ANNA UNIVERSITY, CHENNAI

UNDERGRADUATE CURRICULUM (UNIVERSITY DEPARTMENTS)

Campus: Madras Institute of Technology

Department: Production Technology

Programme: Production 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	1		23
II	4		7	11				1		23
III	16		4	4			1			25
IV	20						2	2		24
V	20						2	3		25
VI		15			3	3	1		1	23
VII	6	3			3	3	3	4		22
VIII							8			8
Total	66	18	15	26	6	6	24	11	1	173
% of Category	38	10	9	15	3	3	14	6	1	100

CATEGORY OF COURSES

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

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

*** TCP –** Total Contact Period(s)

#**TYPE OF COURSE**

LIT –Laboratory Integrated Theory
T – Theory
L – Laboratory Course
IPW – Internship cum Project Work
PW – Project Work
CDP – Capstone Design Project

Semester– I							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / 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	EE23C04	Electrical, Electronics and Measurements Engineering	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	-	UC
9		Audit Course – I		2-0-0	2	-	UC
					Total Credits	**23**	

Semester– II							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / 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	CS23C02	Computer Programming in Python	LIT	3-0-2	5	4	ESC
5	ME23C03	Engineering Mechanics	T	3-1-0	4	4	ESC
6	PR23201	Engineering Materials	LIT	3-0-2	5	4	PCC
7	UC23H02	தமிழரும் தொழில் நுட்பமும் / Tamils and Technology	T	1-0-0	1	1	UC
					Total Credits	**24**	

SEMESTER– III							
S. No.	Course Code	Course Name	Course type	Periods / week		Credits	Cate Gory
				L-T-P	TCP		
1	MA23C08	Numerical Methods	T	3-1-0	4	4	HSMC
2	AU23C02	Mechanics of Solids	LIT	3-0-2	5	4	ESC
3	PR23C01	Theory of Machines	LIT	3-0-2	5	4	PCC
4	CE23C02	Fluid Mechanics and Machinery	LIT	3-0-2	5	4	PCC
5	PR23301	Foundry and Welding Technology	LIT	3-0-2	5	4	PCC
6	PR23302	Metal Forming	LIT	3-0-2	5	4	PCC
7		Skill Development Course Level –I	L	0-0-2	2	1	SDC
8		Audit Course – II		2-0-0	2	-	UC
TOTAL CREDITS						**25**	

Semester– IV							
S. No.	Course Code	Course Name	Course Type	Periods / Week		Credits	Category
				L-T-P	TCP		
1	PR23401	Machine Component Design	T	3-1-0	4	4	PCC
2	PR23402	CNC Machines and Automated Production Systems	LIT	3-0-2	5	4	PCC
3	PR23403	Machining Processes	LIT	3-0-2	5	4	PCC
4	PR23404	Statistics for Production Management	LIT	2-0-2	4	3	PCC
5	AU23C01	Applied Thermodynamics	LIT	3-0-2	5	4	PCC
6	UC23U01	Universal Human Values	LIT	1-0-2	3	2	UC
7	PR23405	Material Processing Laboratory	L	0-0-2	2	1	PCC
8		Industry Oriented Course - I	T	1-0-0	1	1	SDC
9		Skill Development Course Level-II	L	0-0-2	2	1	SDC
Total Credits						**24**	

Semester– V							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1	PR23501	Quantitative Techniques in Management	LIT	3-0-2	5	4	PCC
2	PR23502	Computer Aided Design and Analysis	LIT	3-0-4	7	5	PCC
3	PR23503	Mechanical Measurements and Metrology	LIT	3-0-2	5	4	PCC
4	PR23504	Unconventional Machining Technologies	T	3-0-0	3	3	PCC
5	PR23505	Fluid Power Systems	LIT	3-0-2	5	4	PCC
6	PR23U02	Perspectives of Sustainable Development in Production Engineering	T	3-0-0	3	3	UC
7		Skill Development Course Level –III	L	0-0-2	2	1	SDC
8		Industry Oriented Course-II	T	1-0-0	1	1	SDC
					Total Credits	**25**	
Courses for Honors Degree							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.	PR23D01	Capstone Design Project – Level I	CDP	0-0-8	8	4	SDC
(OR)							
1.		Honours Elective – I	T	3-0-0	3	3	
2.		Honours Elective – II	T	3-0-0	3	3	

Courses for Minor Degree							
1.		Minor Elective – I	T	3-0-0	3	3	
2.		Minor Elective – II	T	3-0-0	3	3	

Semester– VI (Preference for Foreign Exchange)							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / 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		Emerging Technology Course - I	T	3-0-0	3	3	ETC
7		Open Elective – I	T	3-0-0	3	3	OEC
8		Industry Oriented Course-III	T	1-0-0	1	1	SDC
9	PR23L01	Self Learning Course	T	1-0-0	0	1	SLC
				Total Credits		**23**	

Courses for Honours Degree							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.	PR23D02	Capstone Design Project-Level II	CDP	0-0-12	12	6	SDC
(OR)							
1.		Honours Elective – III					
2.		Honours Elective – IV					
Courses for Minor Degree							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.		Minor Elective – III					
2.		Minor Elective – IV					

Semester– VII							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1	PR23701	Mechatronics	LIT	3-0-2	5	4	PCC
2		Professional Elective – VI	T	3-0-0	3	3	PEC
3		Emerging Technology Course –II	T	3-0-0	3	3	ETC
4		Open Elective – II	T	3-0-0	3	3	OEC
5	UC23E01	Engineering Entrepreneurship Development	T	2-0-2	4	3	UC
6	PR23U01	Standards for Production Engineering	T	1-0-0	1	1	UC
7	PR23702	Advanced Manufacturing Laboratory	L	0-0-2	2	1	PCC
8	PR23703	Comprehension	L	0-0-1	1	1	PCC
9	PR23704	Mini Project		0-0-4	4	2	SDC
10	PR23705	Summer Internship		0-0-2	2	1	SDC
				Total Credits		**22**	
Courses for Honours Degree							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.	PR23D03	Capstone Design Project – Level III	CDP	0-0-16	16	8	SDC
(OR)							
1.		Honours Elective – V					
2.		Honours Elective – VI					

Courses for Minor Degree							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.		Minor Elective – V					
2.		Minor Elective – VI					

Semester– VIII							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.	PR23801	Project Work / Internship cum Project Work	PW/IPW	0-0-16	16	8	SDC
Total Credits						**8**	

Professional Elective Courses:

Verticals

Sl. No.	Vertical 1 Adv. Manufacturing Processes	Vertical 2 Integrated Production systems	Vertical 3 Industrial Management	Vertical 4 Diagnostic and Quality Control	Vertical 5 Automation Engineering	Vertical 6 Diversified Group-I
1.	Direct Digital Manufacturing	Material Handling and Storage Systems	Experimental Design Techniques	Non-Destructive Testing and Evaluation	Electrical Drives and Actuators	Particulate Processing
2.	Production of Automotive Components	Digital Manufacturing	Total Quality Management	Condition Monitoring	Immersive Technologies and Haptics	Human Factors and Work Design
3.	Composite Materials	Product Life Cycle Management	Supply Chain inventory Management	Vibration Analysis and Control	Embedded Systems and Programming	Design of Press Tools
4.	Advanced Forming	Value Added Engineering	Lean Manufacturing and Six Sigma	GD&T in design and manufacturing	Micro Electro Mechanical Systems	Manufacturing of biomedical components
5.	Precision Manufacturing and Nano Technology	Design for Manufacturing and Assembly	Engineering Economics and Cost Analysis	Engineering Data Analytics	Industrial Automation	Reprocessing of Materials
6.	Design of Jigs ,Fixtures & Gauges	Industrial Safety and Management	Process Planning & Cost Estimation	Statistical Quality Control and Reliability	Machine Vision	Heat and Mass Transfer

PROFESSIONAL ELECTIVE COURSES (PEC)

Vertical 1: Advanced Manufacturing Processes							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.	PR23001	Direct Digital Manufacturing	T	3-0-0	3	3	PEC
2.	PR23002	Production of Automotive Components	T	3-0-0	3	3	PEC
3.	PR23C02	Composite Materials	T	3-0-0	3	3	PEC
4.	PR23003	Advanced Forming	T	3-0-0	3	3	PEC
5.	PR23004	Precision Manufacturing and Nano Technology	T	3-0-0	3	3	PEC
6.	PR23C03	Design of Jigs, Fixtures & Gauges	T	3-0-0	3	3	PEC

Vertical 2: Integrated Production systems							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.	PR23005	Material Handling and Storage Systems	T	3-0-0	3	3	PEC
2.	PR23006	Digital Manufacturing	T	3-0-0	3	3	PEC
3.	IE23C04	Product Life Cycle Management	T	3-0-0	3	3	PEC
4.	PR23007	Value Added Engineering	T	3-0-0	3	3	PEC
5.	PR23008	Design for Manufacturing and Assembly	T	3-0-0	3	3	PEC
6.	PR23009	Industrial Safety and Management	T	3-0-0	3	3	PEC

Vertical 3: Industrial Management							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.	PR23010	Experimental Design Techniques	T	3-0-0	3	3	PEC
2.	IE23C07	Total Quality Management	T	3-0-0	3	3	PEC
3.	PR23011	Supply Chain Inventory Management	T	3-0-0	3	3	PEC
4.	IE23C03	Lean Manufacturing and Six Sigma	T	3-0-0	3	3	PEC
5.	PR23012	Engineering Economics and Cost Analysis	T	3-0-0	3	3	PEC
6.	PR23C08	Process Planning and Cost Estimation	T	3-0-0	3	3	PEC

Vertical 4: Diagnostic and Quality Control							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.	PR23013	Non-Destructive Testing and Evolution	T	3-0-0	3	3	PEC
2.	PR23C09	Condition Monitoring	T	3-0-0	3	3	PEC
3.	RA23C03	Vibration Analysis and Control	T	3-0-0	3	3	PEC
4.	PR23C04	GD&T in design and manufacturing	T	3-0-0	3	3	PEC
5.	RA23C01	Engineering Data Analytics	T	3-0-0	3	3	PEC
6.	PR23014	Statistical Quality Control and Reliability	T	3-0-0	3	3	PEC

Vertical 5: Automation Engineering							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.	PR23015	Electrical Drives and Actuators	T	3-0-0	3	3	PEC
2.	PR23016	Immersive technologies and Haptics	T	3-0-0	3	3	PEC
3.	PR23017	Embedded Systems and Programming	T	3-0-0	3	3	PEC
4.	PR23018	Micro Electro Mechanical Systems	T	3-0-0	3	3	PEC
5.	RA23C02	Industrial Automation	T	3-0-0	3	3	PEC
6.	PR23C05	Machine Vision	T	3-0-0	3	3	PEC

Vertical 6: Diversified Group- I							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.	PR23019	Particulate Processing	T	3-0-0	3	3	PEC
2.	PR23C07	Human Factors and Work Design	T	3-0-0	3	3	PEC
3.	PR23020	Design of Press Tools	T	3-0-0	3	3	PEC
4.	PR23021	Manufacturing of biomedical components	T	3-0-0	3	3	PEC
5.	PR23022	Reprocessing of Materials	T	3-0-0	3	3	PEC
6.	PR23023	Heat and Mass Transfer	T	3-0-0	3	3	PEC

Courses for Honors Degree							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.	PR23024	Advanced Casting and Joining	T	3-0-0	3	3	PEC
2.	PR23025	Surface Coating	T	3-0-0	3	3	PEC
3.	PR23026	Advanced Operations Research	T	3-0-0	3	3	PEC
4.	PR23027	Industrial Tribology	T	3-0-0	3	3	PEC
5.	PR23028	Robotics Engineering	T	3-0-0	3	3	PEC
6.	PR23029	Product Design and Development	T	3-0-0	3	3	PEC
7.	PR23030	Intelligent Manufacturing Systems	T	3-0-0	3	3	ETC
8.	PR23031	Processing of Semiconductor materials	T	3-0-0	3	3	ETC

Courses for Minors Degree in Production Engineering & Management							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.	PR23032	Machining Processes and Machine Tools	T	3-0-0	3	3	PCC
2.	PR23033	Foundry and Welding Processes	T	3-0-0	3	3	PCC
3.	PR23034	Statistical Quality Control and Reliability	T	3-0-0	3	3	PEC
4.	PR23C08	Process Planning and Cost Estimation	T	3-0-0	3	3	PCC
5.	PR23035	Supply Chain Inventory Management	T	3-0-0	3	3	PEC
6.	PR23C06	Material Handling and Storage Systems	T	3-0-0	3	3	PEC

Emerging Technology Courses							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
Semester V							
1	PR23E01	Machine Learning	T	3-0-0	3	3	ETC
2	PR23E02	Flexible Electronics Machine Learning Manufacturing	T	3-0-0	3	3	ETC
Semester VI							
4	PR23E03	Laser Based Manufacturing	T	3-0-0	3	3	ETC
5	PR23E04	Industrial 4.0 and IOT	T	3-0-0	3	3	ETC

Open Elective Courses							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1	PR23901	Biomimetic Engineering	T	3-0-0	3	3	OEC
2	PR23902	Reliability Analysis and Maintainability	T	3-0-0	3	3	OEC
3	PR23903	Supply chain Inventory management	T	3-0-0	3	3	OEC
4	PR23904	Lean six sigma	T	3-0-0	3	3	OEC
5	PR23905	Maintenance Engineering	T	3-0-0	3	3	OEC
6	PR23906	Green Electronics Manufacturing	T	3-0-0	3	3	OEC

Bridge Course For Lateral Entry Students (Diploma)							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.		Engineering Materials	T	3-0-2	5	4	PCC
2.		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.		Engineering Drawing& 3D Modelling	T	2-0-4	6	4	SDC
2.		Engineering Mechanics	T	3-1-0	4	4	ESC

List of Industrial Oriented Courses							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.		Engineering Plastic Parts Design& Development	T	1-0-0	1	1	SDC
2.		Geometric Dimensioning and Tolerance	T	1-0-0	1	1	SDC
3.		Non-Destructive Evaluation	T	1-0-0	1	1	SDC
4.		Piping Design	T	1-0-0	1	1	SDC
5.		Marine Vehicles	T	1-0-0	1	1	SDC
6.		Marine Robotics	T	1-0-0	1	1	SDC

List of Skill Development Courses							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
Level I							
1.	PR23S01	Essentials for NX Designers	L	0-0-2	2	1	SDC
2.	PR23S02	TURNING -Numerical control programming	L	0-0-2	2	1	SDC
3.	PR23S03	Basics of PLC	L	0-0-2	2	1	SDC
Level II							
4.	PR23S04	Synchronous Modelling and Parametric Design	L	0-0-2	2	1	SDC
5.	PR23S05	MILLING -Numerical control programming	L	0-0-2	2	1	SDC
6.	PR23S06	Basic of Industrial Robotics – KUKA robots	L	0-0-2	2	1	SDC
Level III							
7.	PR23S07	NX Sheet Metal	L	0-0-2	2	1	SDC
8.	PR23S08	Rapid Prototyping Technology	L	0-0-2	2	1	SDC
9.	PR23S09	Advanced Industrial Robotics – KUKA robots	L	0-0-2	2	1	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. Government College of Engineering, Tirunelveli 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

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

ME23C01	ENGINEERING DRAWING AND 3D MODELLING	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 6+12

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)

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 6+12

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

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 6+12

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

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 6+12

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

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 6+12

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

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

Question pattern suggestion: Part – A (Either or type) (5 × 16 = 80) & Part – B (Compulsory) (1 × 20 = 20)

COURSE OUTCOME:-

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 softwares

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

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

TEXTBOOKS:

1. Engineering Drawing" by N S Parthasarathy and Vela Murali
2. Engineering Drawing and Graphics with Auto CAD" by Venugopal K

REFERENCE BOOKS:

1. "Basic Engineering Drawing: Mechanical Semester Pattern" by Mehta and Gupta
2. "Engineering Drawing" by Basant Agrawal and C M Agrawal
3. "Engineering Drawing With Auto CAD" by B V R Gupta
4. "Engineering Drawing" by P S Gill
5. "Engineering Drawing with an Introduction to AutoCAD" by Dhananjay Jolhe
6. "Engineering Drawing" by M B Shah
7. "Fundamentals of Engineering Drawing" by Imtiaz Hashmi
8. "Computer Aided Engineering Drawing" by S Trymbaka Murthy
9. "CAED : Computer Aided Engineering Drawing for I/II Semester BE/Btech Courses" by Reddy KB
10. "Computer-Aided Engineering Drawing" by Subrata Pal

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

EE23C04 ELECTRICAL, ELECTRONICS AND MEASUREMENTS ENGINEERING

L	T	P	C
3	0	2	4

UNIT – I ELECTRICAL CIRCUITS **9**

DC Circuits: Circuit Components: Resistor, Inductor, Capacitor – Ohm's Law -Kirchhoff's Laws – Independent and Dependent Sources – Simple problems- Nodal Analysis, Mesh analysis with Independent sources only (Steady state) – Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, Instantaneous Power, Real Power, Reactive Power and Apparent Power, Power Factor – Steady State Analysis of RLC Circuits-Introduction to Balanced 3-Phase Circuits.

