. 60. Springer, 2017.

OPEN ELECTIVE II

MF23909 ELECTRONICS PACKAGING TECHNOLOGY L T P C

3 0 0 3

OBJECTIVE

Impart knowledge on wafer preparation, PCB fabrication, through hole technology, and surface mount technology. Introduce types of electronic components and their packaging, and elaborate on various steps involved in surface mount technology.

UNIT I INTRODUCTION TO ELECTRONICS PACKAGING 9

History, definition, wafer preparation - crystal growth, crystal trimming and grinding, wafer slicing, edge rounding, lapping, etching, policing, laser inspection-Printed circuit boards, types- single sided, double sided, multi layer and flexible printed circuit board, materials, manufacturing, inspection.

UNIT II ELECTRONIC COMPONENTS AND PACKAGING 9

Through hole components – axial, radial, multi leaded, odd form. Surface-mount components- active, passive. Interconnections - chip to lead interconnection, die bonding, wire bonding, TAB, flip chip, chip on board, multi chip module, direct chip array module, leaded, leadless, area array and embedded packaging, package marking and testing. miniaturization and trends. Electronics Packaging hierarchy - Level 1 - Component, Level 2 - Etched wiring board, Level 3 - Assembly, Level 4 - Module. Types of electronics packaging. Through hole technology(THT), Surface mount technology(SMT) and Mixed technology

UNIT III SURFACE MOUNT TECHNOLOGY PROCESS 9

SMT equipment and material handling systems, handling of components and assemblies - moisture sensitivity and ESD, safety and precautions needed, IPC and other standards, stencil printing process - solder paste material, storage and handling, stencils and squeegees, process parameters, quality control. Component placement- equipment type, packaging of components for automated assembly, soldering- wave soldering, reflow process, process parameters, profile generation and control, lead free soldering, adhesive, underfill and encapsulation process

UNIT IV INSPECTION AND TESTING OF POPULATED PCBS 9

Inspection techniques, equipment and principle - X-ray Radiography, X-ray Laminography, Ultrasonic Imaging, Automated Optical Inspection, Laser Inspection, Infrared Inspection. Testing of PCB assemblies-Manual Testing, Populated Substrate shorts testing, In-Circuit Analysis, In-Circuit Testing, Functional Testing, In-Product Testing. Defects and Corrective action - stencil printing process, component placement process, reflow soldering process.

UNIT V REPAIR, REWORK, QUALITY AND RELIABILITY OF ELECTRONICS ASSEMBLIES 9

Repair tools, methods, rework criteria and process - coating removal, conductor repair, base board repair, Reliability fundamentals, reliability testing, failure analysis, design for manufacturability, assembly, testing, reliability, and environment. e-waste management. Repair Reuse Recycling (RRR) of electronic packaging. , thermo- mechanical effects and thermal management

TOTAL: 45 PERIODS

OUTCOME

Upon completing of the course students will be able to:

CO1: Identify wafer preparation, PCB fabrication, through hole technology and surface mount technology.

CO2: Recognize the importance of various electronic components and their packaging

CO3: Demonstrate various steps in surface mount technology

CO4: Identify various testing and inspection methods of populated PCB's

CO5: Discuss various defects, repair, rework and quality aspects of Electronics assemblies.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1											3	1	
2	3	1											3	1	
3	3	3	2	2									3	1	
4	3	3	3		2								3	1	
5	3	3	3		2		3						3	1	3
Avg	3	2.2	2.6	2	2		3						3	1	3

TEXT BOOKS

1. Prasad R., "Surface Mount Technology – Principles and practice", second Edition, Chapman and Hall, 2012, New York, ISBN 9789401165341.
2. Tummala R.R., "Fundamentals of microsystem packaging", Mc -Graw Hill, 2001, ISBN 00-71- 37169-9.

REFERENCES

1. Puligandla Viswanadham and Pratap Singh, "Failure Modes and Mechanisms in Electronic Packages", Chapman and Hall, New York, 1998, N.Y. ISBN-13: 978-0412105913.
2. Totta P., Puttlitz K. and Stalter K., "Area Array Interconnection Handbook", Kluwer Academic Publishers, Norwell, MA, USA, 2012. ISBN 9781461355298
3. Lee N.C., "Reflow Soldering Process and Trouble Shooting SMT,BGA,CSP and Flip Chip Technologies", 2003, Elsevier Science. ISBN 978-0-08-049224-7
4. Zarrow P. and Kopp D. "Surface Mount Technology Terms and Concepts", 1997, Elsevier Science and Technology,.ISBN 0750698756.
5. Harper C.A., "Electronic Packaging and Interconnection Handbook" Second Edition, McGraw Hill Inc., New York, N.Y., 2004, ISBN: 9780071430487

6. Martin B. and Jawitz W., “Printed Circuit board materials handbook”, McGraw-Hill Professional, 1997ISBN-13:978-0070324886

MF23910 INDUSTRIAL AND BIO-INSPIRED ROBOTICS L T P C

3 0 0 3

OBJECTIVE

To introduce various robotic system configurations and their industrial applications, acquaint students with robot programming methods and commands, and explore animal locomotion principles such as ground locomotion, flapping flight, swimming, and water surface locomotion, adapting these principles to bio-inspired robotic platforms.

UNIT I INTRODUCTION TO ROBOTIC SYSTEM 9

Robotic system overview - Mechatronics - Anatomy of mechatronics systems - Actuator Systems - Sensors Systems – Vision systems, Control Systems, processors, controllers, open loop systems and closed loop systems

UNIT II INDUSTRIAL ROBOTICS 9

Industrial Robotics definition and generations - anatomy - configuration and work envelop - Path control - end-effectors, grippers and tools - selection and design - collaborative robots - human robot interaction (HRI) – Industrial Automation- RGV, AGV: Implementation of Robots in Industries - Various Steps; Safety Considerations for Robot Operations

UNIT III INDUSTRIAL ROBOT PROGRAMMING AND ECONOMICS 9

Robot programming- Methods - Manual, Walk through-Lead through Programming and Off-line programming, Robot programming Languages - VAL Programming-Motion Commands, Sensor Commands, End Effectors commands and simple Programs. - Economic Analysis of Robots.

UNIT IV BIO-INSPIRED ROBOTS 9

Introduction - nature and robotics - biologically inspired designs vs. traditional technology - Animals vs. robots - Bio-Inspired Materials and Structures- Bio-Inspired Sensors- Muscle: Biomechanics vs. Artificial Muscle Actuators – Limbless robots- case study

UNIT V PRINCIPLES OF ANIMAL LOCOMOTION 9

Basic Physics of Locomotion: quantification and evaluation of nature - measurement of maneuverability and agility - Energy requirements for locomotion -Scaling effects - Locomotion on Ground - Crawling (warms, snakes, etc.) - Jumping - Walking - Running – Climbing - Flying - Gliding and Soaring - Hovering - Flapping Flight - Moving on the Surface

of Water - Walking - Jumping - Running – Swimming- Robot fish - Oars and Hydrofoils - Undulation - Jet Propulsion– Case Studies

TOTAL: 45 PERIODS

OUTCOME

Upon completing of the course students will be able to:

CO1: Ability to understand various systems in Robots.

CO2: To select and design the robot for industrial applications.

CO3: To implement various programming methods for different configurations of robot.

CO4: To identify different nature inspired mechanisms and materials for robots.

CO5: To incorporate various animal locomotion for developing prototype of robot

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	2	2	2	2		-	-	-	-	1	2	2	2
2	2	2	2	2	2	2		-	-	-	-	1	3	2	2
3	2	2	2	3	3	3		-	-	-	-	1	3	2	3
4	2	2	2	3	3	3		-	-	-	-	1	2	2	3
5	2	2	2	3	3	3		-	-	-	-	1	3	2	3
Avg	2	2	2	2.6	2.6	2.6						1	2.6	2	2.6

TEXT BOOKS

1. Nicholas Odrey, Groover. M.P "Industrial Robotics -Technology, Programming and Applications", Tata M Graw Hill, 2nd Edition, July 2017
2. Malcolm S. Gordon, Reinhard Blickhan, John O. Dabiri, John J. Videler , "Animal Locomotion Physical Principles and Adaptations",CRC Press, 2021.
3. J.J. Craig. "Introduction to Robotics: Mechanics and Control" Prentice Hall; 3rd edition, 2009

REFERENCES

1. McNeill Alexander R, "Principles of Animal Locomotion", Princeton University Press, 2006
2. Bio-mechanisms of Swimming and Flying: Fluid Dynamics, Biomimetic Robots, and Sports Science, edited by Naomi Kato and Shinji Kamimura, Springer Verlag, 2007.
3. Kiyoshi Toko, "Biomimetic Sensor Technology" Cambridge University Press,2000.
4. Yoseph Bar-Cohen, "Biomimetics: Biologically Inspired Technologies" CRC Press, 2005
5. Guoyuan Li, Houxiang Zhang, Jianwei Zhang, "Bio-Inspired Locomotion Control of Limbless Robots", Springer Singapore, 2023.
6. Ruxu Du, Zheng Li, Kamal Youcef-Toumi, Pablo Valdivia Alvarado, "Robot Fish-Bio-inspired Fishlike Underwater Robots", Springer Verlag London, 2015.
7. Joseph Ayers, Joel L. Davis, and AlanRudolph, "Neurotechnology for Biomimetic Robots" MIT Press, 2002.