UNIT – II ELECTRICAL MACHINES **9**

Construction and Working Principle – DC Separately and Self excited Generators, EMF Equation, Types and Applications. Working Principle of DC motors, Torque Equation, Types and Applications. Construction, Working Principle and Applications of Transformer - Three phase Alternator, Synchronous motor and Single and Three Phase Induction Motor.

UNIT – III ANALOG ELECTRONICS **9**

Semiconductor Materials: Silicon & Germanium – PN Junction Diodes, Zener Diode – Characteristics Applications – Bipolar Junction Transistor-Biasing, JFET, SCR, MOSFET, IGBT – Types, I-V Characteristics and Applications, Rectifier and Voltage regulators.

UNIT – IV LINEAR INTEGRATED CIRCUITS **9**

Ideal OP – Amp Characteristics, Basic Applications of Op-Amp – Inverting and Non- inverting Amplifiers, Summer, Differentiator and Integrator - S/H Circuit, D/A Converter (R-2R ladder), A/D Converters-Flash type ADC using OP-AMPS. Functional Block, Characteristics of 555 Timer – Astable Multi-Vibrator Mode.

UNIT – V MEASUREMENTS AND INSTRUMENTATION **9**

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

TOTAL: 45 PERIODS

Laboratory Experiments:

LIST OF EXPERIMENTS:

ELECTRICAL

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.

ELECTRONICS

1. Half wave and full wave Rectifiers.
2. Application of Zener diode as shunt regulator.
3. Inverting and non-inverting amplifier using operational amplifier.
4. Astable multivibrator using IC 555.

TOTAL: 30 PERIODS

COURSE OUTCOMES

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

CO 1: Explain the working principle and applications of electrical machines, electronic elements and measurement instruments. (L2)

CO 2: Demonstrate the basic concepts of electrical, electronic circuits and measurement devices. (L1)

CO 3: Analyze the electrical and electronic circuits. (L4)
CO 4: Select the electric, electronic circuit, electrical machines and instruments for the applications. (L3)
CO 5: Interpret the characteristics of electrical machines and instruments. (L5)

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	3	3	2	2	-	-	-	-	-	-	-	1	-	3	1
CO2	2	3	2	3	-	-	-	-	-	-	-	1	-	2	1
CO3	3	2	1	1	-	-	-	-	-	-	-	1	-	2	1
CO4	1	2	2	2	-	-	-	-	-	-	-	1	-	3	2
CO5	1	1	2	2	-	-	-	-	-	-	-	2	-	2	3
CO/PO & PSO Average	**2**	**2.2**	**1.8**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.2**	**-**	**2.4**	**1.6**
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. Del Toro 'Electrical Engineering Fundamentals' Pearson Education, New Delhi, 2022.
2. Alan S. Moris, Principles of Measurements and Instruments, Prentice-Hall of India Pvt. Ltd., New Delhi, 1988.
3. SmarjitGhosh 'Fundamentals of Electrical and Electronics Engineering, 2nd Edition 2010.

REFERENCES:

1. Rajendra Prasad 'Fundamentals of Electrical engineering', ThirdEdition, Prentice Hall of India, 2014.
2. Sanjeev Sharma 'Basics of Electrical Engineering' Wiley, 2019.
3. John Bird, Electrical Circuits theory and Technology, Taylor & Francis Ltd, Seventh Edition, 2022.
4. Doebelin, E.O., Measurements Systems – Application and Design', McGrawHill Publishing Co, 2019.
5. D.Roy Choudhury, Shail B. Jain, Linear Integrated Circuits, New age international Publishers, 2018.

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) (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.

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) (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.

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

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

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.

1. Non-uniform bending -Determination of Young's modulus of the material of the beam.
2. Uniform bending -Determination of Young's modulus of the material of the beam
3. 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.

1. Torsional pendulum-Determination of rigidity modulus of wire and moment of inertia of the disc
2. Melde's string experiment - Standing waves.
3. 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.

1. 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
2. Air wedge -Determination of the thickness of a thin sheet/wire
3. Optical fibre - Determination of Numerical Aperture and acceptance angle
   -Determination of bending loss of fibre.
4. 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.

1. Photoelectric effect – Determination of Planck's constant.
2. Black Body Radiation (Demonstration)
3. 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								

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**

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		

PR23201	ENGINEERING MATERIALS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES

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

1. To impart knowledge on the various microstructural features of metallic materials.
2. To analyze heat treatments techniques and their effects in the engineering materials.
3. To desire the various non-ferrous alloys and their applications.
4. To describe the properties and applications of polymers and ceramics
5. To study the mechanical behavior of the materials.

UNIT - I MICROSTRUCTURAL DEVELOPMENT AND METALLOGRAPHY 9

Basics of Metallographic microscopy -sample preparation – resolution – contrast – Metallographic microscope - quantitative techniques - microstructures of Steels and Cast irons- Constitution of alloys – phase diagrams, isomorphous, eutectic, peritectic, eutectoid and peritectoid reactions, Iron-Carbide phase diagram - Effect of alloying elements on steel (Mn, Si, Cr, Ni, Mo, V, Ti and W) – Specification and Standards, Properties and application -stainless and tool steels – HSLA steels – TRIP steel- maraging steels – Gray, white, malleable, spheroidal / graphite, alloy cast irons.

UNIT – II HEAT TREATMENT AND KINETICS 9

Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram CCR - Types and stages of annealing, stress relief, recrystallisation and spheroidizing – normalizing, Hardenability, Jominy end quench test - hardening and tempering of steel –Cryo-treatment, Austempering, martempering – case hardening, carburizing, nitriding cyaniding, carbonitriding – Flame, Induction Laser ,Electron beam hardening, plasma phase hardening, Vacuum Hardening.

UNIT – III NON-FERROUS METALS 9

Specification, Properties and application: Copper and Copper alloys, Brass, Bronze and Cupronickel – Aluminium alloys and AI-Cu –precipitation strengthening treatment – Bearing alloys, Alloys of Titanium, Zinc, Magnesium and Nickel –Intermetallics - Ni, Ti Aluminides – Refractory alloys- Superalloys- Shape memory alloys- high entropy alloys- Bulk Metallic glasses- Metal matrix composite and applications.

UNIT – IV NON-METALLIC MATERIALS 9

Polymers- Thermo, Thermoset Polymers, Co and mixed Polymers- Commodity Polymers, PE, PS,PVC,PMMA, - Engineering Polymers, PA, PPS, PI, PTFE- Natural and Synthetic rubbers, Elastomers- Adhesives-Polymer matrix composites- Ceramics- Natural and Synthetic Ceramic- Feldspar, Corrundum, Garnet- WC, TC, TiC, Si_3N_4,Al_2O_3, CBN, PCD, Uses of abrasives and cutting tools- Ceramic Matrix composite.

UNIT – V DEFORMATION AND FAILURE OF MATERIALS 9

Elastic, anelastic and viscoelastic behaviour - Dislocation in FCC,BCC,HCP – stress field - interaction between dislocations -Strengthening mechanism- effect of temperature- deformation mechanism maps - Types of Fracture – Fracture mechanics - fracture toughness ductile-brittle transition - types of wear - corrosion – Creep- mechanisms of creep-creep resistance materials. Fatigue failure-the S-N curves-factors that affect fatigue life.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS

1. Metallographic Sample Preparation: Cutting, mounting, grinding, polishing, and etching of metallic samples to prepare them for microstructural analysis. (Unit- I)
2. Metallographic Examination: Macrostructure examination: Visual inspection of the macrostructure of metallic samples to assess features such as segregation, cracks, and inclusions. (Unit-I)
3. Heat Treatment: Annealing: Heat treatment process to soften metallic materials and relieve internal stresses. (Unit-II)
4. Hardening &Tempering: Heat treatment process to reduce the hardness and brittleness of quenched metallic materials. (Unit-II)
5. Grain Size Determination: Measurement of grain size in metallic samples using quantitative metallography methods such as ASTM grain size measurement or image analysis. (Unit-I)
6. Superplastic Tensile Testing: Conducting tensile tests on superplastic materials at elevated temperatures and low strain rates. (Unit-II)
7. Jominy end quench test: Metallurgical experiment used to evaluate the hardenability of a steel alloy. (Unit-II)

Any 6 experiments

TOTAL: 30 PERIODS
TOTAL: 75 PERIODS

COURSE OUTCOMES

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

1. Discuss the microstructural features of ferrous alloys and prepare specimen.
2. Relate the heat treatment, microstructure and its properties
3. List the properties and uses of non - ferrous alloys.
4. List the properties and uses of Engineering polymers and ceramics
5. Interpret the mechanical behaviour with the mechanism through mechanical testing

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	-	-	-	1	-	1	2	-	1	1	-	1
CO2	2	2	1	2	-	-	1	-	1	2	-	1	1	1	1
CO3	2	1	1	-	-	-	1	-	1	2	-	1	1	-	1
CO4	2	1	1	-	-	-	1	-	1	2	-	1	1	-	1
CO5	2	2	1	2	-	-	1	-	1	2	-	1	1	1	1
CO/PO & PSO Average	2.0	1.4	1.0	2.0	-	-	1.0	-	1.0	2.0	-	1.0	1.0	1.0	1.0
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Balasubramanian.R, Callister's, "Materials Science and Engineering", 7th Edition, Wiley India Pvt. Limited, 2010.
2. Kenneth G.Budinski and Michael K.Budinski, "Engineering Materials-Properties and Selection", 9th Indian Reprint, Prentice-Hall of India Private Limited, 2014.

REFERENCES

1. Callisers's Jr. W.D, Rethuish, D.G, "Materials Science and Engineering", 9thEdition, Wiley,2014.
2. Donald R. Askeland, Pradeep P. Fulay and Wendelin J. Wright, "The Science and Engineering of Materials", 7thEdition, Cengage Learning, Inc. 2022.
3. Raghavan V., "Materials Science and Engg: A first Course", 6thEdition, Prentice Hall of IndiaPvt Ltd., 2015.
4. Sidney H. Avner, "Introduction to Physical Metallurgy", McGraw Hill Book Company, 2ndEdition, 2017.
5. Yang Leng, "Materials Characterization: Introduction to Microscopic and Spectroscopic
6. Methods", John Wiley and Sons, 2nd Edition, 2013.

UC23H02 தமிழரும் தொழில்நுட்பமும்/Tamils and Technology L T P C
1 0 0 1

அலகு I <u>நெசவு மற்றும் பானைத் தொழில்நுட்பம்</u>: 3

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

அலகு II <u>வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்</u>: 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 <u>உற்பத்தித் தொழில் நுட்பம்</u>: 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 <u>வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்</u>: 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 <u>அறிவியல் தமிழ் மற்றும் கணித்தமிழ்</u>: 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 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.

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 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.

MA23C08 **NUMERICAL METHODS**

L	T	P	C
3	1	0	4

OBJECTIVES:

- To provide the mathematical foundations of numerical techniques for solving Eigen value problems and linear system of equations.
- To apply the interpolation techniques for equal and unequal intervals for the given data.
- To understand the techniques of numerical integration and differentiation for solving ordinary differential equations.
- To provide the mathematical tool in solving initial value problems and boundary value problems.
- To demonstrate the utility of Numerical techniques for solving Partial Differential Equations in Heat and Fluid problems.

UNIT I SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9+3

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton-Raphson method- Solution of linear system of equations-Gauss elimination method – Pivoting - Gauss-Jordan methods – Iterative methods of Gauss-Jacobi and Gauss-Seidel - Matrix Inversion by Gauss-Jordan method – Eigen values of a matrix using Power method and Jacobi's method.

UNIT II INTERPOLATION AND APPROXIMATION 9+3

Interpolation with unequal intervals - Lagrange interpolation – Newton's divided difference interpolation – Cubic Splines - Interpolation with equal intervals - Newton's forward and backward difference formulae – Least square method - Linear curve fitting.

UNIT III NUMERICAL DIFFERENTATION AND INTEGRATION 9+3

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's 1/3 and Simpson's 3/8 rules – Romberg's method - Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's rules.

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 9+3

Single step-methods - Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first and second order differential equations - Multi-step methods - Milne's and Adams-Bashforth predictor-corrector methods for solving first order differential equations.

UNIT V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 9+3

Finite difference methods for solving two-point linear boundary value problems - Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on

rectangular domain – One dimensional heat-flow equation by explicit and implicit (Crank-Nicholson) methods - One dimensional wave equation by explicit method.

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 :

1. Solution of algebraic and transcendental equations
2. Newton-Raphson method
3. Iterative methods of Gauss-Jacobi and Gauss-Seidel
4. Matrix Inversion by Gauss-Jordan method
5. Eigen values of a matrix by Power method and by Jacobi's method
6. Interpolation with equal and unequal intervals
7. Numerical differentiation and integration
8. Solution of ODE by Taylor series and 4^{th} order R-K method
9. Solution of one-dimensional heat and wave equation
10. Solution of Laplace and Poisson Equations

OUTCOMES:

CO1: Understand the common numerical methods and how they are used to obtain approximate solutions to the algebraic and transcendental equations.
CO2: Apply numerical methods to obtain approximate solutions to mathematical problems using interpolation.
CO3: Apply numerical interpolation techniques in solving various mathematical problems.
CO4: Apply and find accurate solutions to ODE of First and Second order equations.
CO5: Understand various numerical techniques for solving PDE.