MF23021 **DESIGN AND MANUFACTURING OF AEROSPACE COMPONENTS** **L T P C**

3 0 0 3

OBJECTIVE

Understand fundamental aerospace design and manufacturing principles, explore industry materials and processes, develop CAD and CAM skills for aerospace applications, learn quality assurance and testing methods, and analyze environmental and regulatory aspects of aerospace manufacturing.

UNIT I INTRODUCTION TO AEROSPACE MANUFACTURING 9

Overview of the aerospace industry-Basic principles of aerospace design- Historical development of aerospace manufacturing-Introduction to aerospace materials- Aerospace manufacturing processes: Overview- Lean manufacturing principles in aerospace - Safety standards and practices in aerospace manufacturing.

UNIT II MATERIALS FOR AEROSPACE APPLICATIONS 9

Characteristics of aerospace materials-Metal alloys: Aluminum, Titanium, and Nickel-based superalloys-Composites: Carbon fiber, Glass fiber, and Kevlar- Advanced materials: Ceramics and Smart materials- Material selection criteria for aerospace applications- Heat treatment and surface finishing processes- Case studies on material failures and improvements

UNIT III AEROSPACE MANUFACTURING PROCESSES 9

Forming processes in aerospace manufacturing: Forging, Extrusion, and Rolling- Machining processes in aerospace manufacturing: Milling, Turning, and Drilling- Additive manufacturing in aerospace: Techniques and applications- Welding and joining techniques: TIG, MIG, and Friction stir welding- Non-destructive testing methods: Ultrasonic, Radiographic, and Eddy current testing- Assembly processes in aerospace manufacturing- Case studies on manufacturing process optimization

UNIT IV CAD/CAM IN AEROSPACE MANUFACTURING 9

Introduction to CAD/CAM systems- Application of CAD in aerospace design- CAM for manufacturing aerospace components- CNC machining and programming- Simulation and modeling in aerospace design- Integration of CAD/CAM in the aerospace industry- Case studies on CAD/CAM applications in aerospace.

UNIT V QUALITY ASSURANCE AND ENVIRONMENTAL CONSIDERATIONS 9

Quality assurance methods and standards (AS9100, ISO 9001)- Testing and inspection techniques: Destructive and non-destructive- Statistical process control in aerospace manufacturing- Environmental impact of aerospace manufacturing- Sustainable manufacturing practices in aerospace- Regulatory aspects and compliance (FAA, EASA)- Case studies on quality assurance and environmental management.

TOTAL: 45 PERIODS

OUTCOME

Upon completing of the course students will be able to:

1. Explain the fundamental principles of aerospace design and manufacturing.

2. Identify and select appropriate materials and processes for aerospace applications.

3. Utilize CAD/CAM tools effectively for the design and manufacturing of aerospace components.

4. Implement quality assurance and testing methods in aerospace manufacturing.

5. Evaluate the environmental and regulatory impacts of aerospace manufacturing practices.

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3			1	1	1	1	1	1	1	1	1	3	2	2
2	3			2	2	1	2	1	1	1	1	1	3	3	2
3	2			2	3	1	2	1	1	2	1	2	2	3	3
4	2			3	2	2	2	2	1	1	2	2	3	2	2
5	2			2	2	2	3	1	1	2	2	2	3	2	3
Avg	2.4	2.4	2.2	2	2	1.4	2	1.2	1	1.4	1.4	1.6	2.8	2.4	2.4

TEXT BOOKS

1. "Aerospace Materials" by Brian Cantor, Patrick Grant, Colin Johnston

2. "Manufacturing Processes for Engineering Materials" by Serope Kalpakjian, Steven R. Schmid

REFERENCES

1."Introduction to Aerospace Materials" by Adrian P. Mouritz

2."Aircraft Materials and Analysis" by Tariq Siddiqui

3. "Manufacturing Engineering and Technology" by Serope Kalpakjian, Steven R. Schmid

MF23022	SYSTEM SIMULATION FOR MANUFACTURING ENGINEERS	L	T	P	C
		3	0	0	3

OBJECTIVES:

The objective of this course is to impart a comprehensive understanding of system simulation, its industrial significance, and the various techniques for generating and utilizing random numbers. It covers generation techniques, validation, verification, modeling, and analysis of simulations, equipping students with the skills to solve real-time problems in discrete systems using simulation software.

UNIT I PREAMBLE TO SYSTEM SIMULATION 9

Systems, general systems theory, Functions/Relationship, concept of simulation, Stochastic activities, Types of Models, Principles used in Modeling, simulation as a decision-making tool, types of simulation, Important measures of performance, Advantages and disadvantages of simulation, Steps in simulation model building.

UNIT II RANDOM NUMBERS 9

Methods of generating random numbers, Desirable attributes of random numbers, manual methods, computerized methods, Pseudo random numbers and random variates, discrete and continuous random probability distributions, tests for random numbers, Need for testing random numbers, Application of random numbers in simulation models

UNIT III DESIGN OF SIMULATION 9

Problem formulation, data collection and reduction, time flow mechanism, key variables, logic flow chart, starting condition, run size, experimental design consideration, output analysis and interpretation, validation. Monte Carlo method of simulation, Manual simulation techniques

UNIT IV SIMULATION SOFTWARE AND DATA HANDLING 9

Study and selection of simulation languages, Animation based Simulation packages, Selection of Simulation language / package, Use of any one of the simulation software for simulation model building, programmable blocks, Creation of database, Data handling and reporting, terminating conditions, Interpretation of results using statistical analysis

UNIT V ADVANCED HEURISTICS AND AREAS OF APPLICATION 9

Ear deaf Analysis - Development of simulation models for Manufacturing and production systems, inventory optimization techniques, Advanced Sequencing and Scheduling problems, queuing systems - Problems,

Heuristics for scheduling - Single pass heuristics, multipass heuristics, Evolutionary Optimization techniques - Genetic algorithm, Ant Colony algorithm, Particle Swarm optimization - Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

CO 1: Discuss various types of systems and identify different elements of a system to build simulation models and to use them.

CO 2: Generate, test and use random numbers in different ways.

CO 3: Explain various steps in building simulation models and how to run them for effective analysis of real life scenarios and obtain superior results.

CO 4: Develop capabilities of taking up consultancy projects and completing them successfully.

CO 5: Describe various cases in system simulation and its approaches

CO - PO MAPPING :

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2										3	1	
2	3	2	2										3	1	
3	3	3	3	2									3	1	
4	3	2	3	3	3								3	1	
5	3	3	3	2	3	2							3	1	
Avg	3	2.6	2.6	2.3	3	2							3	1	

REFERENCES:

1. Banks J., Nelson B.L., Nicol D.M and Shahabudeen. P, "Discrete event system simulation", 4th edition Prentice Hall, India, 2005.
2. R. Pannerselvam and P. Senthilkumar, 'System Simulation, Modelling and languages, PHI Learning Pvt, Ltd, 2013
3. Law A.M. and Kelton W.D., "Simulation Modeling and Analysis", 2nd edition, McGraw Hill Inc. (2015), New York.
4. Geoffrey Gordon, "System Simulation", second edition, Prentice Hall, India, 2005.
5. Shannon R.E., "systems simulation – The art and Science", Prentice Hall, 1975.
6. Hardbound by Altaf Q. H. Badar, 'Evolutionary Optimization Algorithms' 1st Edition 2021 , CRC Press

MF23023 MICRO AND NANO MANUFACTURING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To introduce Meso, Micro and Nano manufacturing and their respective applications.
- To familiarize the students with diamond, turn machining, advanced micro machining and nano finishing methods.
- To familiarize the students with synthesis of nanomaterials and types of characterization techniques to be used.

UNIT I INTRODUCTION 9

Introduction to Meso, Micro and Nano manufacturing, Miniaturization and applications, classification- subtractive, additive, mass containing processes, Theory of micromachining, micro turning, micro drilling, micro milling- Micro stereo lithography - micro forming, micro moulding, micro casting- micro joining, Applications of Micro and Nano products in IT and telecommunications, Automotive, Medicine.

UNIT II DIAMOND TURNING 9

Diamond turn machining-need, classification, components, material removal mechanisms, Tooling for diamond turning, Process parameters and optimization - Molecular Dynamic simulation to study nanoscale cutting-tool path strategies in surface generations- symmetric, asymmetric and freeform, applications of DTM products. Case studies.

UNIT III ADVANCED MACHINING / FINISHING PROCESSES 9

Introduction to mechanical and beam energy based micro machining processes- Ultrasonic micro machining, Focused Ion Beam machining, Laser Beam micro machining, Pulsed water drop micromachining, Micro/ Nano finishing processes- Abrasive Flow Machining, Magnetic Abrasive Finishing, Magneto Rheological Abrasive Flow Machining, Magneto Rheological Finishing. Hybrid micro/nano machining – Electro Chemical Spark Micro Machining, Electro Discharge Grinding, Electrolytic In Process Dressing Grinding. Case studies.

UNIT IV SYNTHESIS OF NANOMATERIALS 9

Introduction to nano materials, Methods of production of Nanoparticles, Sol-gel synthesis, Inert gas condensation, High energy Ball milling, Plasma synthesis, Electro deposition and other techniques. Synthesis of Carbon Nanotubes – Solid carbon source based production techniques, Gaseous carbon source based production techniques – Diamond Like Carbon coating. Nano wires. Case studies.

UNIT V CHARACTERISATION TECHNIQUES 9

Metrology for micro machined components -Optical Microscopy, White Light Interferometry, Molecular Measuring Machine, Micro CMM- Atomic Force Microscopy.

Scanning Probe Microscopy (SPM) – Scanning Electron Microscope, Transmission Electron Microscope, Scanning Thermal Microscopy, Tribological characteristics -Micro abrasion wear - 3D surface roughness measurement- Nano indentation- Ellipsometric Analysis. Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

CO 1: Recognize the importance of Meso, Micro and Nano manufacturing and their respective applications.

CO 2: Elaborate on Diamond turn machining process

CO 3: Describe the advanced micro machining and nano finishing methods.

CO 4: Acquire knowledge on synthesis of nanomaterials

CO 5: Identify the type of characterization techniques to be used.

CO - PO MAPPING :

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	1	2	1	1	1	1	1	1	2	2	3	1
2	3	3	3	2	3	1	1	1	2	1	2	2	3	3	2
3	3	3	3	3	3	1	1	1	2	1	2	2	2	3	2
4	3	2	3	2	3	1	2	1	2	1	2	3	3	3	2
5	3	3	2	3	3	2	2	1	1	2	2	3	3	2	1
Avg	3	2.6	2.6	2.2	2.8	1.2	1.4	1	1.6	1.2	1.8	2.4	2.6	2.8	1.6

REFERENCES:

1. Jain, V.K, "Micro manufacturing Processes", by CRC Press, ISBN: 9781439852903, 2013.
2. Bhushan, B., "Handbook of Nanotechnology", Springer, Germany, ISBN-13: 978-3662543559, 2017.
3. Jain, V.K "Introduction to Micromachining", Narosa publishing house, ISBN: 978-81-7319-915-8, 2014.
4. Balasubraminan, R., RamaGopal, V., Sarepaka Sathyan Subbiah "Diamond Turn Machining: Theory and Practice" by CRC Press, ISBN-13:978-1-4987-8758-1,2018.
5. Dehong Huo, Kai Cheng "Micro-Cutting: Fundamentals and Applications (Microsystem and Nanotechnology)" by Wiley, ISBN-13: 978-0470972878, 2013.
6. Yang Leng "Materials Characterization: Introduction to Microscopic and Spectroscopic Methods" by Wiley-VCH, ISBN-13: 978-3527334636, 2013
7. Bandyopadhyay, A.K., "Nano Materials", New Age International Publishers, New Delhi, SBN 8122422578, 2008.
8. Grundy, P.J. and Jones, G.A."Electron Microscopy in the Study of Materials", Edward Arnold Limited, 1976.

MF23024 SURFACE ENGINEERING AND TRIBOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

The primary objective of this course is to equip students with a comprehensive understanding of the principles and practices of surface engineering and tribology, enabling them to analyze, design, and apply surface modification techniques and tribological solutions to enhance the performance, durability, and reliability of engineering components across various industries.

UNIT I INTRODUCTION TO SURFACE ENGINEERING AND TRIBOLOGY 9

Definition and significance of surface engineering and tribology- Classification of surface engineering techniques and tribological concepts- Role of surfaces in engineering applications- Surface properties: hardness, wear resistance, friction, lubrication, and corrosion resistance

UNIT II SURFACE MODIFICATION TECHNIQUES 9

Mechanical Surface Treatments: Shot Peening, Burnishing and Laser Shock Peening- Thermal and Thermochemical Treatments: Carburizing, Nitriding, and Boriding- Thermal Spraying (Plasma, HVOF)- Laser Surface Hardening. Coating Technologies: Physical Vapor Deposition (PVD): Chemical Vapor Deposition (CVD): Electroplating and Electroless Plating. Advanced Surface Engineering Techniques: Ion Implantation, Nanostructured Coatings, Functionally Graded Materials.

UNIT III FUNDAMENTALS OF TRIBOLOGY 9

Principles of friction, wear, and lubrication, Types of wear: adhesive, abrasive, corrosive, and fatigue wear, Lubrication regimes: hydrodynamic, elastohydrodynamic, and boundary lubrication, Tribological testing - Pin-on-Disk, Ball-on-Flat, Wear Track Analysis.

UNIT IV APPLICATIONS AND ENVIRONMENTAL ASPECTS OF SURFACE ENGINEERING AND TRIBOLOGY 9

Applications in aerospace, automotive, biomedical, and electronic industries, Economic considerations in surface engineering and tribology, Environmental impacts and sustainability, Future trends and developments in surface engineering and tribology

UNIT V FUTURE TRENDS IN SURFACE ENGINEERING AND TRIBOLOGY 9

Emerging Technologies: Nano-tribology, Smart Coatings, Surface Texturing, Sustainability in Surface Engineering: Green Manufacturing Processes, Eco-friendly Coatings. Research and Development Directions: Advanced Materials for Surface Engineering, Innovative Tribological Solutions

TOTAL: 45 PERIODS

COURSE OUTCOMES:

By the end of the course, students will be able to:

1. Comprehend the Fundamentals of Surface Engineering and Tribology
2. Apply Surface Modification Techniques

3. Analyze Tribological Principles and Testing Methods
4. Evaluate Applications and Environmental Considerations
5. Explore Future Trends and Innovations

CO - PO MAPPING :

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2		2										1	1	
2	1		1		2								2	3	
3	2		2										1	1	
4	1			2									1	1	
5	2	3		3		2							2	2	
Avg	1.6	3	1.6	2.5	2	2	0	0	0	0	0	0	1.4	1.6	0

REFERENCES:

1. ASM International. (1994). *ASM Handbook, Volume 5: Surface Engineering*.
2. Bhushan, B. (2001). *Modern Tribology Handbook, Two Volume Set*. CRC Press.
3. Budinski, K. G., & Budinski, M. K. (2002). *Engineering Materials: Properties and Selection*. Prentice Hall.
4. Davis, J. R. (2004). *Handbook of Thermal Spray Technology*. ASM International.
5. Goodhew, P. J., Humphreys, F. J., & Beanland, R. (2000). *Electron Microscopy and Analysis*. Taylor & Francis.
6. Holmberg, K., & Matthews, A. (2009). *Coatings Tribology: Properties, Mechanisms, Techniques and Applications in Surface Engineering*. Elsevier.
7. Hutchings, I. M., & Shipway, P. (2017). *Tribology: Friction and Wear of Engineering Materials*. Butterworth-Heinemann.

MF23025 **SMART MATERIALS** **L T P C**
3 0 0 3

OBJECTIVES:

To provide students with a comprehensive understanding of the principles, types, and applications of smart materials, enabling them to analyze, design, and implement smart material solutions in manufacturing processes and systems.