TEXT BOOKS:

1. Grewal, B.S. and Grewal,J.S., "Numerical Methods in Engineering and Science (C, C++, and MATLAB)", Stylus Publishing, LLC, 2018.
2. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.

REFERENCES:

1. Gerald. C. F. and Wheatley. P. O., "Applied Numerical Analysis", Pearson Education, Asia, 6th Edition, New Delhi, 2006.
2. Mathews, J.H. "Numerical Methods for Mathematics, Science and Engineering", 2nd Edition, Prentice Hall,1992.
3. Brian Bradie, "A Friendly Introduction to Numerical Analysis", Pearson Education, Asia, New Delhi,2007.
4. Sastry, S.S, "Introductory Methods of Numerical Analysis", PHI Learning Pvt. Ltd, 5th Edition,2015.
5. Sankara Rao . K, "Numerical Methods for Scientists and Engineers", PHI Learning Pvt Ltd., New Delhi, 2007.

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

AU23C02	MECHANICS OF SOLIDS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

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

1. To know about how a solid (materials, structures) behaves when it is subjected to forces and deformations.
2. To apply the fundamental concepts of principle of superposition, equilibrium, compatibility, force- deformation, and stress-strain relationships to the solid and structural mechanics problems
3. To analyze determinate and indeterminate bars, beams, to determine axial forces, torques, shear forces, and bending moments
4. To have physical insight into distribution of stresses and strains in structural members
5. To identify the biaxial stresses in acting in a body or an element.

UNIT – I STRESS, STRAIN AND AXIAL LOADING 9

Stress and strain, elastic limit, Hooke's law, factor of safety, shear stress, shear strain, relationship between elastic constants. Stresses in stepped bars, uniformly varying sections, composite bars due to axial force. Lateral strain, Poisson's ratio, volumetric strain, changes in dimensions and volume. Thermal stresses and impact loading. Design of truss.

UNIT – II STRESSES IN BEAMS 9

Beam – Definition, types of end supports, types of beam, types of loading. Shear force diagram and bending moment diagram for cantilever, simply supported and overhanging beams under point load, UDL, UVL and moments. Euler beam theory - Bending equation, section modulus, Bending stress in beams – Shear stress in beams. Unsymmetric bending

UNIT – III DEFLECTION OF BEAMS AND COLUMNS 9

Governing differential equation - Problems on Double integration method - Macaulay’s Method – Moment area method. Concepts of Conjugate Beam method and Method of superposition. Castiglianos 1st and 2nd theorems. Columns – different end conditions – buckling load – Euler’s theory – Rankine’s formula.

UNIT – IV TORSION AND SPRINGS 9

Theory of torsion and assumptions - torsion equation, polar modulus, stresses in solid and hollow circular shafts, power transmitted by a shaft, shafts in series and parallel, deflection in shafts fixed at the both ends. Springs – types, Deflection expression for closed coiled helical spring – Stress in springs - design of springs.

UNIT – V BIAXIAL STRESS 9

Principal stresses, normal and tangential stresses, maximum shear stress - analytical and graphical method. Stresses in combined loading. Thin walled cylinder under internal pressure –

changes in dimensions – volume. spherical shells subjected to internal pressure – deformation in spherical shells – Lame's theory. Strain energy. Theories of failures.

TOTAL: 45 PERIODS

1.Tension Test.(Unit –I)

2.Torsion Test.(Unit –IV)

3.Testing of Springs. .(Unit –IV)

4.Impact test i) Izod ii) Charpy.(Unit –I)

5.Hardness Test i) Vickers ii)Brinell iii) Rockwell iv) Shore.(Unit –I)

6.Deflection of Beams.(Unit –III)

TOTAL: 75 PERIODS

COURSE OUTCOMES:

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

1. Know about how a solid (materials, structures) behaves when it is exposed to forces and deformations.
2. Apply the fundamental concepts of principle of superposition, equilibrium, compatibility, force-deformation, and stress-strain relationships to the solid and structural mechanics problems through destructive testing
3. Analyze determinate and indeterminate bars, beams, to determine axial forces, torques, shear forces, and bending moments.
4. Have physical insight into distribution of stresses and strains in structural members.
5. Identify the biaxial stresses in acting in a body or an element.

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	3	3	3	3	3	1	1	-	2	2	-	3	3	-	1
CO2	3	3	3	3	3	1	1	-	2	2	-	3	3	1	1
CO3	3	3	3	3	3	1	1	-	2	2	-	3	3	1	1
CO4	3	3	3	3	3	1	1	-	2	2	-	3	3	1	1
CO5	3	3	3	3	3	1	1	-	2	2	-	3	3	1	1
CO/PO & PSO Average	3.0	3.0	3.0	3.0	3.0	1.0	1.0	-	2.0	2.0	-	3.0	3.0	1.0	1.0
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. James M Gere, Barry J Goodno, "Mechanics of Materials, SI Edition", 9thEdition, Cengage Learning India Pvt. Ltd., 2022
2. Russell C. Hibbeler, "Mechanics of Materials", 10thEdition, Pearson education, 2022
3. Stephen Timoshenko, 'Strength of Materials', Vol I & II, CBS Publishers and Distributors, 3rd Edition, 2021.

REFERENCES:

1. Roy R Craig, "Mechanics of Materials", 3rdEdition, John Wiley & Sons, 2011
2. R.K.Rajput, 'Strength of Materials', S Chand; 6thEdition, 2015.
3. Timothy A. Philpot, "Mechanics of Materials: An Integrated Learning System," 4thEdition, Wiley, 2017.

4. William A. Nash, Merle C. Potter, "Schaum's Outline of Strength of Materials", 7thEdition, McGraw Hill Education, 2019
5. Ramamrutham S, "Strength Of Materials", Dhanpat Rai Publishing Company, 16thEdition, 2011
6. Clive L. Dym, Irving H. Shames, “Solid Mechanics: A Variational Approach, Augmented Edition”, Springer publishers, 2013
7. Saad, M. H., “Elasticity: Theory, Applications and Numerics”, Academic Press; 3rd Edition, 2014
8. Timoshenko, S. P., J. N. Goodier, “Theory of Elasticity”, McGraw Hill Education; 3rd Edition, 2017
9. Srinath, L. S, “Advanced Mechanics of Solids”, McGraw Hill Education, 3rd Edition, 2017
10. Crandal, S, Lardner, T, Dahl, N and Sivakumar, M. S., An Introduction to Mechanics of Solids", McGraw-Hill Education; 2nd Edition, 1978

PR23C01	THEORY OF MACHINES	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

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

1. To impart knowledge on various types of mechanisms and synthesis.
2. To understand the effects of friction in motion in transmission and machine components.
3. To familiarize higher pairs like cams and gears transmission.
4. To impart knowledge of mechanical vibrations
5. To study the undesirable effects of unbalances resulting from prescribed motions in mechanisms.

UNIT – I MECHANISMS 9

Definition – Machine and Structure – Kinematic link, pair and chain – classification of Kinematic pairs– Single and Multi DoF– Inversion of mechanisms along with their practical applications. Introduction to Kinematic analysis and synthesis of simple mechanisms – Determination of velocity and acceleration of mechanism by polygon method, instantaneous centre method and vector approaches.

UNIT – II FRICTION 9

Types of friction – friction in screw and nut – screw jack - bearings – clutch - brakes –belt (Flat and V).

UNIT – III GEARS AND CAMS 9

Gear – basic terminology of gears–laws of gearing – interference– geometric and kinematic considerations for various tooth profiles, the cycloidal and involute profiles, standards in tooth forms, spur gears and other types of gears. Gear trains, Simple, compound and epicyclic gear trains and their applications-Cam-terminology-different types of cams and followers – Cam design for different follower motion curves, graphical construction of cam profiles for different types of followers.

UNIT – IV VIBRATIONS 9

Basic terminology related to vibrations, free and forced vibrations without and with damping – critical speed of shafts - Torsional vibrations in shafts.

UNIT – V BALANCING, GOVERNORS, AND GYROSCOPES 9

Static and dynamic balancing – balancing of rotating and reciprocating masses - principles of balancing machine. Governors - Analysis of different types of governors - Gyroscopic - applications of gyroscope - Gyroscopic effects.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS:

1. Analysis of kinematic chains. (Unit –I)
2. Determination of Mass moment of inertia of Fly wheel and Axle system by a) compound pendulum, b) turn table apparatus and c) bifilar suspension. (Unit –V)
3. Motorized gyroscope – Study of gyroscopic effect and couple. (Unit –V)

4. Governor - Determination of range sensitivity, effort etc., for Watt, Porter, Proell and Hartnell Governors. (Unit –V)
5. Cams – Cam profile drawing, Motion curves and study of jump phenomenon. (Unit –III)
6. Single and Multi-degrees of freedom -Spring Mass System. (Unit –IV)
7. Determination of torsional natural frequency of single and Double Rotor systems. (Unit –IV)
8. Whirling of shafts – Determination of critical speeds of shafts with concentrated loads. (Unit –IV)
9. Balancing of rotating masses. (Unit –V)
10. Vibration analysis – Shaker Table. (Unit –IV)

TOTAL = 30 PERIODS

Any 7 Experiments

TOTAL: 75 PERIODS

COURSE OUTCOMES

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

1. Apply the kinematics mechanism to industrial needs.
2. Discuss the frictional effects in machine elements.
3. Estimate gear, gear trains and cam and their parameters for transmission systems.
4. Examine the outcomes of free, forced and damped vibrations.
5. Analyse the undesirable effect of unbalancing.

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	3	2	1	1	-	-	1	1	1	1	-	2	1	-	1
CO2	3	2	1	1	-	-	1	1	1	1	-	2	1	-	1
CO3	3	2	1	1	-	-	1	1	1	1	-	2	1	-	1
CO4	3	2	1	1	-	-	1	1	1	1	-	2	1	-	1
CO5	3	2	1	1	-	-	1	1	1	1	-	2	1	-	1
CO/PO & PSO Average	**3.0**	**2.0**	**1.0**	**1.0**	**-**	**-**	**1.0**	**1.0**	**1.0**	**1.0**	**-**	**2.0**	**1.0**	**-**	**1.0**
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1.Sadhu Singh, "Theory of Machines", Pearson Education, 2013.
2. Rattan S.S., “Theory of machines”, Tata McGraw Hill publishing Co., 4th edition 2014.

REFERENCES:

1. Gosh A and Mallick A.K., “Theory of Machines and Mechanisms”, Affiliated East West press, 2009.
2. Malhotra D.R. and Gupta H.C, “The Theory of machines”, Satya Prakasam, Publications, 2008.
3. Rao J.S. and Dukkipati R.V., “Mechanism and Machine Theory”, Second Edition, Wiley
4. Eastern Limited, 2006.
5. Shigley J.E. and Uicker J.J., “Theory of Machines and Mechanisms”, McGraw Hill, 2006.
6. Ambekar A.G., “Mechanism and Machine Theory”, PHI India Pvt Ltd, 2015

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

COURSE OBJECTIVES:

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

- To learn about the basic properties of fluids.
- To introduce the concept of incompressible and viscous flows.
- To have a thorough knowledge on dimensional analysis and model studies.
- To study the applications of conservation laws to flow through pipes and hydraulic machines.
- To learn the basics of water turbines, their classification and working principles

UNIT I BASIC EQUATIONS 9

Definition of fluid, Newton's law of viscosity, Units and dimensions-Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension, Control volume- application of continuity equation and momentum equation, Incompressible flow, Bernoulli's equation and its applications.

UNIT II INCOMPRESSIBLE VISCOUS FLOW 9

Exact flow solutions in channels and ducts, Couette and Poisuielle flow, laminar flow through circular conduits and circular annuli- concept of boundary layer – measures of boundary layer thickness – Darcy Weisbach equation, friction factor, Moody's diagram.

UNIT – III DIMENSIONAL ANALYSIS AND MODEL STUDIES 9

Need for dimensional analysis–methods of dimension analysis–Similitude–types of similitude Dimensionless parameters–application of dimensionless parameters–Model analysis. Euler's equation – Theory of Roto dynamic machines – various efficiencies – velocity components at entry and exit of the rotor, velocity triangles – Centrifugal pumps, working principle, work done by the impeller, performance curves – Cavitation in pumps- Reciprocating pump–working principle.

UNIT – IV PUMPS 9

Euler's equation – Theory of Roto dynamic machines – various efficiencies – velocity components at entry and exit of the rotor, velocity triangles – Centrifugal pumps, working principle, work done by the impeller, performance curves – Cavitation in pumps- Reciprocating pump–working principle.

UNIT – V TURBINES 9

Classification of water turbines, heads and efficiencies, velocity triangles- Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines, working principles – draft tube Specific speed, unit quantities, performance curves for turbines – governing of turbines.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS

1. Stability of Floating Body. (Unit –I)
2. Verification of Bernoulli's Theorem(Unit –I)

3. Venturimeter Characteristics(Unit –I)
4. Orifice meter Characteristics(Unit –I)
5. Measurement of Coefficient of Discharge of given Orifice meter(Unit –I)
6. Measurement of Coefficient of Discharge of given Venturi meter(Unit –I)
7. Impacts of jets on solid surfaces(Unit –II)
8. Velocity distribution in pipes and Laminar Flow Characteristics(Unit –II)
9. Determination of the density & viscosity of water and friction factor of water flow in a pipe(Unit –I)
10. Determination of the performance characteristics of a centrifugal pump(Unit –IV)
11. Determination of Performance characteristics of a reciprocating pump(Unit –IV)
12. Study of Pressure Measuring Devices(Unit –I).

Any 8 experiments

TOTAL = 30 PERIODS
TOTAL = 75 PERIODS

COURSE OUTCOMES

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

1. Exhibit the basic understanding on fluid properties and fluid statics.
2. Demonstrate the understanding in fluid kinematics and governing equations.
3. Use the governing equations for fluid flow problems and understand the elementary
4. Analyze laminar and turbulent flow problems.
5. Acquire knowledge on the various types of fluid machines.

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	3	3	2	2	1	2	2	1	2	1	1	2	3	2	3
CO2	3	3	2	2	1	2	2	1	2	1	1	2	3	2	3
CO3	3	3	2	2	1	2	2	1	2	1	1	2	3	3	3
CO4	3	3	2	2	1	2	2	1	2	1	1	3	3	2	2
CO5	3	3	2	2	1	2	2	1	2	1	1	3	3	2	2
CO/PO & PSO Average	3.0	3.0	2.0	2.0	1.0	2.0	2.0	1.0	2.0	1.0	1.0	2.4	3.0	2.0	3.0
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Rathakrishnan. E, “Fluid Mechanics”, Prentice Hall of India, 2nd Edition, 2007
2. Subramanya K, “Theory and Applications of Fluid Mechanics”, Tata McGraw Hill, 1993.
3. Yunus A.Cengel and John M. Cimbala, “Fluid Mechanics”, McGraw Hill, 2nd Edition, 2013.