UNIT I INTRODUCTION TO SMART MATERIALS 9

Definition and classification of smart materials; overview and significance; fundamental properties including mechanical, electrical, thermal, and magnetic; multifunctional characteristics; mechanisms of smart materials; interaction with external stimuli such as temperature, stress, and magnetic fields.

UNIT II PIEZOELECTRIC AND ELECTROSTRICTIVE MATERIALS 9

Principles of piezoelectricity and electrostriction; material examples and properties; applications in manufacturing including actuators, sensors, and energy harvesting; design and fabrication techniques; integration into systems.

UNIT III SHAPE MEMORY ALLOYS (SMAS) 9

Principles of shape memory effect and superelasticity; material examples such as NiTi and Cu-based alloys; applications in manufacturing including actuators and adaptive structures; biomedical applications; design and fabrication techniques; challenges and considerations.

UNIT IV MAGNETOSTRICTIVE AND ELECTRORHEOLOGICAL MATERIALS 9

Principles of magnetostriction and electrorheology; material examples such as Terfenol-D and electrorheological fluids; applications in manufacturing including actuators, sensors, and vibration control; adaptive structures; design and fabrication techniques; system integration.

UNIT V ADVANCED SMART MATERIALS AND FUTURE TRENDS 9

Emerging smart materials including nano-smart materials, smart polymers, and gels; applications and case studies in aerospace, automotive, electronics, and biomedical industries; future trends and research directions; innovations in smart materials; sustainable and eco-friendly smart materials.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

CO1: Explain the basic principles, classification, and properties of various smart materials and their mechanisms of action.

CO2: Apply knowledge of piezoelectric and electrostrictive materials to design and integrate them into manufacturing systems for applications such as sensors, actuators, and energy harvesting.

CO3: Design and implement shape memory alloys in manufacturing processes, understanding their properties, applications, and challenges in integration.

CO4: Utilize magnetostrictive and electrorheological materials in manufacturing applications for actuation, sensing, and adaptive control, considering their design and fabrication requirements.

CO5: Investigate emerging smart materials and their applications, recognizing future trends and potential research directions in the field of smart materials for manufacturing.

CO - PO MAPPING :

CO's	PO's												PSO's		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	2	1										1	2	1
2	1		1		1								1	1	1
3	1		1										3	2	2
4	1		1		2								1	2	2
5	1	2		2	2								1	1	1
Avg minor	2	1	2	1.6	0	0	0	0	0	0	0	1.4	1.6	1.4	1

REFERENCES:

1. "Smart Materials and Structures" by M.V. Gandhi and B.S. Thompson
2. "Smart Materials and Nondestructive Evaluation for Energy Systems" by Reza Ghodssi and Pinna Sartori.
3. "Shape Memory Alloys: Modeling and Engineering Applications" by Dimitris C. Lagoudas
4. "Piezoelectric Materials: Advances in Science, Technology and Applications" by Q. Li and T. Kimura
5. "Magnetostrictive Materials and Applications" by E. du Trémolet de Lacheisserie

MF23026	BIOMANUFACTURING AND BIOMEDICAL DEVICE FABRICATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

The primary objective of this course is to provide students with a comprehensive understanding of the principles, techniques, and applications involved in biomanufacturing and the fabrication of biomedical devices, enabling them to design, develop, and implement advanced manufacturing solutions in the biomedical field.

UNIT I INTRODUCTION TO BIOMANUFACTURING AND BIOMEDICAL DEVICES 9

Definition and scope of biomanufacturing; significance and applications of biomedical devices; overview of biomanufacturing processes; classification and types of biomedical devices; regulatory standards and quality assurance in biomedical device manufacturing.

UNIT II BIOMATERIALS AND THEIR PROCESSING 9

Types of biomaterials: metals, ceramics, polymers, and composites; properties and selection criteria for biomedical applications; biocompatibility and bioactivity; processing techniques for biomaterials: casting, molding, machining, and additive manufacturing; surface modification and coating techniques for biomaterials.

UNIT III BIOMEDICAL DEVICE FABRICATION TECHNIQUES 9

Microfabrication and nanofabrication techniques; lithography, etching, and deposition processes; 3D printing and additive manufacturing for biomedical devices; micro-electromechanical systems (MEMS) for biomedical applications; lab-on-a-chip technologies; precision machining and assembly of biomedical devices.

UNIT IV BIOMANUFACTURING PROCESSES AND SYSTEMS 9

Cell culture and tissue engineering; bioprinting and bioassembly; bioreactors and bioprocessing; manufacturing of implants, prosthetics, and scaffolds; sterilization techniques for biomedical devices; quality control and validation in biomanufacturing processes.

UNIT V APPLICATIONS AND FUTURE TRENDS 9

Applications in orthopedics, cardiovascular, dental, and neural devices; drug delivery systems and diagnostic devices; advancements in regenerative medicine and tissue engineering; emerging technologies in biomanufacturing; sustainability and ethical considerations in biomedical device fabrication; future trends and research directions.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

CO1: Explain the fundamental principles, processes, and applications of biomanufacturing and biomedical device fabrication.
CO2: Select and process appropriate biomaterials for various biomedical applications, considering their properties, biocompatibility, and bioactivity.
CO3: Apply advanced fabrication techniques such as microfabrication, nanofabrication, and additive manufacturing to develop biomedical devices.
CO4: Implement biomanufacturing processes for cell culture, tissue engineering, and bioprinting, ensuring quality control and validation.

CO5: Evaluate the applications, advancements, and future trends in the field of biomanufacturing and biomedical device fabrication.

CO - PO MAPPING :

CO's	PO's												PSO's		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	1	2	1										1	1	1
2	1		1		1								1	1	1
3	1	1	1										2	2	2
4	1	3		2									1	1	1
5	1		2		2		2						1	2	2
Avg	1	2	1.25	2	1.5	0	2	0	0	0	0	0	1.2	1.4	1.4

REFERENCES:

1. "Biomanufacturing: Principles and Applications" by Chander Prakash, Sunpreet Singh, and Grzegorz Krolczyk
2. "Biomedical Device Technology: Principles and Design" by Anthony Y. K. Chan
3. "Biomaterials Science: An Introduction to Materials in Medicine" by Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, and Jack E. Lemons
4. "3D Printing in Medicine: A Practical Guide for Medical Professionals" by Deepak M Kalaskar
5. "Biomedical Microsystems" by Ellis Meng

MF23027	MACHINE LEARNING IN MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES:

The main learning objective of this course is to familiarize the students with the concepts of Machine learning in Manufacturing.

UNIT I INTRODUCTIN 9

Introduction- Smart manufacturing – Evolution of modern quality control in manufacturing – Breakdown of traditional quality control methods– quality 4.0- Artificial intelligence – Cloud storage and computing – Industrial internet of Things.

UNIT II DATA AND CLASSIFICATION 9

Big data – Manufacturing big data – Transforming data into a learning data – Binary classification of quality data sets.

Binary classification – Binary classification of quality – classification errors – Empirical case study on classification metrics – Binary patterns.

UNIT III MACHINE LEARNING THEORY AND FEATURE ENGINEERING 9

Overfitting and underfitting- Learning curves – Curse of dimensionality – Early stopping – Loss function for binary classification.

Feature creation - Feature selection – Feature visualization – Feature preprocessing

UNIT IV CLASSIFIER DEVELOPMENT AND LEARNING QUALITY CONTROL 9

Modelling paradigms – Machine learning algorithms – Classifier fusion – Data driven insights – Manufacturing pattern-recognition problem – Problem solving strategy – Boosting statistical process control- Managerial implications.

UNIT V APPLICATIONS OF MACHINE LEARNING IN MANUFACTURING 9

Applications - Predictive maintenance – Quality control - Demand forecasting

Case Study – Structured data – Unstructured data

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

CO1 : Understand the fundamental concepts of machine learning.

CO2 : Realise the concept of data and its classification.

CO3 : Appreciate machine learning theory and feature engineering.

CO4 : Apprehend classifier development and to learn quality control.

CO5 : Apply the concept of the machine learning in manufacturing.

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2				2							3	2	1
2	3	3			3								2	3	2
3	3	3	2		3								3	3	2
4	3	2	2	3	3		2						2	3	3
5	3	2			3								2	3	3
Avg	2.4	2	3	3	2	2						2.4	2.8	2.2	3

TEXT BOOKS

1. Carlos A. Escobar, Ruben Morales-Menendez "Machine Learning in Manufacturing Quality 4.0 and the Zero Defects Vision Elsevier Science . 2024.