REFERENCES:

1. Bansal, R.K., “Fluid Mechanics and Hydraulics Machines”, Laxmi Publications (P) Ltd., New Delhi, 9th Edition,2015.
2. Kumar. K.L, “Engineering Fluid Mechanics”, 7th Edition, Chand Publishers, 2006.
3. Ramamurtham. S, Hydraulics, Fluid Mechanics and Fluid Machines, Dhanpat Rai Publishing Co Pvt., Ltd, 9th Edition, 2012.

PR23301 FOUNDRY AND WELDING TECHNOLOGY

L	T	P	C
3	0	2	4

COURSE OBJECTIVES:

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

1. To gain comprehensive knowledge in traditional and advanced casting processes, including mould and core making techniques.
2. To familiarize with methods for moulding sand testing, sand mould preparation and casting
3. To understand basic metal joining processes and familiarize with special welding techniques.
4. To trained in handling various types of special welding machine and its processes.
5. To acquire a foundation in metallurgy for both casting and welding processes.

UNIT – I FOUNDRY 9

Introduction to casting – pattern – materials allowances – coding – types – moulds – mould making, sand – properties, types and testing of sands – core making – type of cores – single box, two box and three box moulding processes, runner, riser and gate and chills chaplets- Furnaces and atmosphere-Casting Defects

UNIT – II SPECIAL CASTING PROCESSES 9

Pressure die, Centrifugal, Continuous, Investment, Shell moulding, Squeeze, Stir, electro slag casting – CO2 moulding – Plaster Mould castings – Antioch process – Slush casting- Counter gravity low pressure casting - Electro magnetic levitation casting.

UNIT – III METAL JOINING PROCESSES 9

Types of metal joining - soldering, brazing and welding – edge preparation – filler material – flux – shielding gases – fusion welding – gas welding – flame types – Manual arc welding – arc theory – power supply – braze welding – Thermit welding – High Frequency Resistance welding – spot, seam, projection, percussion and flash- Shielded Metal Arc welding, Gas Metal Arc Welding-Gas Tungsten Arc Welding- Weld symbols and defects

UNIT – IV DESIGN OF WELDMENTS AND CASTINGS

Type of joints, joint efficiency, factor of safety, symbols, selection of edge preparation, design considerations, types of loading, Permissible stress, allowable defects, computation of stresses in welds, weld size calculation, code requirement for statically loaded structures

UNIT – V CASTING AND WELDING METALLURGY 9

Weld thermal cycle- weld metal solidification –microstructure of HAZ in steel and Al alloys-pre and post weld heat treatments-Casting Solidification principles –Formation of columnar , equiaxed grains and dendritic solidification – Properties related to freezing mechanism- Directional solidification – progressive solidification.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS

WELDING

1. GTAW of thin sheets.(Unit –III)
2. GMAW of ferrous metal.(Unit –III)
3. Spot welding of plate.(Unit –III)
4. Friction Stir Welding.(Unit –IV)
5. Ultrasonic Welding.(Unit –IV)
6. Plasma Welding/cutting.(Unit –IV)

FOUNDRY

1. Green and Dry Strength of Moulding sand.(Unit –I)
2. Permeability test.(Unit –I)
3. Determining the clay and moisture content.(Unit –I)
4. Sieve analysis of dry silica sand.(Unit –I)
5. Casting of non-ferrous metal.(Unit –I)
6. Test for fluidity.(Unit –I)

Any four experiments in each division

TOTAL = 30 PERIODS

TOTAL =75 PERIODS

COURSE OUTCOMES

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

1. Elaborate the process of pattern making, moulding and core making and select the appropriate special casting processes.
2. Analyse moulding sand properties and prepare mould for special casting.
3. Describe different metal joining processes, including soldering, brazing, and welding and special casting processes
4. Create simple joints using various types of welding by selecting appropriate process parameters.
5. Describe micro structural evolution during casting and welding

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	-	1	1	-	1	1	-	1	1	-	1
CO2	2	-	1	1	1	1	1	-	1	1	-	1	1	-	1
CO3	2	-	1	1	-	1	1	-	1	1	-	1	1	-	1
CO4	2	-	1	1	1	1	1	-	1	1	-	1	1	-	1
CO5	2	-	1	1	1	1	1	-	1	1	-	1	1	-	1
CO/PO & PSO Average	2.0	-	1.0	1.0	-	1.0	1.0	-	1.0	1.0	-	1	1.0	-	1.0
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. John Campbell, "Complete Casting Handbook: Metal Casting Processes, Techniques and Design", Elsevier Science, 2018.
2. David H. Phillips, "Welding Engineering: An Introduction", Wiley, 2023.

REFERENCES:

1. Howard B. Cary, Scott C. Helzer "Modern Welding Technology" Prentice Hall, 2011.
2. Mahi Sahoo, Sam Sahu, Sudhari Sahu, “Principle of metal casting", McGraw Hill – Education, 2014.
3. J. Paulo Davim, "Welding Technology", Springer International Publishing, 2021
4. Robert Bruce Tuttle, "Foundry Engineering: The Metallurgy and Design of Castings", Create Space Independent Publishing Platform, 2012.
5. Dheerendra Kumar Dwivedi, "Fundamentals of Metal Joining: Processes, Mechanism and Performance", Springer Nature Singapore, 2022.

PR23302	METAL FORMING	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

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

1. To analyze the mechanism of plastic deformation in metals.
2. To interpret various rolling and forging processes.
3. To explain various extrusion and drawing processes.
4. To describe various sheet metal forming process
5. To study recent advancement in metal forming processes.

UNIT – I FUNDAMENTALS OF METAL FORMING 9

State of stress–Components of stress, symmetry of stress tensor, principle stresses–Stress Deviator – Von-mises and Tresca yield criteria-octahedral shear stress and shear strain theory Flow stress determination- Power and Energy of deformation- Effective strain and Effective strain rate- Strain Hardening - temperature effect in metal forming- hot, cold and warm working-spring back effect.

UNIT – II FORGING AND ROLLING 9

Principle – classification – equipment – tooling – processes parameters and calculation of forces during forging and rolling processes – Ring compression test – Post forming heat treatment – defects causes and remedies– applications –Roll forming - Thread Rolling.

UNIT – III EXTRUSION AND DRAWING PROCESSES 9

Classification of extrusion processes – tool, equipment and calculation of force during extrusion processes – influence of friction – defects, causes and remedies – Rods, Wires and Tubes drawing – tool, equipment and principle – defects, causes and remedies – Tube drawing and sinking processes – Mannesmann process of seamless pipe manufacturing – Tube bending-Residual stresses in Rod, Wire and Tubes.

UNIT – IV SHEET METAL FORMING PROCESSES 9

Classification – conventional and High Energy Rate Forming processes – Explosive forming, electro- hydraulic forming and Magnetic pulse forming presses –types and selection of presses – formability studies– Formability Limit Diagram, Limiting Draw ratio – processes: Deep drawing, spinning, stretch forming, plate bending, Rubber pad forming, bulging and press brake forming-Superplastic forming- incremental forming- Hybrid forming - Lubrication and Cushion systems for sheet metal forming.

UNIT – V POWDER FORMING AND ADVANCES IN FORMING 9

Metal Powder and fabrication procedures, Applications, Preparation of powders, Compaction and sintering - Hot and cold pressing – Powder rolling and forging - Electroforming – fine blanking –Hydroforming – Peen forming – Laser Forming – Micro forming – Isothermal forging – high speed for forging and extrusion near net shape forming – Ultra fine grained materials by severe plastic deformation –Computer simulation in forming.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS

1. Deep Drawing Test: Simulate the deep drawing process by deforming a metal sheet into a cup-shaped geometry and analyze the formability and deformation behavior.(Unit –III)
2. Formability Test: Assess the formability of a metal sheet or plate by conducting tests such as Erichsen cupping.(Unit –IV)
3. Extrusion Test: Perform an extrusion process to shape a metal specimen and analyze the deformation behavior, including extrusion force and extrude quality. (Unit –III)
4. Rolling Test: Simulate the rolling process by reducing the thickness of a metal specimen using a rolling mill and analyze the effect of rolling parameters on material properties.(Unit –V)
5. Metal Forming Simulation: Utilize computer-aided simulation software to predict the deformation behavior and optimize process parameters in metal forming operations .(Unit –V)
6. Hydroforming Experiment: Utilize hydroforming techniques to form a metal tube or sheet into complex shapes using fluid pressure, examining the formability and dimensional accuracy of the hydroformed part. (Unit –V)
7. Incremental Forming Analysis: Perform incremental forming operations, such as single-point incremental forming or two-point incremental forming, to investigate the deformation mechanisms and formability of the process. (Unit –IV)
8. Superplastic Forming: Conducting superplastic forming experiments for various metallic materials under controlled conditions to achieve complex shapes. Analyzing the deformation characteristics, strain distribution, and microstructural changes during the forming process. (Unit –IV)
9. Thread rolling. (Unit –IV)

Any 7 Experiments

TOTAL = 30 PERIODS

TOTAL = 75 PERIODS

COURSE OUTCOMES

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

1. Relate mechanism of plastic deformation to metal forming
2. Analyze the force, defect and post processing required for bulk forming processes
3. Interpret the forces, defects and post processing required for extrusion and drawing processes.
4. Compare various sheet metal forming processes
5. Explain concepts of powder forming and advanced techniques in forming.

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	3	2	1	1	-	-	1	-	1	2	-	1	1	-	1
CO2	3	2	1	1	-	-	1	-	1	2	-	1	1	-	1
CO3	3	2	1	1	-	-	1	-	1	2	-	1	1	-	1
CO4	3	2	1	1	-	-	1	-	1	2	-	1	1	-	1
CO5	3	2	1	1	-	-	1	-	1	2	-	1	1	-	1
CO/PO & PSO Average	3.0	2.0	1.0	1.0	-	-	1.0	-	1.0	2.0	-	1.0	1.0	-	1.0

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS

1. Anupam Agrawal, D. Ravi Kumar, Kakandikar Ganesh Marotrao, "Metal Forming Processes: Developments in Experimental and Numerical Approaches", Taylor & Francis Group, 1st Edition 2023.
2. Dieter G.E., “Mechanical Metallurgy”, McGraw Hill, Co., 3rd Edition, 2017.

REFERENCES

1. SeropeKalpakjian, Steven R Schmid, “Manufacturing Process for Engineering Materials”, 6thEdition, Pearson Education, 2016.
2. Rao, P.N. “Manufacturing Technology”, Vol. 1, 5th Edition, Tata McGraw Hill Education (India) Private Limited, 2019.
3. John Noel Harris, "Mechanical Working of Metals: Theory and Practice", Elsevier Science, 2014.
4. Norman W. Henley, "Drop Forging, Die Sinking and Machine Forming of Steel: Modern Shop Practice, Processes, Methods, Machines, Tools and Details", Forgotten Books, 2019.
5. Hosford W.F. and Caddell R.M., “Metal Forming: Mechanics and Metallurgy”, 4th Edition, Cambridge University press, Cambridge, 2014.

PR23401	MACHINE COMPONENT DESIGN	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

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

- To introduce the students to the fundamentals of machine design, material selection and to solve the basic design problems.
- To determine the forces on shaft and coupling and formulate design solutions for its size.
- To understand the standard nomenclature, forces, failures, application, design procedure of Spur, Helical, Bevel gears and gearbox to determine standard geometry.
- To select a suitable rope, belt and chain drive system based on conditions.
- To classify the different types of springs and bearings to determine standard design procedure of bearing under different loading conditions.

UNIT – I INTRODUCTION TO MACHINE DESIGN AND DESIGN OF JOINTS 9+3

Theories of Failure-Stress Concentration, Stress Concentration Factors, Variable Stress, Fatigue Failure, Endurance Limit, Design for Finite and Infinite Life, Soderberg and Goodman Criteria. Design of Bolts under Static Load, Design of Bolt with tightening / Initial Stress, Design of Bolts subjected to Fatigue – Keys -Types, Selection of Square and Flat Keys-Design of Riveted Joints and Welded Joints.

UNIT – II DESIGN OF SHAFTS AND COUPLINGS 9+3

Design of Shaft – Static and Varying Loads, Strength and Rigidity - Design of Coupling - Types, Flange, Muff and Flexible Rubber Bushed Coupling

UNIT – III DESIGN OF GEARS AND GEAR BOX 9+3

Design of Spur, Helical, Bevel and Worm Gear drives - Design of Gear Box

UNIT – IV DESIGN OF TRANSMISSION SYSTEMS 9+3

Design of Belt drives - Flat , V Belts, Chain Drive, Rope Drives

UNIT – V DESIGN OF SPRINGS AND BEARINGS 9+3

Design of Helical Spring-Types, Materials, Static and Variable Loads - Design of Leaf Spring, Design of Journal Bearing - Antifriction Bearing - Types, Life of Bearing, Reliability Consideration, Selection of Ball and Roller Bearings and Thrust Bearings.

TOTAL: 60 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. Interpret the fundamentals of Engineering design and Failure theories
2. Design shafts, couplings, bolts & joints and keys.
3. Design gears and gearboxes
4. Design flexible transmission systems

5. Apply design procedure for selection of appropriate springs and bearings

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	3	2	2	1	-	-	-	-	-	1	-	1	2	-	1
CO2	3	2	2	1	-	-	-	-	-	1	-	1	2	-	1
CO3	3	2	2	1	-	-	-	-	-	1	-	1	2	-	1
CO4	3	2	2	1	-	-	-	-	-	1	-	1	2	-	1
CO5	3	2	2	1	-	-	-	-	-	1	-	1	2	-	1
CO/PO & PSO Average	3.0	2.0	2.0	1.0	-	-	-	1.0	0	1.0	-	1.0	2.0	-	1.0
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Wei Jiang, "Analysis and Design of Machine Elements", Wiley, 2019.
2. Sundararajamoorthy T. V, Shanmugam. N, "Machine Design", Anuradha Publications, 2015.

REFERENCES

1. Bhandari. V.B., “Design of Machine Elements”, Tata McGraw-Hill Publishing Company Ltd., 4th Edition, 2017.
2. Jalaludeen. S.Md., “Machine Design Vol - I & Vol - II”, Anuradha publications, 2006.
3. Joseph Edward Shigley, Charles R. Mischke, “Mechanical Engineering Design”, McGraw Hill, International Edition, 4th Edition 2011.
4. “P.S.G.Design Data Hand Book”, PSG College of Tech Coimbatore -2024
5. Robert L.Norton, “Machine Design – An Integrated Approach”, Prentice Hall International Edition, 6th Edition, 2020.

PR23402	CNC MACHINES AND AUTOMATED PRODUCTION SYSTEMS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

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

1. To understand the constructional features of CNC machining centres and its applications.
2. To write CNC part programming for industrial problems.
3. To apply group technology concepts in a production environment.
4. To illustrate flexible manufacturing systems in a manufacturing industry.
5. To select suitable robot specifications for industrial needs.

UNIT – I STRUCTURE OF CNC MACHINE AND CNC MACHINING 9

CNC Machine Building, Structural Details, Configuration and Design, Guide Ways – Friction, Anti Friction and Other Types of Guideways, Elements Used To Convert The Rotary Motion To A Linear Motion – Screw And Nut, Recirculating Ball Screw, Planetary Roller Screw, Recirculating Roller Screw, Rack And Pinion, Spindle Assembly, Torque Transmission Elements – Gears, Timing Belts, Flexible Couplings, Bearings- Maintenance Of CNC Machines. Coordinates, Axes, and Motion - CNC Systems - CNC Controls - Operating a CNC Machine – CNC Milling – Types, Machines axes, Machining centers, CNC Turning – Types, Number of axes, Axes designation - Advantages and Disadvantages of CNC Technology - Applications.