REFERENCES

1.Jiafu Wan, Baotong Chen, Shiyong Wang "Smart Manufacturing Factory Artificial-Intelligence-Driven Customized Manufacturing "CRC Press, 2023.

2.Pedro Larrañaga, David Atienza, Javier Diaz-Rozo, Alberto Ogbechie, Carlos Esteban Puerto-Santana, Concha Bielza "Industrial Applications of Machine Learning "CRC Press, 2018.

MF23028 ENTERPRISE RESOURCE PLANNING

L	T	P	C
3	0	0	3

OBJECTIVES:

The primary objective of this course is to provide students with a comprehensive understanding of Enterprise Resource Planning (ERP) systems, including the core and extended modules, the implementation cycle, the impacts of ERP post-implementation, and the emerging trends in ERP technology and practices.

UNIT I OVERVIEW OF ERP SYSTEMS 9

Overview of enterprise systems – Evolution - Risks and benefits - Fundamental technology - Issues to be consider in planning design and implementation of cross functional integrated ERP systems.

UNIT II ERP SOLUTIONS AND FUNCTIONAL MODULES 9

Overview of ERP software solutions- Small, medium and large enterprise vendor solutions, BPR, and best business practices - Business process Management, Functional modules- Management Information system - Executive information system - Decision support system - Business Intelligence for ERP systems.

UNIT III ERP IMPLEMENTATION 9

Planning Evaluation and selection of ERP systems - Implementation life cycle - ERP implementation- transition strategies- Methodology and Frame work- Training – Data Migration. People Organization in implementation-Case studies-Consultants, Vendors and Employees- Case studies in ERP implementation

UNIT IV POST IMPLEMENTATION 9

Maintenance of ERP- Organizational and Industrial impact; Success and Failure factors of ERP Implementation- Operation and Maintenance of an ERP system - ERP Audit-Case studies.

UNIT V EMERGING TRENDS ON ERP 9

Extended ERP systems and ERP add-ons -CRM, SCM, Business analytics - Future trends in ERP systems-web enabled, Wireless technologies, cloud computing- Application development- Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

CO 1: Get an idea about ERP.
CO 2: Awareness of core and extended modules of ERP
CO 3: Knowledge of ERP implementation cycle.
CO 4: Gain knowledge about effects of ERP after its implementation.
CO 5: Understand the emerging trends on ERP.

CO - PO MAPPING :

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2		2												1
2	2		1												1
3	1		1		1										2
4	1			1											1
5	1			2		2									1
Avg	1.4		1.3	1.5	1	2									1.2

REFERENCES:

1. Alexis Leon, "Enterprise Resource Planning", second edition, Tata McGraw-Hill, 2008.
2. Alexis Leon, "ERP Demystified".,Tata Mc Graw-Hill, 2000.
3. Jagan Nathan Vaman, ERP in Practice, Tata McGraw-Hill, 2008.
4. Mahadeo Jaiswal and Ganesh Vanapalli, "Textbook of Enterprise Resource Planning" Macmillan India, 2009.
5. Simha R. Magal and Jeffery Word, "Essentials of Business Process and Information System", Wiley India, 2012
6. Vinod Kumar Garg and N.K. Venkitakrishnan, ERP- Concepts and Practice, Prentice Hall of India, 2011.

MF23029 **MANUFACTURING PROCESSES**

L	T	P	C
3	0	0	3

Pre requisites: Basic knowledge in material properties and terminologies

OBJECTIVES:

To impart overall knowledge on the basics of manufacturing processes such as Casting, Forming, Joining, Material removal and Property enhancing operations.

UNIT I SOLIDIFICATION PROCESSES **9**

Introduction to casting – Casting terminology - Heating and Pouring - Solidification and Cooling - Pattern allowances - Types of patterns – Types of moulds - Expendable-Mould Casting Processes – Sand casting – Cores and core making – Other expendable-moulding processes – Nonexpendable-Mould Casting processes – Metal moulding - Die casting – Centrifugal casting – Investment casting.

UNIT II METAL FORMING AND SHEET METAL WORKING **9**

Introduction to Metal Forming - Material Behaviour in Metal Forming - Temperature in Metal Forming - Friction and Lubrication in Metal Forming; Bulk deformation processes in metalworking – Rolling – Forging – Extrusion – Wire and Bar drawing; Sheet metal working processes –Shearing operations – Bending operations – Drawing operations - Presses and dies.

UNIT III JOINING AND ASSEMBLY PROCESSES **9**

Overview of Welding technology – Physics of welding – Welding processes – Arc welding – Resistance welding – Oxyfuel Gas welding – Solid state welding – Weld quality – Weldability – Welding equipments; Brazing – Soldering – Adhesive bonding.- Threaded fasteners – Rivets and Interference fitting.

UNIT IV MATERIAL REMOVAL PROCESSES **9**

Theory of chip formation in machining – Cutting force, Temperature and surface finish in metal cutting – Cutting tool Geometry and materials - Cutting parameters; Turning and related Operations – Hole making operations - Milling operations – Shaping, Planing and Broaching operations – Abrasive operations – Grinding – Honing – Lapping operations.

UNIT V PROPERTY ENHANCING AND SURFACE PROCESSING OPERATIONS **9**

Heat treatment of metals - Iron carbon diagram - Annealing - Normalizing – Hardening - Tempering – Precipitation hardening - Surface hardening processes – Case hardening – Nitriding – Induction hardening – Vacuum treatment - Heat treatment furnaces; Thermal and mechanical coating processes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

CO1 Gain basic knowledge in casting and explain different types of casting methods.

CO2 Explain different types of bulk forming and sheet metal operations.

CO3 Understand the basics of welding and explain different types of joining processes.

CO4 Understand the mechanism of metal removal and different types of material removal operations.

CO5 Understand the property enhancement processes.

CO - PO MAPPING :

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	1	-	-	-	-	-	-	-	-	2	1	3	1
2	3	1	1	-	-	-	-	-	-	-	-	2	1	3	1
3	3	1	1	-	-	-	-	-	-	-	-	2	1	3	1
4	3	1	1	-	-	-	-	-	-	-	-	2	1	3	1
5	3	1	1	-	-	-	-	-	-	-	-	2	1	3	1
Avg	3	1	1	-	-	-	-	-	-	-	-	2	1	3	1

TEXT BOOKS

1. Jain R.K., "Production Technology: Manufacturing Processes, Technology and Automation", 17th Edition, Khanna publication, India,
2. P N Rao, Manufacturing technology, Volume I, Foundry, Forming and Welding, McGraw Hill Education (India) Private Limited
3. P N Rao, Manufacturing technology, Volume II, Metal Cutting and Machine Tools, McGraw Hill Education (India) Private Limited.
4. R.K. Rajput, A textbook of manufacturing technology (Manufacturing Processes): Laxmi Publications (p) Ltd.

REFERENCE BOOKS

1. Serope Kalpakjian, Steven R. Schmid, Manufacturing Processes for Engineering Materials, Pearson, 6th Edition.
2. J. T. Black, Ronald A. Kohser - DeGarmo's Materials and Processes in Manufacturing, 13th Edition, Wiley.
3. Mikell P. Groover, Fundamentals of Modern Manufacturing - Materials, Processes, and Systems, Seventh Edition.
4. Amitabha Ghosh and Asok Kumar Mallik, Manufacturing science, Second Edition, Affiliated East-West Press Private Limited, New Delhi.

MF23030	CAD/CAM	L	T	P	C
		3	0	0	3

The main learning objective of this course is to familiarize the students with the concepts of CAD and CAM to students

UNIT I FUNDAMENTALS OF COMPUTER GRAPHICS 9

Product cycle- Design process - Computer Aided Design – Computer graphics – co-ordinate systems- 2D and 3D transformations- homogeneous coordinates - graphic primitives (point, line, circle drawing algorithms) - Clipping- viewing transformation.

UNIT II GEOMETRIC MODELING & CAD STANDARDS 9

Representation of curves - Hermite cubic spline curve, Bezier curve, B-spline curves, Surface Modeling – Surface Entities, Representation of Surface, Bezier Surface, B-Spline Surface, Solid Modeling, Boundary Representation (B- Rep), Sweeps Representation, Constructive Solid Geometry (CSG).

Standards for computer graphics- Graphical Kernel System (GKS) - Data exchange standards - IGES, STEP and DXF - communication standards.