UNIT – II CNC PROGRAMMING 9

Coordinate Systems and Reference Points -The Ten Steps of CNC Programming - Structure of A Part Program, G Codes and M Codes, Tool Length Compensation, Cutter Radius and Tool Nose Radius Compensation, Do Loops, Subroutines, Canned Cycles, Mirror Image, Parametric Programming, Machining Cycles, Programming For Machining Centre And Turning Centre For Well Known Controllers, Generation of CNC Codes From CAM Packages.

UNIT – III INTRODUCTION TO AUTOMATED PRODUCTION SYSTEMS AND GROUP TECHNOLOGY 9

Automation and types, Automated Manufacturing System, Reasons for Automating, the USA Principle, Strategies for automation and process improvement, automation migration strategies, levels of automations, Types of Automations. Part family, Part classification and coding, production flow analysis – OPITZ classification system, cellular manufacturing, quantitative analysis in cellular manufacturing. Rank Order Clustering Technique (ROC), Holier Method –I,II, Single Linkage Cluster Analysis Technique(SLCA). Application of group technology

UNIT – IV FLEXIBLE MANUFACTURING SYSTEMS 9

Types of flexibility, types of FMS, FMS components, FMS Components-Workstations, Material Handling and Storage Systems, Computer Control System, Human Resources, FMS Applications and Benefits., Quantitative analysis of FMS, Sizing the FMS, System performance measure. Automated Material Handling & Storage: Functions, Types, Analysis of material handling equipment, Design of Conveyor & AGV systems. Problems. Development for a total material handling system.

UNIT – V INDUSTRIAL ROBOTICS 9

Robot – Definition – Robot Anatomy – Coordinate systems, Work Envelope, types and classification – specifications – Pitch, yaw, Roll, Joint Notations, Speed of Motion, PayLoad – Robot Parts and their functions – Need for Robots – End effectors- applications -Programming.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS

1. Programming and machining of turning, thread cutting and grooving operation in CNC Lathe. (Unit –II)
2. Programming and simulation for canned cycle in CNC lathe. (Unit –II)
   (a) Stock removing in facing cycle
   (b) Stock removing in turning cycle
   (c)Grooving cycle
   (d) Thread cutting cycle.
3. Programming for mirroring / scaling function / Pocket milling and drilling cycle in a CNC milling. (Unit –II)
4. Programming and Simulation of profile cutting in CNC Router. (Unit –II)
5. Programming for hexagonal cutting and cross drilling in a four-axis CNC machining center. (Unit –II)
6. 3D Profile cutting in CNC Hot wire cutter/ Plasma Cutter. (Unit –II)
7. Generate CL Data and Post process data using CAM packages for Machining and Turning Centre . (Unit –II)

Note: For all the above experiments study the part, create machine sequence, identify cutting tools and process parameters

TOTAL = 30 PERIODS

TOTAL = 75 PERIODS

COURSE OUTCOMES

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

1. Describe constructional features of CNC Machine Tools.
2. Create CNC manual/automated program for given part drawing through programming
3. Apply group technology and their application in industries.
4. Discuss FMS and its components.
5. Explain robot application in automated production system

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	1	-	1	2	-	1	1	-	1
CO2	2	1	1	1	1	1	1	-	1	2	-	1	1	-	1
CO3	2	1	1	1	1	1	1	-	1	2	-	1	1	-	1
CO4	2	1	1	1	1	1	1	-	1	2	-	1	1	1	1
CO5	2	1	1	1	1	1	1	-	1	2	-	1	1	1	2
CO/PO & PSO Average	2.0	1.0	1.0	1.0	1.0	1.0	1.0	-	1.0	2.0	-	1.0	1.0	1.0	1.2
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Radhakrishnan P, “Computer Numerical Control (CNC) Machines”, New Age International Publishers, 2020.
2. Shivanand H K, Benal M M and Koti V, “Flexible Manufacturing System”, New Age International, 2016.

REFERENCES

1. Rao P.N., “CAD/CAM”, 3rd Edition, Tata McGraw-Hill, 2010.
2. Michael Fitzpatrick, “Machining and CNC Technology”, McGraw-Hill, 2013.
3. Graham T. Smith, “CNC Machining Technology, Volume II Cutting, Fluids and Workholding Technologies”, Springer, 1993.
4. Mikell P. Groover, “Automation, Production system and Computer integrated Manufacturing”,
5. Prentice Hall of India Pvt. Ltd., 4th Edition, 2014.
6. Radhakrishnan P, Subramanian S and Raju V, “CAD/CAM/CIM”, New Age International Publishers, 3rd Edition, 2014.

PR23403	MACHINING PROCESSES	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- The main learning objective of this course is to prepare the students To gain essential knowledge of metal cutting processes, including tool types, tool wear, and the use of cutting fluids.
- To understand the various operations and attachments of different types of lathes
- To comprehend the mechanisms of shapers, planers, and slotters, and their influence on material removal rates.
- To understand drilling, milling, and gear hobbing operations.
- To inculcate knowledge on various surface finishing processes.

UNIT – I INTRODUCTION TO METAL CUTTING 9

Introduction - Metal Removal Processes, Types of Machine Tools – Theory of Metal Cutting - Chip Formation, Orthogonal Cutting- Oblique Cutting - Machinability of metal Cutting Tool - Classification of cutting tools - Single point Cutting Tool Geometry-Cutting Tool Materials, Tool Wear, Tool Life, and Cutting Fluids - Functions and properties.

UNIT – II LATHE AND IT'S OPERATIONS 9

Centre Lathe – Construction - Taper Turning Methods, Thread Cutting operation, Lathe

Attachments & Accessories. Capstan and Turret Lathes – Automats – Single Spindle, Swiss Type, Multi Spindle Automatic lathe – Construction - Features – Advantages – Limitations – Applications- Material Removal Rate (MRR)

UNIT – III RECIPROCATING MACHINE TOOLS 9

Shaper - Principal parts, Classification, Specification of shaper, Shaper Mechanisms, Types - Gear Shaper - Cutting Speed, Feed, Depth of cut & machining time - Introduction to Planer - Principal parts and working of Double housing Planer, Principal parts of Slotter - Working of slotter - MRR

UNIT – IV DRILLING AND MILLING MACHINES 9

Drilling operations - Twist drill geometry – Radial drilling machine - Jigs and Fixtures – Locating devices - Milling - Classification - Milling cutters and classification - Milling operations - Indexing methods - Simple and compounding- Gear hobbing- Cutting speed, feed, depth of cut and machining time - MRR

UNIT – V GRINDING AND FINISHING PROCESSES 9

Grinding Wheel – Specifications and Selection, Types of Grinding Process – Cylindrical Grinding, Surface Grinding, Centre less Grinding – Features – Advantages – Limitations – Applications – Finishing process - Honing, Lapping, Polishing and Buffing-Introduction to texturing – Features and Uses – Applications - MRR

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS

1. Taper Turning and knurling processes.(Unit –II)
2. Eccentric turning.(Unit –II)
3. External and Internal thread cutting .(Unit –III)
4. Shaping – Square and Hexagonal Heads .(Unit –III)
5. Contour milling - vertical milling machine .(Unit –IV)
6. Spur and helical gear cutting using milling machine.(Unit –IV)
7. Gear generation using gear hobber /gear shaper.(Unit –III)
8. Grinding – Cylindrical, Surface and Centerless grinding (dressing) .(Unit –V)
9. Tool angle grinding with tool and Cutter Grinding.(Unit –V)

Any 8 Experiments

TOTAL = 30 PERIODS
TOTAL = 75 PERIODS

COURSE OUTCOMES

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

1. Analyze metal cutting mechanics, tool wear and cutting fluids
2. Comprehend and perform the various operations of lathe
3. Identify the appropriate reciprocating machine tools and execute operations.
4. Describe constructional features and demonstrate various operations related to drilling, milling and gear hobbing.
5. Select appropriate surfaces and their finishing operations for various applications.

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	-	-	-	-	1	-	1	1	1	-	1
CO2	2	1	-	1	-	-	-	-	1	-	1	1	1	-	1
CO3	2	1	-	1	-	-	-	-	1	-	1	1	1	-	1
CO4	2	1	-	1	-	-	-	-	1	-	1	1	1	-	1
CO5	2	1	-	1	-	-	-	-	1	-	1	1	1	-	1
CO/PO & PSO Average	2.0	1.0	-	1.0	-	-	-	-	1.0	-	1.0	1.0	1.0	-	1.0
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. K. L. Narayana, Swarna Venkata Ramana, P. Vamsi Krishna, "Production Technology", I.K. International Publishing House Pvt. Limited, 4th Edition, 2018
2. Sharma.P.C., “A Text Book of Production Technology”, S.Chand and Company, 11th Edition, 2010.

REFERENCES:

1. Hajra Choudhary, “Elements of Production Technology –Vol.II”, Asia Publishing House,2010.
2. Serope Kalpakjian, Steven R. Schmid, "Manufacturing Processes for Engineering Materials", Pearson, 2023
3. R. K Jain, "Production Technology", Khanna Publications, 2012
4. P N Rao, "Manufacturing Technology Vol 2", McGraw-Hill India, 2018.

PR23404	STATISTICS FOR PRODUCTION MANAGEMENT	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

- The main learning objective of this course is to prepare the students:
- To train the students so that students will be able to design experimental designs and use these concepts for research design.
- To make use of the concept of probability for industrial applications.
- To stress upon the importance of the sampling theory and its usefulness in industrial quality control.
- To make students familiarize with the concepts of estimation theory and its applications.
- To help students understand the usefulness of tests of significance and its applications in industry and research.

UNIT – I PROBABILITY THEORY 9

Random variables – Discrete and continuous random variable- Probability mass and density functions- Joint density and mass functions-Moment about mean and origin- Moment generating and characteristic functions – Binomial, Poisson, Normal distributions and their applications-manufacturing problems.

UNIT – II SAMPLING THEORY 9

Sampling with and without replacement- Random sample- Sampling distributions of means, proportions, difference of means and proportions - Student ‘t’ distribution- Chi square distribution Fisher’s distribution and their applications to production problems.

UNIT – II ESTIMATION THEORY 9

Point and Interval estimation- Confidence limits for mean, proportions, difference of means, proportions- Confidence limits using student ‘t’ distribution, Chi square and F distribution applications.

UNIT – IV TESTING OF HYPOTHESIS 9

Procedure for testing hypothesis and significance- Level of Significance of large samples for means, proportions, difference of means and difference of proportions- Tests based on student t distribution, chi square distribution and F distribution – One factor experiments – Mathematical model for one factor experiments- Two factor experiments-Mathematical model for two factor experiments Applications to manufacturing.

UNIT – V DECISION MAKING TOOLS 9

SWOT diagram, Decision Making diagram, Strategy map, Decision Matrix, Pareto Analysis, Ishikawa diagram, Force Field Analysis, Pugh matrix, Ratio analysis,

TOTAL: 45 PERIODS

List of Experiments

1. Exercise on representation of data and distribution. (Unit- I)
2. Exercise on descriptive statistics – Correlation analysis, Measure of Dispersion Moments, Skewness, Kurtosis and Measure of Central Tendency. (Unit- I)
3. Exercise on Statistical Inference – One Sample Tests, Two Sample Tests. (Unit- II)
4. Exercise on Analysis of Variance – One way, Two way. (Unit- III)
5. Exercise on Design of Experiments – Randomized Block Design, Latin Square Design**.** (Unit- IV)

COURSE OUTCOMES

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

1. Interpret the concept of probability and statistics for industrial applications
2. Estimate the quality of the sample using sampling theory in industrial quality control.
3. Estimate the life of the sample using estimation theory in industrial reliability analysis.
4. Formulate hypothesis and conduct Design of experiments.
5. Utilize appropriate decision making tools in production management

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	3	2	1	1	-	-	-	-	-	-	-	1	1	1	1
CO2	3	2	1	1	-	-	-	-	-	-	-	1	1	1	1
CO3	3	2	1	1	-	-	-	-	-	-	-	1	1	1	1
CO4	3	2	1	1	-	-	-	-	-	-	-	1	1	1	1
CO5	3	2	1	2	1	-	-	-	-	-	-	1	1	1	2
CO/PO & PSO Average	3.0	2.0	1.0	1.2	1.0	-	-	-	-	-	-	1.0	1.0	1.0	1.2
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Richard I.Levin and David S. Rubin, “Statistics for Management”, Pearson India, 2018.
2. Richard Barrett Clements, “Handbook of Statistical Methods in Manufacturing”, PH, 1991.

REFERENCES

1. Gupta.S.C. and Kapoor.V.K, “Fundamentals of Mathematical Statistics”, Sultan Chand, 2017.
2. Hooda.R.P., “Statistics for business and economics”, Vikas Publications, 2010.
3. Morris. H. Degroot, Mark J. Schervish, “Probability and Statistics”, Pearson Education, 4th Edition, 2019.
4. Vijay K. Rohatgi, Ehsanes Saleh A.K Md, “An Introduction to Probability and Statistics”, Wiley, 2008.
5. Rukmangadachari. E, E. Keshava Reddy, “Probability and Statistics”, Pearson, 2015.

AU23C01	APPLIED THERMODYNAMICS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

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

- To impart knowledge of basic principles of thermodynamics via real world engineering examples
- To analyse and evaluate cardinal air standard cycles
- To analyse and evaluate cardinal Steam power cycles
- Summarize the governing concepts of Refrigeration and Air conditioning
- To inculcate various modes of heat transfer, related to real time scenarios of thermodynamics applied in engineering practice

UNIT I BASIC THERMODYNAMICS 9

Systems, closed, open and isolated. Property, state, path and process, quasi-static process, Zeroth low, First law. Steady flow energy equation. Engineering Applications of Steady flow energy equation Heat and work transfer in flow and non-flow processes. Second law, Kelvin-Planck statement – Clausius statement - Concept of Entropy, Clausius inequality, Entropy changes in non- flow processes. Available and Unavailable Energy.

UNIT II AIR STANDARD CYCLES AND COMPRESSORS 9

Cycle, Carnot cycle, Otto, Diesel, Dual combustion and Brayton cycles. Air standard efficiency. Mean effective pressure. Comparison of cycles based on same on same compression ratio and same heat input

UNIT III STEAM AND JET PROPULSION 9

Formation of steam and its thermodynamic properties, p-v, p-T, T-v, T-s, h-s diagrams. p-v-T surface Properties of steam, Dryness fraction, Quality of steam-by-steam tables and Mollier chart –Rankine cycle, Work done, Steam rate.