UNIT III INTRODUCTION TO CNC MACHINE TOOLS 9

Evolution of CNC Technology - principles - features - advantages - applications - CNC controllers - characteristics - interpolators - types of CNC Machines – construction, operation, machine specification of turning centre - machining centre (3 and higher axes) - grinding machine - vertical turret lathe - turn-mill centre – multitask machines

UNIT IV CNC PROGRAMMING, TOOLING AND WORK HOLDING DEVICES 9

Coordinate system - Simple program - structure of a CNC part program - G & M Codes - tool length compensation - cutter radius and tool nose radius compensation - canned cycles- generation of CNC codes from CAM packages.

Cutting tool materials for CNC machine tools- hard metal insert tooling- inserts and tool holder classification - qualified - semi qualified and preset tooling - ATC - APC - work holding devices for rotating and fixed work parts.

UNIT V CELLULAR MANUFACTURING AND FLEXIBLE MANUFACTURING SYSTEM (FMS) 9

Group Technology(GT), Part Families–Parts Classification and coding–Simple Problems in Opitz Part Coding system–Production flow Analysis–Cellular Manufacturing–Composite part concept–Types of Flexibility — FMS — FMS Components — FMS Application & Benefits — FMS Planning and Control — Quantitative analysis in FMS

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

CO1 : Employ the fundamental concepts of computer graphics and its tools in a generic framework.

CO2 : Create and manipulate the geometric models using curves, surfaces, solids and to understand the various standard used in CAD.

CO3 : Understand the evolution, types and principle of CNC machine tools.

CO4 : Demonstrate competency in manual part program and generation of CNC part program using CAM packages and to understand the cutting tools used in CNC machine tools.

CO5 : To introduce the concept of cellular manufacturing and flexible manufacturing system.

CO - PO MAPPING :

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2		3									2	1	
2	3	3	2		3								2	1	
3	3				2	2							3	3	
4	3	2			3		2						2	3	
5		3	2	2	3								3	3	
Avg	3	2.5	2	2.5	2.75	2	2						2.4	2.2	

TEXT BOOKS

1. Ibrahim Zeid "Mastering CAD CAM" Tata McGraw-Hill Publishing Co., 2007.
2. P. N. Rao, CAD/CAM: Principles and Applications, Tata McGraw-Hill Publishing Co., 2010, ISBN: 9780070681934.

REFERENCES

1. Groover, M. P., CAD/CAM: Computer-Aided Design and Manufacturing, Pearson Education, 2008.
2. Chris McMahon and Jimmie Browne "CAD/CAM Principles, practice and manufacturing management "Pearson education Asia, 2001.
3. HMT, "Mechatronics", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2017, ISBN- 13: 978-0074636435.
4. Mike Mattson., "CNC Programming Principles and Applications", 2nd Edition, Delmar Cengage learning, United States, 2010, ISBN: 9781418060992.
5. Radhakrishnan P., "Computer Numerical Control Machines and Computer Aided Manufacturing", New Age International Publishers., United States, 2018, ISBN-13: 978-8122433975.

MF23031	ADVANCES IN MANUFACTURING	L	T	P	C
		3	0	0	3

PREREQUISITE: Basic knowledge of machining processes (traditional and non- traditional machining), Familiarity with machining processes and terminology, Fundamental knowledge of materials and their properties, Basic knowledge of materials deformation and mechanics, Understanding of material properties at micro scales, Basic knowledge of computer networks and communication protocols, Awareness of data analytics and its application in manufacturing.

OBJECTIVES:

To analyze various non-traditional and precision machining techniques, understand contemporary metal forming methods, distinguish between micromachining and microfabrication, and develop smart manufacturing systems.

UNIT I UNCONVENTIONAL MACHINING 9

Introduction - Electrical discharge machining - Micro electrical discharge machining - Wire electrical discharge machining - Micro wire electrical discharge machining - Electro chemical machining - Ultrasonic machining - Plasma arc machining- Laser beam machining- Electron beam machining - Ion beam machining - Abrasive flow machining - Abrasive water jet machining- Comparison of different non-traditional machining processes- Hybrid machining processes.

UNIT II PRECISION MACHINING 9

Introduction - Ductile mode machining of hard and brittle materials - Ultra precision grinding and selection of grinding wheels - Electrolytic in process dressing -Chemical mechanical polishing - Diamond turn machining - High speed machining -Magneto rheological finishing processes.

UNIT III MODERN METAL FORMING 9

Introduction - Orbital forging - Isothermal forging - Rubber pad forming –Incremental forming - Fine blanking -Powder forming: Powder rolling, Powder extrusion - High speed extrusion.

UNIT IV MICRO MACHINING AND MICRO FABRICATION 9

Introduction - Mechanical micro machining - Micromachining tool design - Chip formation - Size effect in micromachining - micro turning, micro milling. Micro drilling- micro machine tools. Introduction to micro fabrication - LIGA, surface micromachining - Bulk micromachining - Etching - Sputtering - Chemical vapor deposition - Physical vapor deposition.

UNIT V ELECTRONICS MANUFACTURING 9

Wafer preparation - fabrication of Printed circuit board- Electronics packaging, types-Through hole technology(THT) and Surface mount technology (SMT) - Through hole components – axial, radial, multi leaded, odd form. Surface-mount components - SMT Process – stencil printing process - Component placement- soldering- wave soldering, reflow process, Inspection techniques - design for manufacturability, assembly, reliability, and environment, e-waste management. Repair Reuse Recycling (RRR) of electronic packaging.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

CO1: Categories different non-traditional machining processes.
CO2: Infer the different precision machining processes.
CO3: Recognize the modern metal forming processes.
CO4: Interpret different micro machining and micro fabrication techniques.
CO5: Demonstrate the Industry 4.0 and smart manufacturing system concepts.

CO - PO MAPPING :

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	1						1	2	2	2	1
2	3	2	1	1	1						1	2	2	2	1
3	3	2	1	1	1						1	2	2	2	2
4	3	2	1	1	1						1	2	2	2	1
5	2	2	1	1	3						3	2	2	2	1
Avg	2.8	2	1	1	1.4						1.4	2	2	2	1.2

REFERENCES:

1. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", A press, 2016.
2. Anand Pandey, "Modern Machining Processes", Ane Books Pvt. Ltd., New Delhi, 2019.
3. Balasubramaniam R. and Ramagoplan V.S, Sathyan Subbiah, "Diamond Turn Machining", CRC Press, New York, 2018.
4. Jain V.K., "Introduction to Micromachining", Narosa, New Delhi, 2014.
5. Kalpakjian S., and Schmid S.R., "Manufacturing Processes for Engineering Materials", Pearson, New Delhi, 2012.
6. Venkatesh V. C. and SudinIzman, "Precision Engineering", Tata McGraw-Hill, New Delhi, 2007.

MF23032 METROLOGY AND STATISTICAL QUALITY CONTROL L T P C

3 0 0 3

COURSE OBJECTIVES:

To provide students with a comprehensive understanding of measurement principles, techniques, and standards in metrology, while introducing them to advanced metrology methods and quality control concepts, ensuring they can apply this knowledge to maintain precision and accuracy in manufacturing processes.

UNIT I FUNDAMENTALS OF MEASUREMENTS 9

Introduction to Metrology – Elements of measurements – Precision and Accuracy – Methods of Measurement – Errors in Measurements – Causes – Standards and Calibration – Types of Standards – Clean Room – Types, Do's and Don'ts in Metrology Laboratory.

UNIT II LINEAR AND ANGULAR MEASUREMENTS 9

Comparators – Types, Advantages and Disadvantages, Slip Gauges, Rollers, Limit Gauges – Design – Types – Principles – Applications: Auto collimator – Angle Dekkor – Alignment Telescope – Sine Bar – Bevel Protractors.

UNIT III SURFACE FINISH AND ADVANCES IN METROLOGY 9

Surface Roughness – Roughness Parameters – Importance of Roughness – 2 D Roughness Measurement – Importance of 3 D Roughness Measurement.

Principle of Interference – Michelson Interferometer, Heterodyne Laser Interferometer, Machine Vision and Applications in Metrology, Co–ordinate Measuring Machines – Constructional Features – Types – Applications of CMMs.

UNIT IV INTRODUCTION TO QUALITY CONCEPTS 9

Quality – Definitions, Quality Improvement; Brief History of Quality Methodology; Statistical Methods for Quality Control and Improvement; Total Quality Management

UNIT V CONTROL CHARTS FOR VARIABLES AND ATTRIBUTES 9

Control Chart Technique Control Charts for Variables, Control Chart for Mean (X-Chart), Range Chart (R-Chart), Standard Deviation Chart (S-Chart), Process Capability Analysis

Control charts for attributes: np-chart, p-chart, c-chart and u-chart. Acceptance sampling plans for attributes, producer's risk and consumer's risk.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course the students shall be able to:

CO1: Explain the fundamentals of metrology, including elements of measurements, precision, accuracy, errors, standards, and calibration.

CO2: Apply linear and angular measurement techniques, including the use of comparators, slip gauges, limit gauges, and angular measurement devices.

CO3: Analyze surface finish parameters and utilize advanced metrology tools such as interferometers, machine vision systems, and coordinate measuring machines.

CO4: Understand and implement quality concepts, including the history, methodologies, and statistical methods for quality control and improvement.

CO5: Utilize control charts for variables and attributes to monitor and improve manufacturing processes, and understand the principles of acceptance sampling plans.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	2	2	2	2	-	-	-	-	1	3	3	3
2	2	2	2	2	2	2	2	-	-	-	-	1	3	3	3
3	2	2	3	3	3	3	2	-	-	-	-	1	3	3	3
4	2	2	3	3	3	3	2	-	-	-	-	1	3	3	3
5	2	2	3	3	3	3	2	-	-	-	-	1	3	3	3
Avg	2.2	2.2	2.6	2.6	2.6	2.6	2					1	3	3	3

TEXT BOOKS:

1. **"Engineering Metrology and Measurements"** by R.K. Jain, Khanna Publishers, 21st Edition, 2016.
2. **"Mechanical Measurements"** by Thomas G. Beckwith, Roy D. Marangoni, and John H. Lienhard V, Pearson Education, 6th Edition, 2007.
3. **"Metrology for Engineers"** by J.F.W. Galyer and Charles R. Shotbolt, Cassell, 5th Edition, 1990.
4. **"Quality Control and Industrial Statistics"** by A.J. Duncan, Irwin/McGraw-Hill, 5th Edition, 1986.
5. **"Statistical Quality Control"** by Eugene L. Grant and Richard S. Leavenworth, McGraw-Hill Education, 7th Edition, 1996.

MF23033 **SMART MANUFACTURING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:
To introduce Industry 4.0 concepts, including smart factories and Digital Twin, familiarize students with the Internet of Things (IoT) and Artificial Intelligence & Machine Learning (AI & ML), and impart knowledge on Cyber-Physical Systems (CPS) and their various elements.

UNIT I PRINCIPLE OF INDUSTRY 4.0 & SMART FACTORY **9**
Industry 4.0 — Definition, principles, Introduction to Industry 4.0: Industry 4.0: Globalization and Emerging Issues, Smart and Connected Business Perspective, Smart Factories, Industry 4.0: Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis Industrial Revolutions, Benefits of Industry 4.0, challenges in Industry 4.0, Smart manufacturing, Internet of Things, Industrial Gateways, Basics of Communication requirements. Application of Industry 4.0 in process & discrete industries.

UNIT II CYBER PHYSICAL SYSTEMS **9**
Cyber Physical Systems in Real world, Basic Principle of Cyber Physical Systems, CPS Design Recommendations, CPS system requirements, Cyber Physical System Application, Case study of Cyber Physical Systems, Hardware platforms for Cyber Physical Systems (Sensors/Actuators, Microprocessor/Microcontrollers), Wireless Technologies for Cyber Physical Systems, Continuous Dynamics, Discrete dynamics, Hybrid Systems, Structure of Models, Synchronous Reactive models, Dataflow models of computation, Timed models of computation. Security and Privacy Issues in CPSs, Local Network Security for CPSs, Internet-Wide Secure Communication, Security and Privacy for Cloud-Interconnected CPSs, Case Study: Cybersecurity in Digital Manufacturing/Industry 4.0

UNIT III DIGITAL TWIN IN MANUFACTURING **9**
Digital twin - Definition, types of Industry & its key requirements, Importance, Application of Digital Twin in process, product, service industries. Real time use of Digital Twin, Benefits, impact and challenges, Features and Implementation of Digital Twins, Types of Digital Twins, Digital Twin use cases, Applications for digital twins in Manufacturing

UNIT IV AI / ML IN MANUFACTURING **9**
Machine Learning Application, Basics of Machine Learning, The Machine Learning Process, Machine Learning working cycle, Preparing Data, Running Experiments, Finding the Model, Training the Model, Deploying and using a Model, Machine Learning in practice (examples of existing or future applications in the field of manufacturing)

UNIT V CPS BUSINESS MODELS **9**
Cyber-Physical Systems and new Business Models, How CPS can induce new Business Models, The Role of horizontal and vertical value streams, New Business Models for the Smart Factory, Characteristics of Business Models within the Smart Factory, Examples of new Business Models - Business Model: Service provider - Business Model: Data provider - Business Model: Technology provider - Business Model: Platform provider

T: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Acquire knowledge on Industry 4.0 & smart factory
CO2: Understand various elements of cyber physical systems
CO3: Support and value digital twin in process and discrete industry.
CO4: Support and value AI / ML in manufacturing

CO5: Describe the CPS business models

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	2	2	-	1	2	-	-	2	-	3	2	2	2
2	3	2	1	2	-	1	1	-	-	2	-	3	2	1	1
3	3	2	1	2	-	1	1	-	-	2	-	3	2	3	3
4	3	1	1	1	2	1	1	-	-	2	-	3	2	2	2
5	3	1	1	1	2	1	1	-	-	2	-	3	2	2	2
Avg.	3	1.4	1.2	1.6	2	1	1.2	-	-	2	-	3	2	2	2

TEXT BOOKS:

1. Alp Ustundag and Emre Cevikcan, "Industry 4.0: Managing The Digital Transformation", Springer Series in Advanced Manufacturing., Switzerland, 2017
2. Principles of Cyber Physical Systems, Rajeev Alur, MIT Press, 2015
3. E. A. Lee, Sanjit Seshia , "Introduction to Embedded Systems – A Cyber–Physical Systems Approach", Second Edition, MIT Press, 2017

REFERENCES:

1. Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, "Digital Twin Driven Smart Manufacturing", Elsevier Science., United States, 2019
2. Introduction to Industrial Internet of Things and Industry 4.0, Sudip Misra, Chandana Roy, Anandarup Mukherjee, CRC Press, 2020.
3. Ïnternet of Things - A Hands on Approach, Vijay Madisetti, Arshdeep Bahga, University Press.
4. Introduction to Internet of Things: A practical Approach, Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, ETI Labs.
5. The Internet of Things: Enabling Technologies, Platforms, and Use Cases, Pethuru Raj and Anupama C. Raman, CRC Press. 5. Designing the Internet of Things, Adrian McEwen, Wiley
6. Alasdair Gilchrist , "Industry 4.0: The Industrial Internet of Things", Apress., United States ,2015.
7. Christoph Jan Bartodziej, "The Concept Industry 4.0 An Empirical Analysis of Technologies and Applications in Production Logistics", Springer Gambler., Germany, 2017.

MF23034 MANUFACTURING MANAGEMENT SYSTEMS L T P C
3 0 0 3

COURSE OBJECTIVES:
To introduce students to the planning of manufacturing systems through demand and supply management, resource management, and shop floor planning and control, while also gaining knowledge on designing forecasting systems, various forecasting methods, MRP, ERP, DRP, and tools for shop floor data collection and control.

UNIT I MANUFACTURING PLANNING AND CONTROL 9
Basic concepts – Types of Production System – Functions of Production Planning and Control – Problems with Production Planning and Control – Computer Integrated Production Management System – Evolution of the Manufacturing Planning and Control (MPC) System-Demand Management in MPC System and the MPC Environment: Make-to-stock, Assemble-to-order, Make-to-order, Engineer-to-order.

UNIT II FORECASTING 9
Forecasting –Forecasting Methods- Intuitive forecasting – Extrapolation- Prediction- Time Horizon – Design of Forecasting Systems – Developing the Forecast Logic – Single and Double Moving Average Methods, Single and Double Exponential Smoothing Methods, Simple Regression Method of Forecasting – Forecast uncertainty- Improving forecast -Measure of Forecast Accuracy.

UNIT III RESOURCE PLANNING - SIMPLIFY 9
Material Requirement Planning (MRP)– Inputs- Open-loop control systems : items and BOMs- Inventory Management concepts -Inventory records - Master production scheduling: Stability- Mechanics- MPS techniques- - Evolution of MRP - Capacity planning- -Infinite vs finite capacity scheduling - Optimization - Sequencing - Problems - Feedback and work to lists- Rough-cut capacity planning -Optimized production technology- OPT principles- Scheduling logic – Distribution Resource Planning (DRP)-Case Studies.