UNIT IV REFRIGERATION AND AIR-CONDITIONING 9

Principles of refrigeration, Vapour compression – Types of VCR system with respect to condition of vapour, Problems, Vapour absorption types, comparison - Co-efficient of performance (COP), Properties of refrigerants

UNIT V HEAT AND MASS TRANSFER 9

Modes of heat transfer, Heat conduction in parallel, radial and composite wall – Heat

TOTAL: 45 PERIODS

PRACTICALS

1. Determination of Specific heat of a solid. (Unit-I)
2. Performance test on 4 stroke engine. (Unit-II)
3. COP test on vapor compression refrigeration test rig. (Unit-IV)
4. Free and forced convective heat transfer from a flat plate . (Unit-V)

5. Determination of effectiveness of counter flow heat exchanger. (Unit-V)
6. Determination of effectiveness of parallel flow heat exchanger. (Unit-V)
7.

TOTAL: 30 PERIODS
TOTAL: 30 PERIODS

COURSE OUTCOMES

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

- Will demonstrate understanding of the nature of the thermodynamic processes for pure substances of ideal gases
- Will interpret First Law of Thermodynamics and its application to systems and control volumes
- Will solve any flow specific problem in an engineering approach based on basic concepts and logic sequences.
- Will compare and contrast between various types of refrigeration cycles
- Will get exposed to the basics and modes of heat transfer

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	3	3	3	3	3	1	1	-	2	2	-	3	1	-	1
CO2	3	3	3	3	3	1	1	-	2	2	-	3	1	-	1
CO3	3	3	3	3	3	1	1	-	2	2	-	3	1	-	1
CO4	3	3	3	3	3	1	1	-	2	2	-	3	1	-	1
CO5	3	3	3	3	3	1	1	-	2	2	-	3	1	-	1
CO/PO & PSO Average	3.0	3.0	3.0	3.0	3.0	1.0	1.0	-	2.0	2.0	-	3.0	1.0	-	1.0
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Chattopadhyay. P, “Engineering Thermodynamics”, Oxford University Press, New Delhi, 2010.
2. Nag.P.K., “Engineering Thermodynamics”, Tata McGraw-Hill, New Delhi, 2007.
3. Rathakrishnan E., “Fundamentals of Engineering Thermodynamics”, Prentice-Hall India, 2005.
4. Ganesan.V, “Thermodynamics: Basics and Applied”, McGraw Hill Education (India) Private Limited, 2018.

REFERENCES

1. Arora C.P, “Thermodynamics”, Tata McGraw-Hill, New Delhi, 2003.
2. Holman.J.P., “Thermodynamics”, 3rd Edition, McGraw-Hill, 2007.
3. Mathur & Sharma Steam Tables, Jain Publishers, New Delhi.
4. Merala C, Pother, Craig W, Somerton, “Thermodynamics for Engineers”, Schaum Outline Series, Tata McGraw-Hill, New Delhi, 2004.
5. Ramalingam K.K., “Thermodynamics”, Sci-Tech Publications, 2006

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

PR23405 MATERIAL PROCESSING LABORATORY

L	T	P	C
0	0	2	1

COURSE OBJECTIVES

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

1. To familiarize students towards advanced casting techniques
2. To motivate students towards advanced fabrication techniques
3. To expose students with near net shaping methods

LIST OF EXPERIMENTS

1. Study the ultrasonic cavitation effect by stir casting of alloying materials.
2. Study the metallurgical and mechanical characteristics of the Squeeze casting of alloy materials.
3. Study the geometrical variations of incrementally formed simple components.
4. Study the metallurgical and mechanical characteristics of friction stir processed aluminium alloy.
5. Study the rate of deposition and metallurgical characteristics for the given sample using Chemical vapor deposition.
6. Prepare the polymer composite by Hand layup method with suitable combination of resin and hardener.
7. Study and simulate the effect of cavity pressure, mold flow behavior, mold temperature and the quality of compression molded components.
8. Develop a sintered components with the given metal powders.
9. Develop a sample components using Injection molding for the given material.
10. Develop a mechanical CAD model and 3D components using additive manufacturing

TOTAL = 30 PERIODS

COURSE OUTCOMES

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

1. Demonstrate advanced casting techniques for simple products.
2. Use advanced fabrication techniques and coatings
3. Design and develop 3D models using additive manufacturing techniques.

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	2	-	1	1	-	2
CO2	2	-	-	1	-	-	1	-	2	2	-	1	1	-	2
CO3	2	-	-	1	-	-	1	-	2	2	-	1	1	-	2
CO/PO & PSO Average	2.0	-	-	1.0	-	-	1.0	-	2.0	2.0	-	1.0	1.0	-	2.0
1 – Slight, 2 – Moderate, 3 – Substantial															

PR23501	QUANTITATIVE TECHNIQUES IN MANAGEMENT	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

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

1. To familiarize the students with concepts of Linear Programming
2. To introduce the replacement models to students
3. To enable the students to utilize the queuing models for application to waiting line problems.
4. To stress importance of inventory management and their use in industry.
5. To familiarize project network and decision tree problems to students so that they can use them in project management.

UNIT – I LINEAR PROGRAMMING 9

Problem formulation - Graphical method – simplex method- Big M method- Two Phase Method– Dual Simplex method- Special cases of LP– transportation model- assignment model – applications.

UNIT – II REPLACEMENT MODELS AND GAME THEORY 9

Basic replacement model – individual replacement and group replacement problems –applications – game theory – terminology – decision criteria – solution to a 2 x 2 and 2 x n games – applications of LP in game theory – applications.

UNIT – III QUEUING MODELS AND SEQUENCING 9

Elements of queue – queue discipline – Poisson arrival and exponential service – Queue Models - queue length –waiting time – steady state conditions – applications – concept of simulation – Monte Carlo method – applications-Scheduling – priority rules -sequencing – methods of sequencing – Johnson's rule – Heuristic approach, line balancing –applications..

UNIT – IV INVENTORY MANAGEMENT 9

Inventory – Purpose – Economic Order Quantity – Quantity Discount Model – Material

Requirement Planning –Q System-P system- Finite Replenishment– ABC Analysis.

UNIT – V PROJECT NETWORK ANALYSIS AND DECISION TREE ANALYSIS 9

Introduction to Project Management-Network – CPM/PERT – Project time estimation – critical path – crashing of network, Decision tree analysis – applications.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS

1. LP Models formulation and solving using software(Unit-I)
2. Formulation of Transportation Problem and Assignment solving using software package (Unit-I)
3. Solving Maximal Flow problem(Unit-V)
4. Solving Minimal Spanning Tree problems(Unit-V)
5. Solving shortest route problems(Unit-V)
6. Solving Waiting line problems (Unit-III)
7. Solving Queuing problems(Unit-III)

Any 6 Experiments

TOTAL = 30 PERIODS
TOTAL: 75 PERIODS

COURSE OUTCOMES

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

1. Use the simplex method to solve problems in industry
2. Identify a suitable replacement model so that replacement of equipment can be done
3. optimally
4. Utilize the knowledge on queuing models and sequencing in production systems
5. Identify inventory model for a specific industry
6. Select a suitable project network technique for project management

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	3	2	-	1	1	-	-	-	2	2	-	2	1	1	2
CO2	3	2	-	1	1	-	-	-	2	2	-	2	1	1	2
CO3	3	2	-	1	1	-	-	-	2	2	-	2	1	1	2
CO4	3	2	0	2	1	1	1	-	2	2	-	2	1	2	2
CO5	3	2	1	2	1	-	-	-	2	2	-	2	1	2	2
CO/PO & PSO Average	3.0	2.0	1.0	1.4	1.0	1.0	1.0	-	2.0	2.0	-	2.0	1.0	1.4	2.0
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Hamdy A. Taha, "Operations Research: An Introduction", Pearson, 2022.
2. Michael Carter, Camille C. Price, Ghaith Rabadi, "Operations Research: A Practical Introduction", CRC Press, 2023.

REFERENCES

1. Guptha.P.K. and Man-Mohan, “Problems in Operations Research”, Sultan Chand and Sons, 2014.
2. Monks. J.G, “Operations Management theory and Practice”, McGraw Hill, 2nd Edition 1996.
3. Ravindran, Philips and Sojberg, “Operations Research Principles and Practice”, John Wiley and Sons, Singapore, 2nd Edition, 2007.
4. Sharma J.K., “Operations Research Theory and Applications”, Macmillan India Ltd., 4th Edition, 2009.
5. Kothari D P,Awari G K, “Quantitative Techniques in Business, Management and Finance”, CRC Press, Taylor and Francis Group, 2017.

PR23502	COMPUTER AIDED DESIGN AND ANALYSIS	L	T	P	C
		3	0	4	5

COURSE OBJECTIVES:

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

1. Analyze and evaluate 2D and 3D transformations, projections, and curves in computer graphics.
2. Apply and create geometric models using wireframe, surface, and solid modeling techniques, adhering to industry standards.
3. Analyze and interpret mathematical models and governing equations for general field problems in engineering.
4. Apply principles of one-dimensional finite element analysis to analyze dynamic behavior and heat transfer in engineering systems.
5. Evaluate and utilize numerical methods and isoparametric formulation for solving 2D problems in engineering.

UNIT – I COMPUTER GRAPHICS 9

2D and 3D Transformations, Transformation matrices, homogeneous transformation – Projections – Curves, Bezier Curves, B-Spline Curves and NURBS - Control points, Knot vector, Parametric curves.

UNIT – II GEOMETRIC MODELING 9

Geometric Modelling, Wireframe Modelling, Surface Modelling, Solid Modelling - Boundary Representation (B-Rep), Constructive Solid Geometry (CSG), Graphics Standards, OpenGL, DirectX, ISO standards (e.g., ISO 10303, STEP) - Assembly Modelling - Use of Software Packages.

UNIT – III ELEMENTS OF FINITE ELEMENT ANALYSIS 9

Historical Background – Mathematical Modelling of field problems in Engineering –Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

UNIT – IV 1D PROBLEMS AND DYNAMIC ANALYSIS 9

One Dimensional Second Order Equations – Discretization – 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. Fourth Order Beam Equation – Transverse deflections and Transverse Natural frequencies of beams.

UNIT – V 2D PROBLEMS AND ISOPARAMETRIC FORMULATION 9

Scalar variable problems, Triangular elements and Quadrilateral elements - Vector variable problems, Plane stress, plane strain and axisymmetric problems – Constitutive matrices and Strain displacement matrices – Stiffness matrix -2D Heat Transfer - Natural co-ordinate systems – Isoparametric elements – Shape functions for isoparametric elements –– Serendipity elements – Numerical integration – Application of FEM in various Manufacturing Process.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS

2D and 3D CAD Modelling Lab

1. 2D Modelling of Mechanical Components(Unit-II)
2. Isometric Modelling using 2D Modelling (Unit-II)
3. Drawing Layouts and Printing: Set up drawing layouts, including title blocks, viewports, and plotting settings for printing or plotting drawings. (Unit-II)
4. Orthographic Projection, Sectional Views, Bill of Materials and Layout Setup in 2D Modelling of Automobile and Machine Component(Unit-II)
5. 3D Modelling of Simple Mechanical Components using Layout(Unit-II)
6. 3D Modelling and Assembly of Automobile and Mechanical Components(Unit-II)
7. 3D Sheet Metal Modelling of Switch Box (Unit-II)
8. 3D Steel Frame Weldment(Unit-II)
9. 3D Motion Study(Unit-II)
10. 3D Surfacing (Unit-II)

Finite Element Simulation Lab Experiments

1. Shear Stress and Bending Moment Simulation for various beams(Unit-IV)
2. Truss Analysis (Unit-IV)
3. Vibration Analysis (Unit-IV)
4. Plastic Deformation Analysis (Unit-IV)
5. Ductile Damage Evaluation Analysis(Unit-IV)
6. Steady State Heat Transfer Analysis(Unit-V)
7. Sheet metal bending Simulation Process(Unit-V)
8. Deep Drawing Simulation Process(Unit-V)
9. Metal Cutting Simulation Process(Unit-V)
10. Optimization Tutorial(Unit-V)
11. Mould flow analysis(Unit-V)

Note: Any Six experiments from each division

TOTAL = 60 PERIODS

TOTAL = 105 PERIODS

COURSE OUTCOMES

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

1. Assess the effectiveness of various transformations, projections, and curves and construct geometric models using wireframe, surface, and solid modeling techniques, demonstrating proficiency in applying industry standards.
2. Evaluate the mathematical models and governing equations used to represent field problems in engineering and implement appropriate finite element analysis techniques for solving complex 1D and 2D engineering problems.
3. Synthesize and apply isoparametric formulation and numerical integration methods to solve practical engineering problems, particularly in manufacturing processes.
4. Read, understand and design 2D machine components using drafting software and create complex models using 3D modeling software.
5. Enable the student to perform finite element modeling analysis for solid mechanics, heat transfer problems and vibration problems through simulation.

TEXT BOOKS

1. Zhuming Bi, Xiaoqin Wang, "Computer Aided Design and Manufacturing", Wiley, 2020.
2. Daryl L. Logan “A First Course in the Finite Element Method, Enhanced 6th Edition, SI Version”, Cengage Learning, 2022.

REFERENCES

1. Nam-Ho Kim, Bhavani V. Sankar, Ashok V. Kumar, "Introduction to Finite Element Analysis and Design", Wiley, 2018.
2. Chandraputla T.R., and Belegundu A.D., “Introduction of Finite Element in Engineering”, Prentice Hall of India, 5th Edition, 2022.
3. David F.Rogers.J, Alan Adams, “Mathematical Elements for Computer Graphics”, McGraw Hill, 2ndEdition, 2009.
4. Kevin Otto, Kristin Wood, “Product Design”, Pearson Education, 7th Reprint, 2011.
5. Seshu.P., “Text Book of Finite Element Analysis”, Prentice Hall of India, 10th Reprint, 2010.
6. Segarland. L.J., “Applied Finite Element Analysis”, John Wiley and Sons, 2nd Edition, 1987.

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	3	1	1	1	1	-	-	-	-	1	-	1	1	-	1
CO2	2	2	1	1	1	-	-	1	-	1	-	1	1	-	1
CO3	3	2	1	1	1	-	-	-	-	1	-	1	1	-	1
CO4	3	2	1	2	2	-	-	-	-	2	-	1	1	-	2
CO5	3	2	1	2	2	-	-	-	-	2	-	1	1	-	2
CO/PO & PSO Average	2.8	1.8	1.0	1.6	1.0	-	-	1.0	-	1.0	-	1.0	1.0	-	1.4
1 – Slight, 2 – Moderate, 3 – Substantial															

PR23503	MECHANICAL MEASUREMENTS AND METROLOGY	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

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

1. To understand the concept of engineering metrology.
2. To familiarize with metrology instruments used for linear and angular measurements.
3. To learn about the surface texture and measuring instruments
4. To explain about the metrology of screw threads and gears
5. To introduce the concepts of Laser and computer applications in metrology.

UNIT – I FUNDAMENTALS OF MEASUREMENT 9

Fundamentals of Engineering metrology –Static characteristics -Precision, Accuracy, Sensitivity, Repeatability, Reproducibility, Linearity- Errors in measurements– Uncertainties in measurements- precautions-Standards-National, Reference, Secondary, and Working Standards-Calibration, Traceability, interchangeability and selective assembly.

UNIT – II LINEAR AND ANGULAR MEASURING INSTRUMENTS 9

Linear measuring instrument-Vernier callipers, micrometres, Slip gauges, dial gauges and surface plates– Concept of comparators - mechanical, electrical, optical and pneumatic comparators – Angular measuring instruments- angle gauges –bevel protractor– Sine bar – Precision spirit level, Autocollimators – Angle dekkor-Alignment telescope – Clinometers.

UNIT – III TOLERANCE ANALYSIS AND MEASUREMENTS OF SCREW THREADS & GEARS 9

Fundamentals of GD&T – Conventional vs Geometric Tolerance, Interpretation of GD&T, Symbols in Engineering Drawings, Datums, Limits, Fits and Tolerances- Problems (using tables); Design of Limit gauges – Process capability, Tolerances Stackup Analysis – Worst Case Analysis and Root Sum of Squares Analysis, Tolerance Charting. Screw thread terminology- Measurements of internal and external screw thread parameters – thread micrometre two and three wire method– Gear terminology - measurement of various elements of gears by pitch circle, constant chord, base tangent and plug method – measurement using rolling gear tester.

UNIT – IV SURFACE TOPOGRAPHY, STRAIGHTNESS, ROUNDNESS MEASUREMENT AND MEASURING INSTRUMENTS 9

Surface finishing – Definitions – types of surface finish –measurement methods-comparison – Profilometer – advanced surface finishing measuring instruments – Straightness and flatness measurement using precision level and autocollimator - Measurement of roundness and camming–Tool makers microscope – Optical and Laser Alignment telescope.

UNIT – V ADVANCES IN METROLOGY AND COMPUTER AIDED METROLOGY 9

Metrology for machine tools-Laser micrometre - Laser interferometer – Applications – Straightness, Alignment, Ball Bar test, Noncontact and in-process inspection using laser – CMM – Types of CMM – Constructional Features – Probes – Accessories – Software – Applications –

Multi sensor CMMs – Articulated CMMs – Factors affecting CMM measurement – Machine Vision – machine vision systems –Introduction to 3D Scanning-3D Computed Tomography.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS

1. Calibration of linear measuring instruments, measurement of bore diameter, roundness, gear tooth thickness(Unit-I)
2. Calibration of angular measuring instruments, measurement of angle using Sine bar/bevel protractor, measurement of internal and external taper angle. (Unit-I)
3. Inspection of screw thread parameters using three wire methods. (Unit-III)
4. Measurements of radius of curvatures using Tool makers microscope. (Unit-IV)
5. Measurements of micro gear and micro thread parameter using profile projector. (Unit-III)
6. Inspection of straightness and flatness using Autocollimator(Unit-IV)
7. Inspection using Vision Measuring System. (Unit-V)
8. Linear and angular measurements using CMM. (Unit-V)
9. Measurement of surface finishing by contact and non-contact methods. (Unit-IV)

Any 7 Experiments

TOTAL = 30PERIODS

TOTAL = 75 PERIODS

COURSE OUTCOMES

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

1. Outline the principles of Engineering Metrology.
2. Compare equipment for linear measurements and angular measurements.
3. Apply concepts of Geometric Dimensioning and Tolerancing and select appropriate methodology to measure the parameters of screw threads and gears.
4. Explain various principles in surface topography
5. Summarize the advancements in metrology.

TEXT BOOKS

1. Jay L. Bucher, "The Metrology Handbook", ASQ Quality Press, 2012.
2. Gupta.I.C., “A text book of Engineering Metrology”, Dhanpat Rai and Sons, 7th Edition 2012.

REFERENCES

1. “ASTE Hand book of Industrial Metrology”, Prentice Hall of India Limited, 2002.
2. Gayler G.N. and Shotbolt C.R., “Metrology for Engineers”, ELBS, 2000.
3. Rajput R.K., “Engineering Metrology and Instrumentation”, Kataria and Sons Publishers, 2013.
4. Raghavendra and L.Krishnamurthy, “Engineering Metrology and Measurements”, OUP India, 2013.
5. Francis T. Farago and Mark A.Curtis, “Handbook of Dimensional Measurements”, Industrial Press Inc, 2007.

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	-	-	-	1	1	2	-	1	2	-	2
CO2	2	1	-	1	-	-	-	-	1	2	-	1	2	-	2
CO3	3	1	1	1	-	-	-	1	1	2	-	1	2	-	2
CO4	2	1	-	1	-	-	-	-	1	2	-	1	2	-	2
CO5	2	1	-	1	1	-	-	-	1	2	-	1	2	-	2
CO/PO & PSO Average	2.2	1.0	1.0	1.0	1.0	-	-	1.0	1.0	2.0	-	1.0	2.0	-	2.0
1 – Slight, 2 – Moderate, 3 – Substantial															

PR23504	UNCONVENTIONAL MACHINING TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. To make acquainted the various unconventional machining processes and its applications
2. To encourage the students for developing the models (experimental/theoretical) of unconventional machining processes
3. To inculcate specialized knowledge and skill in unconventional machining processes using the principles and methods of engineering analysis and design.
4. To cultivate the ability to develop and implement new improved manufacturing processes resulting in creation and distribution of value in engineering applications.
5. To impart knowledge about the significance of controlling process parameters for the optimal performance for newly developed engineering materials used in industries and research organizations.

UNIT – I ABRASIVE AIDED MACHINING PROCESSES 9

Abrasive machining – water jet machining - ultrasonic machining –Abrasive flow machining - Magnetic Abrasive flow machining, Ice jet machining - construction working principle – steps - types – process parameters – derivations – problems, merits, demerits and applications. Magnetic abrasive polishing-MRR

UNIT – II ELECTRICAL AND CHEMICAL AIDED MACHINING PROCESSES 9

Wire EDM - Electric discharge machining – Electrochemical machining – chemical machining – Maskants - Electrochemical grinding - construction – principle – types – control - circuits – merits, demerits and applications-Hybrid Machining-Electropolishing- MRR-Problems

UNIT – III HIGH ENERGY AIDED MACHINING PROCESSES 9

Laser beam machining – Electron beam machining – Plasma arc machining – Ion beam machining – construction - working principle- types – process parameter – MRR- derivations – problems, merits, demerits –and applications.

UNIT – IV HYBRID ELECTROCHEMICAL PROCESSES 9

Electro chemical grinding – electrochemical honing – electro-chemical super finishing – electrochemical buffing – ultrasonic assisted ECM– laser assisted ECM- construction – principle - MRR -merits, demerits –applications.

UNIT – V HYBRID THERMAL PROCESSES 9

Electro erosion dissolution machining – electro discharge grinding – EDM with ultrasonic assistance – abrasive electro discharge machining - construction – principle –MRR- merits, demerits and applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Recall the key concepts and terminology related to abrasive machining processes and their applications.
2. Explain the basic principles and working mechanisms of electrical and chemical aided machining processes.
3. Identify and describe the different types of high-energy aided machining processes and their specific applications.
4. Apply the principles and techniques of hybrid electrochemical processes to improve surface finish and dimensional accuracy in machining operations.
5. Compare and contrast the characteristics, advantages, and limitations of various hybrid thermal processes for different machining scenarios.

TEXT BOOKS

1. Helmi Youssef, Hassan El-Hofy, “Non-Traditional and Advanced Machining Technologies: Machine Tools and Operations”, CRC Press, 2021.
2. Angelos P. Markopoulos, J. Paulo Davim, "Advanced Machining Processes: Innovative", CRC Press, 2019.

REFERENCES

1. J Paulo Davim, "Modern Machining Technology", Elsevier Science, 2011
2. Mishra, P.K., “Non-Conventional Machining”, Narosa Publications, 2018.
3. Chander Prakash, J. Paulo Davim, Sunpreet Singh, "Advanced Manufacturing and Processing Technology", CRC Press, 1st Edition, 2021.
4. Muslim Mahardika, Andi Sudiarso, "Advanced Machining Processes", UGM Press, 2018.
5. Ghosh, A. and Mallik, A., “Manufacturing Science”, East –West private Limited, 2010.

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	1	1	1	-	-	1	-	1	1	1	1
CO2	2	2	-	1	1	1	1	-	-	1	-	1	1	1	1
CO3	2	2	-	1	1	1	1	-	-	1	-	1	1	1	1
CO4	2	2	-	1	1	1	1	-	-	1	-	1	1	1	1
CO5	2	2	-	1	1	1	1	-	-	1	-	1	1	1	1
CO/PO & PSO Average	2.0	2.0	-	1.0	1.0	1.0	1.0	-	-	1.0	-	1.0	1.0	1.0	1.0
1 – Slight, 2 – Moderate, 3 – Substantial															

PR23505	FLUID POWER SYSTEMS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

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

1. To understand the basic principles of fluid power.
2. To classify the different properties of hydraulic fluids and their effects
3. To explain the working principles of various control elements
4. To illustrate the working principle of hydraulic and pneumatic circuits for different applications.
5. To design electro pneumatic and PLC circuits for industrial applications

UNIT – I INTRODUCTION TO FLUID POWER 9

Introduction to fluid power controls - Hydraulics and pneumatics - Selection criteria, Application of Fluid power, Application of Pascal's Law, equation, Transmission and multiplication of force - Pressure Losses - Fluids, selection & properties - ISO symbols. Pumps - working principle and construction details of Gear, vane and piston pumps.

UNIT – II FLUID POWER ACTUATORS 9

Fluid Power drives - Hydraulic motors, Pneumatic power supply - compressors, air distribution, air motors. Actuators - Selection and specification, cylinders, mounting, cushioning- Hydrostatic transmission drives and characteristics; Accumulators –Intensifiers.

UNIT – III FLUID POWER CONTROL ELEMENTS 9

Control valves - pressure, flow, direction - working principle and construction - Special type - valves - Cartridge, modular, proportional, and servo - Selection and actuation method - Hydraulic supply components -pipe fittings - Fluid conditioning elements.

UNIT – IV HYDRAULIC AND PNEUMATIC CIRCUITS DESIGN 9

Regenerative, speed control and synchronizing circuits - Design of Hydraulic and pneumatic circuits for automation, selection and specification of circuit components, sequencing circuits, cascade, and Karnaugh - Veitch map method.

UNIT – V ELECTRO PNEUMATICS AND PLC CIRCUITS 9

Use of electrical timers, switches, solenoid, relays and proximity sensors electro pneumatic sequencing - PLC - elements, functions and selection - PLC programming - Ladder diagram and different programming methods - Sequencing circuits.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS

1. Speed control of hydraulic motor and cylinder. (Unit-II)
2. Single and double acting cylinder circuits using different directional control values. (Unit-II)

3. Sequencing of Regenerative pneumatic circuits. (Unit-IV)
4. Sequencing of pneumatic circuits. (Unit-IV)
5. Actuating Electro-pneumatic latch circuits. (Unit-V)
6. Actuating Logic pneumatic circuits. (Unit-IV)
7. Actuating electro pneumatic sequencing circuits. (Unit-V)
8. Actuating PLC based electro pneumatic sequencing circuits. (Unit-V)
9. Software Simulation of pneumatic and hydraulic circuits. (Unit-IV)
10. Actuating sorting and distribution station. (Unit-V)

Any 8 Experiments

TOTAL = 30 PERIODS
TOTAL: 75 PERIODS

COURSE OUTCOMES

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

1. Acquire the knowledge on principles and applications of fluid power.
2. Explain the working principle of pumps and actuators, of fluid power system
3. Demonstrate the working principles of control elements
4. Design circuit for typical applications like material handling, press, shaping, milling, grinding.
5. Solve industrial automation problems using electro pneumatics and PLC Circuits.

TEXT BOOKS

1. Anthony Esposito, “Fluid Power with Applications”, Pearson education, 7th Edition, 2014.
2. Ilango Sivaraman, "Introduction to Hydraulics and Pneumatics", Prentice Hall India Pvt.Limited, 3rd edition, 2017.

REFERENCES

1. Andrew Parr, “Hydraulics and Pneumatics”, Jaico Publishing House, 3rd Edition, 2011.
2. Jagadeesha T, "Pneumatics: Concepts, Design and Applications", University Press, 2015.
3. Majumdar, “Oil hydraulics: Principles and Maintenance”, Tata McGraw Hill, 13th Edition, 2006.
4. Majumdar, “Pneumatic system: Principles and Maintenance”, Tata McGraw Hill, 7th Edition, 2008.
5. Peter Rohner, “Fluid Power Logic circuit Design”, Macmillan Press Ltd., 2000.

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	-	1	1	2	2	-	1	1	-	2
CO2	3	-	-	1	1	-	-	-	2	2	-	1	1	-	2
CO3	3	-	-	1	1	-	-	-	2	2	-	1	1	-	2
CO4	3	1	1	1	1	-	-	-	2	2	-	1	1	-	2
CO5	3	1	1	1	1	-	-	-	2	2	-	1	1	-	2
CO/PO & PSO Average	2.8	1.0	1.0	1.0	1.0	-	1.0	1.0	2.0	2.0	-	1.0	1.0	-	2.0
1 – Slight, 2 – Moderate, 3 – Substantial															

		L	T	P	C
PR23U02	PERSPECTIVES OF SUSTAINABLE DEVELOPMENT IN PRODUCTION ENGINEERING	3	0	0	3

COURSE OBJECTIVES:

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

1. Get familiarize students with the application of sustainable manufacturing practices in different industry sectors, such as automotive, electronics, and textiles.

UNIT – 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.

UNIT – 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

UNIT – 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.

UNIT – IV SUSTAINABLE MANUFACTURING PRACTICES IN INDUSTRY **9**

Sustainable practices in automotive, electronics, textiles and apparel manufacturing - Clean and green manufacturing technologies - Advanced process monitoring and control systems - Case studies.Digitalization and Industry 4.0 in sustainable manufacturing - Sustainable material selection - Green supply chain management - carbon footprint: calculation, need to reduce the carbon footprint of manufacturing Operations, Carbon trading and offsetting.

UNIT – V SUSTAINABILITY PRACTICES **30**

1. Experiment on industrial noise measurement
2. Experimental measurement of illumination with various types of bulbs
3. Spindle and feed drive units power measurement in bench drilling machine
4. Estimation of carbon foot print from different machining processes
5. Machining under different cooling and lubrication strategy
6. Coolant life management
7. Determination of ph value for municipal and industrial waters
8. Determination of ph value of normal and polluted soils

Any 6 Experiments

TOTAL: 60 PERIODS

COURSE OUTCOMES

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

1. Design sustainable manufacturing processes by considering factors like green supply chain, material selection through case studies

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

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. Rout ledge.
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.

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															
CO2															
CO3															
CO4	3	3	3										3	3	3
CO5															
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

PR23701	MECHATRONICS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

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

1. To acquire overview of multi-domain engineering integration and make the students get acquainted with the sensors and transducers and its interfacing.
2. To understand and apply the various types of actuators and its drives for interfacing.
3. To apply modeling of basic mechanical system elements and recognize the need of control systems.
4. To impart practical knowledge about the fundamentals of microcontroller to realize the interfacing and control.
5. To render practical exposure in the design and development of mechatronics systems.