UNIT IV COMPUTER AIDED PROCESS PLANNING 9
Need for Process Planning – Functions of Process Planning – Approaches to Computer Aided Process Planning (CAPP) – Variant Process Planning :Group Technology, Part Family Search – Generative method of CAPP: Input Format – Part Description Methods– Computer Aided Design (CAD) Models – Decision Logic – Artificial Intelligence – Knowledge Representation – Forward and Backward Planning – Databases and Algorithms – Expert Process Planning - Automatic Process Planning – Future Trends–Case Studies.

UNIT V SHOP FLOOR CONTROL 9
Functions of Shop Floor Control – Order Release – Order Scheduling: Job Sequencing and Priority Rules – Order Progress –Shop-floor Data Collection Systems - Online and Offline Data Collection Systems -Definition of shop-floor data collection- Rationale for shop-floor data collection- Methods of shop-floor data collection - Computerized SFDC- Technologies for SFDC - Bar codes - Introduction - Bar code technology - Bar code readers - Characteristics of bar codes - Electronic labels- Implementation- Advantages and problems with electronic labels - Other types of SFDC system - Optical character recognition- Magnetic strips - Direct links to process control devices - Voice recognition systems- The people factor.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students shall be able to:
CO1: Be familiarized with the latest trends in manufacturing planning and control System
CO2: Perceive design of forecasting systems and different forecasting methods

CO3: Be acquainted with the basic concepts of resource requirements
CO4: Recognize the need and approaches of computer aided process planning
CO5: Evaluate the functions of shop floor control and associated systems.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	-	3	3	3	3	-	-	3	3	-	3	3	3	3	3
2	-	3	3	3	3	-	-	3	3	-	3	3	3	3	3
3	-	3	3	3	3	-	-	3	3	-	3	3	3	3	3
4	-	3	3	3	3	-	-	3	3	-	3	3	3	3	3
5	-	3	3	3	3	-	-	3	3	-	3	3	3	3	3
Avg	-	3	3	3	3	-	-	3	3	-	3	3	3	3	3

TEXT BOOKS

1. Groover M.P., "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India., 2016, ISBN-13: 978-9332572492.
2. Thomas E. Vollmann, William Lee Berry, David Clay Whybark and F. Robert Jacobs, "Manufacturing Planning and Control Systems for Supply Chain Management" , MCGraw Hill., United States, 2014, ISBN: 9789339205331.
3. David K. Harrison and David J. Petty," Systems for Planning and Control in Manufacturing Systems and management for competitive manufacture", Newones, 2002 ,ISBN:0750649771

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1. Dr. Franjo Cecelja, "Manufacturing Information and Data Systems" , Penton Press,2002, ISBN 1 8571 8031 3
2. Chand T.C., "Expert process planning for manufacturing", Addison Wesley publishing company., United States, 1990, ISBN-13: 978-0201182972.
3. Groover M. and Zimmers E., "CAD/CAM, Computer Aided Design and Manufacturing", Prentice Hall of India., Reprint 2013, ISBN-13: 978-0131101302.
4. Mahadevan .B, "Operations Management: Theory and practice", Pearson., United Kingdom, 2015, ISBN-13: 978-9332547520.
5. Mahapatra, P.B.," Computer-Aided Production Management", Prentice-Hall of India Pvt. Limited., 2004, ISBN-13: 978-8120317420.
6. Nanua Singh, "System Approach to Computer Integrated Design and Manufacturing", Wiley India Edition., Reprint 2011, ISBN-13: 978-0471585176.
7. Wallace J. Hopp Mark L. Spearman, "Factory Physics", Third Edition, Waveland Press, Inc.,2011, ISBN 978-1-57766-739-1

ONLINE COURSE MATERIALS

Course Material from NPTEL: http://nptel.ac.in/courses/112102101/

UC23E01 ENGINEERING ENTREPRENEURSHIP DEVELOPMENT

L	T	P	C
2	0	2	3

COURSE OBJECTIVES:

1. Learn basic concepts in entrepreneurship, develop mind-set and skills necessary to explore entrepreneurship
2. Apply process of problem - opportunity identification and validation through human centred approach to design thinking in building solutions as part of engineering projects
3. Analyse market types, conduct market estimation, identify customers, create customer persona, develop the skills to create a compelling value proposition and build a Minimum Viable Product
4. Explore business models, create business plan, conduct financial analysis and feasibility analysis to assess the financial viability of a venture ideas & solutions built with domain expertise
5. Prepare and present an investible pitch deck of their practice venture to attract stakeholders

MODULE – I: ENTREPRENEURIAL MINDSET **4L,8P**

Introduction to Entrepreneurship: Definition – Types of Entrepreneurs – Emerging Economies – Developing and Understanding an Entrepreneurial Mindset – Importance of Technology Entrepreneurship – Benefits to the Society.

Case Analysis: Study cases of successful & failed engineering entrepreneurs - Foster Creative Thinking: Engage in a series of Problem-Identification and Problem-Solving tasks

MODULE – II: OPPORTUNITIES **4L,8P**

Problems and Opportunities – Ideas and Opportunities – Identifying problems in society – Creation of opportunities – Exploring Market Types – Estimating the Market Size, - Knowing the Customer and Consumer - Customer Segmentation - Identifying niche markets – Customer discovery and validation; Market research techniques, tools for validation of ideas and opportunities

Activity Session: Identify emerging sectors / potential opportunities in existing markets - Customer Interviews: Conduct preliminary interviews with potential customers for Opportunity Validation - Analyse feedback to refine the opportunity.

MODULE – III: PROTOTYPING & ITERATION **4L,8P**

Prototyping – Importance in entrepreneurial process – Types of Prototypes - Different methods – Tools & Techniques.

Hands-on sessions on prototyping tools (3D printing, electronics, software), Develop a prototype based on identified opportunities; Receive feedback and iterate on the prototypes.

MODULE – IV: BUSINESS MODELS & PITCHING **4L,8P**

Business Model and Types - Lean Approach - 9 block Lean Canvas Model - Riskiest Assumptions in Business Model Design – Using Business Model Canvas as a Tool – Pitching Techniques:

Importance of pitching - Types of pitches - crafting a compelling pitch – pitch presentation skills - using storytelling to gain investor/customer attention.

Activity Session: Develop a business model canvas for the prototype; present and receive feedback from peers and mentors - Prepare and practice pitching the business ideas- Participate in a Pitching Competition and present to a panel of judges - receive & reflect feedback

MODULE – V: ENTREPRENEURIAL ECOSYSTEM **4L,8P**

Understanding the Entrepreneurial Ecosystem – Components: Angels, Venture Capitalists, Maker Spaces, Incubators, Accelerators, Investors. Financing models – equity, debt, crowdfunding, etc, Support from the government and corporates. Navigating Ecosystem Support: Searching & Identifying the Right Ecosystem Partner – Leveraging the Ecosystem - Building the right stakeholder network

Activity Session: Arrangement of Guest Speaker Sessions by successful entrepreneurs and entrepreneurial ecosystem leaders (incubation managers; angels; etc), Visit one or two entrepreneurial ecosystem players (Travel and visit a research park or incubator or makerspace or interact with startup founders).

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Develop an Entrepreneurial Mind-set and Understand the Entrepreneurial Ecosystem Components and Funding types

CO2: Comprehend the process of opportunity identification through design thinking, identify market potential and customers

CO3: Generate and develop creative ideas through ideation techniques

CO4: Create prototypes to materialize design concepts and conduct testing to gather feedback and refine prototypes to build a validated MVP

CO5: Analyse and refine business models to ensure sustainability and profitability Prepare and deliver an investible pitch deck of their practice venture to attract stakeholders

REFERENCES:

1. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha (2020). Entrepreneurship, McGrawHill, 11th Edition
2. Bill Aulet (2024). Disciplined Entrepreneurship: 24 Steps to a Successful Startup. John Wiley & Sons.
3. Bill Aulet (2017). Disciplined Entrepreneurship Workbook. John Wiley & Sons.
4. Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business
5. Blank, S. G., & Dorf, B. (2012). The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company. K&S Ranch
6. Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons

7. Marc Gruber & Sharon Tal (2019). Where to Play: 3 Steps for Discovering Your Most Valuable Market Opportunities. Pearson.