UNIT - I MECHATRONICS SYSTEMS AND SENSORS 9

Introduction to Mechatronics Systems – Measurement and Control parameters overview, Key Elements, Ways of Integration – Hardware and Software. Sensors – Characteristics – Static and Dynamic, Types - Linear, Rotational, Velocity, Acceleration, Force, Torque, Flow, Temperature, Proximity, Optical, Selection of Sensors, Analog and Digital Signals, Signal Conditioning and Processing

UNIT - II ACTUATORS 9

Electrical Actuators and Its Characteristics – DC Motors, AC Motors - Servo Motor and Stepper Motor, Switching Devices –Mechanical, Solenoids, Relays, AC Drives - H-Bridge Circuits and Stepper Motor Driving Circuits - Overview of Fluid Power Actuators and Control - Types and Characteristics of Micro and Nano Actuators

UNIT - III SYSTEM MODELLING AND CONTROL 9

Transfer Function - Mechanical System Modelling – Characterization of System Time Response –Stable and Unstable System - Open Loop and Closed Loop Control Systems, Controllers - P, PD,PI, PID and PLC - Comparison of Control Realization in Hardware

UNIT - IV MICROCONTROLLERS 9

Microprocessor – Microcontroller – 8051 Microcontrollers – Architecture, Addressing Modes, Instruction Sets, Programming Exercises -Memories – Different Types – Different I/O Devices, Stepper and Servo Motor Interface, Overview of Advanced Microcontrollers - Typical Applications.

UNIT - V MECHATRONICS SYSTEM DESIGN AND APPLICATIONS 9

Stages in Designing Mechatronics Systems – Traditional and Mechatronic Design – Mechatronics System Elements and Architecture of CNC Machine, Serial Manipulator, Engine Management System, Product Assembly Line Automation.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS

1. Experimentation on Characterization of Optical Sensors and speed measurement using encoder. (Unit-I)
2. Experimentation on Characterization of Temperature Transducers. (Unit-I)
3. Experiments on LVDT and Ultrasonic Transducer for Displacement Measurements. (Unit-I)
4. Experiments on Strain gauge: Load and Torque Measurements(Unit-I)
5. 8 bit and 16 bit Arithmetic Operation in 8051 Microcontroller. (Unit-IV)
6. I/O Port Programming of 8051 Microcontroller for Sensor and Motor Interfacing. (Unit-IV)
7. Modelling and Simulation of Mechanisms using Simulation Software. (Unit-V)
8. Kinematic Analysis and Verification of 1, 2 and 3 DOF Configuration Robots. (Unit-V)
9. Position, Speed and Direction Measurement and Control of Servo Motor. (Unit-II)
10. Robot Control with Stepper Motor Interfacing. (Unit-II)

TOTAL = 30 PERIODS

COURSE OUTCOMES

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

1. Recognize the principles of sensors, actuators, controllers and define mathematical models of mechatronics systems.
2. Appraise the working features of sensor, controller and actuators to develop mechatronics systems.
3. Develop mathematical model, control and integration of mechatronics system.
4. Analyze and select sensors, actuators, Controllers and simulate kinematic mechanisms for automation applications.
5. Apply selected elements to a mechatronics system for realizing the automation application.

TEXT BOOKS

1. William Bolton, "Mechatronics Electronic Control Systems in Mechanical and Electrical Engineering", Pearson Education Limited, 7th edition, 2019.
2. Vijayaraghavan G.K., Balasundaram M.S, Ramachandran K.P., “Mechatronics: Integrated Mechanical Electronic Systems”, Willey, 2013

REFERENCES

1. Bishop R. H, The Mechatronics Handbook, CRC Press, 2002.
2. Mazidi. M.A and Mazidi .J.G, Mckinlay.R.D, “The 8051 Microcontroller and Embedded Systems Using Assembly and C”, Pearson India, 2014.
3. Patranabis D., “Sensor and Actuators”, Prentice Hall of India Pvt Ltd., 2nd Edition 2005.
4. Mohamed Arezki Mellal, "Mechatronic Systems: Design, Performance and Applications", Nova Science Publishers, 2019.
5. John P. Bentley., “Principle of Measurement systems”, Pearson Prentice Hall, 4th Edition, 2005.
6. K. Ogata, “Modern Controls Engineering“, Prentice Hall of India Pvt. Ltd., New , 2016.

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	1	1	-	-	-	-	1	-	1	2	-	1
CO2	2	1	1	1	1	-	-	-	-	1	-	1	2	-	1
CO3	2	1	1	1	1	-	-	-	-	1	-	1	2	-	1
CO4	2	1	1	1	1	-	-	2	2	2	-	1	2	-	2
CO5	2	1	1	1	1	-	-	2	2	2	-	1	2	-	2
CO/PO & PSO Average	2.0	1.0	1.0	1.0	1.0	-	-	-	-	1.0	-	1.0	2.0	-	1.4
1 – Slight, 2 – Moderate, 3 – Substantial															

PR23U01	STANDARDS FOR PRODUCTION ENGINEERING	L	T	P	C
		1	0	0	1

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

Module – I OVERVIEWOF 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 PROCESSES 9
Indian Standards for Welding, Casting, Injection Moulding, Metal Cutting, Machining & Allied Processes

TOTAL: 15 PERIODS

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

REFERENCES

1. Khan, W.A. and SI, A.R., 2005. *Standards for engineering design and manufacturing*. CRC Press.
2. Kverneland, K.O. and Kverneland, K.O., 2007. *Metric standards for worldwide manufacturing*. NY: ASME Press.
3. Niebel, B.W., 1999. *Methods, standards, and work design*. Irwin Professional Publishing.
4. Public Safety Standards of the Republic of India https://law.resource.org/pub/in/bis/manifest.pgd.3.html

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															
CO2															
CO3															
CO4															
CO5															
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

PRXXXX	ADVANCED MANUFACTURING LABORATORY	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES

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

1. To familiarize students towards unconventional machining techniques
2. To enhance knowledge in advanced metal forming and joining techniques
3. To demonstrate advanced welding techniques.

LIST OF EXPERIMENTS

1. Study the material removal mechanism, kerf and surface roughness of the wire cut EDM machined components.
2. Study the material removal mechanism and surface roughness of the EDM machined components.
3. Study the material removal mechanism and surface roughness of the ECM machined components.
4. Study the material removal mechanism, kerf and surface roughness of the abrasive water jet machined sample.
5. Study the metallurgical and mechanical characteristics of given material using Ultrasonic Welding/Machining.
6. Study the metallurgical and mechanical characteristics of given material using Laser Beam Machining.
7. Study the metallurgical and mechanical characteristics of friction stir welded aluminium alloy
8. Develop G code and M code for incremental forming using CAM Software.
9. Develop robot programing and perform single pass MIG welding.
10. Study the metallurgical and mechanical characteristics of submerged arc welded sample.

TOTAL = 30 PERIODS

COURSE OUTCOMES

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

1. Apply unconventional techniques in industries
2. Use advanced forming and joining techniques
3. Select and apply the appropriate joining process for the application.

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	2	-	1	1	-	2
CO2	2	-	-	2	1	-	-	-	2	2	-	1	1	-	2
CO3	2	-	-	2	-	-	1	-	2	2	-	1	1	-	2
CO/PO & PSO Average	2.0	-	-	1.7	1.0	-	1.0	-	2.0	2.0	-	1.0	1.0	-	2.0
1 – Slight, 2 – Moderate, 3 – Substantial															

PR23702 **COMPREHENSION**

L	T	P	C
0	0	1	1

COURSE OBJECTIVES:

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

1. Develop a comprehensive understanding of the fundamentals of contemporary manufacturing systems, including materials, manufacturing processes, product and process control, computer-integrated manufacturing, and quality.
2. Apply problem-solving skills to analyze and solve real-life industrial problems related to manufacturing systems.
3. Foster teamwork and collaboration abilities by working in groups to solve a variety of problems.
4. Enhance critical thinking and decision-making skills in the context of manufacturing systems.
5. Acquire knowledge of continuous assessment methods and receive feedback from faculty members to evaluate progress and understanding of the course material.
6. The students shall be prepared for comprehension of knowledge acquired by the engineering and professional courses through continuous assessment by multiple choice questions on selected topics scheduled throughout the semester and approved by the head of department and evaluated by a committee constituted by the head of the Department.
7. The students are expected to demonstrate understanding, logical and analytical thinking in answering the multiple-choice questions and preparedness for competitive examinations for job and higher studies.

COURSE OUTCOMES

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

1. Understand the key principles and concepts of contemporary manufacturing systems, including materials, processes, control, computer integration, and quality.
2. Apply problem-solving techniques to analyze and solve complex industrial problems related to manufacturing systems.
3. Demonstrate effective teamwork and collaboration skills through group work on problem-solving tasks.
4. Evaluate and make informed decisions regarding manufacturing processes, product design, and quality control in practical situations.
5. Demonstrate the ability to receive and incorporate feedback from faculty members to improve understanding and performance in the course.

TOTAL = 15 PERIODS

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	3	-	-	1	-	1	-	-	1	-	2	3	2	-	1
CO2	3	-	-	1	-	1	-	-	1	-	2	3	2	-	1
CO3	3	-	-	1	-	1	-	-	1	-	2	3	2	-	1
CO4	3	-	-	1	-	1	-	-	1	-	2	3	2	-	1
CO5	3	-	-	1	-	1	-	-	1	-	2	3	2	-	1
CO/PO & PSO Average	3.0	-	-	1.0	-	1.0	-	-	1.0	-	2.0	3.0	2.0	-	1.0
1 – Slight, 2 – Moderate, 3 – Substantial															

PR23703	MINI PROJECT	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

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

1. To stimulate creativity in themselves and learn the impact of innovation creation.
2. To understand several innovation concepts/methodologies.
3. To apply creative and design thinking to real-world business situations.

- The main objective of this course is to help the students to identify innovative projects which promote and enhance creativity to explore the variables. The goal is to improve the creative and innovative aspects in the design, fabrication and implementation of real time problems related to social/industrial and campus based.
- This course will help the students to learn concepts, models, frameworks, tools, etc., in a world where creativity and innovation is fast becoming a precondition for competitive advantages.
- The students will be grouped into 3 or 4 (max) students as a batch and work under a faculty member as project supervisor. The progress of project work will be continuously evaluated by a committee constituted by the Head of the Department. The project report is to be submitted by the group.
- The final end semester exam will be conducted by an external member in a Viva Voce mode.

TOTAL = 60 PERIODS

COURSE OUTCOMES

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

- Understand and analyze the problem which needs engineering solutions.
- Design and simulate the creative solution for the required applications
- Fabricate, analyze and evaluate the developed solution for the suitability of desired applications.

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	3	2	2	2	2	2	2	2	3	3	3	3	2	1	2
CO2	3	2	2	2	2	2	2	2	3	3	3	3	2	1	2
CO3	3	2	2	2	2	2	2	2	3	3	3	3	2	1	2
CO/PO & PSO Average	3.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0	2.0	1.0	2.0
1 – Slight, 2 – Moderate, 3 – Substantial															

PR23704	SUMMER INTERNSHIP	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- The main learning objective of this course is to prepare the students
- To provide industrial exposure, work pattern and hands-on experience
- To gain practical experience and apply academic knowledge in a real word setting
- To expand professional network and refine transferable skills for future career opportunities

The students have to undergo practical industrial training for two weeks (During previous Semester vacation period- either one or two industries) 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 Seventh Semester

COURSE OUTCOMES

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

- Learn the application of engineering basics to solve complex industrial problems
- Foresee group dynamics and engage in life-long learning
- Gain knowledge on computational and design tools for sustainable product development

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	3	3	3	3	3	1	1	1	1	1	1	3	3	3	3
CO2	3	3	3	3	3	1	2	2	1	1	1	3	3	3	3
CO3	3	3	3	3	3	1	3	3	1	1	1	3	3	3	3
CO/PO & PSO Average	3.0	3.0	3.0	3.0	3.0	1.0	2.0	2.0	1.0	1.0	1.0	3.0	3.0	3.0	3.0
1 – Slight, 2 – Moderate, 3 – Substantial															

PR23801	PROJECT WORK / INTERNSHIP CUM PROJECT WORK	L	T	P	C
		0	0	16	8

COURSE OBJECTIVES

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

1. Develop problem-solving skills: The objective of the project work is to provide students with an opportunity to apply the principles and concepts learned in the course to real-world problems. By working on a project, students will develop their problem-solving skills and learn how to analyze and address complex engineering challenges.
2. Enhance interdisciplinary knowledge: The project work allows students to explore interdisciplinary topics and gain a deeper understanding of the interconnected nature of engineering fields. By selecting a project in consultation with faculty members, students can work on projects that involve multiple disciplines, fostering a broader perspective and knowledge base.
3. Foster collaboration and project management skills: The project work involves working in teams and collaborating with faculty members as guides. This objective aims to enhance students' collaboration and project management skills, including effective communication, teamwork, time management, and task allocation.

Evaluation

A project area must be selected by the students in consultation with the faculty members who act as a guide. The objective of the project work is to deepen comprehension of principles by applying them to a problem which may be; design and fabrication of a device / a research project with a focus on the application needed by the industry; a software oriented project involving design and analysis; a management project to apply the latest technique for an industrial problem; material characterization (or) any inter- disciplinary topic of due weightage / continued work of internship in a company etc., The progress of this project is evaluated based on a minimum of three reviews. The review committee will be constituted by the Head of the Department. A project report is to be submitted at the end of the project. The final end semester exam will be evaluated jointly by external and internal examiners based on oral presentation and the demonstration of the project work.

TOTAL = 240 PERIODS

COURSE OUTCOMES

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

1. Application of engineering principles: Through the project work, students will demonstrate the application of engineering principles to solve real-world problems. They will be able to identify appropriate engineering methodologies, tools, and techniques and apply them effectively to achieve project goals.
2. Proficiency in project execution: Students will gain proficiency in executing a project from inception to completion. They will demonstrate their ability to plan, organize, and manage project tasks, allocate resources, and meet project milestones and deadlines.
3. Effective communication and presentation skills: The project work will enhance students' communication and presentation skills. They will learn to articulate their ideas, methodologies, and project outcomes through written reports, oral presentations, and project demonstrations. Students will also develop the ability to effectively communicate technical concepts to both technical and non-technical audiences.

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	3	2	2	2	2	2	2	2	3	3	3	3	2	1	2
CO2	3	2	2	2	2	2	2	2	3	3	3	3	2	1	2
CO3	3	2	2	2	2	2	2	2	3	3	3	3	2	1	2
CO/PO & PSO Average	3.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0	2.0	1.0	2.0
1 – Slight, 2 – Moderate, 3 – Substantial															

PR23D01 CAPSTONE DESIGN PROJECT – LEVEL I

L	T	P	C
0	0	8	4

COURSE OBJECTIVES

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

1. Develop a basic understanding of engineering design principles and manufacturing processes.
2. Apply elementary problem-solving techniques to address fundamental engineering challenges.
3. Function effectively in a team setting, fostering collaboration and communication skills.
4. Utilize basic research methodologies to generate and evaluate simple design alternatives.
5. Understand and consider basic practical constraints, such as cost, time, and materials, in design solutions.

In the initial phase of their capstone project journey, students should focus on grasping the fundamental elements of project execution, following an iterative engineering design process. At this level, students should begin by understanding and applying the basic principles of design, analysis, building, testing, and recommending solutions. They should start with defining customer needs, establishing product requirements, and exploring multiple design concepts. The projects should be innovative yet manageable within the scope of their current knowledge. Emphasis should be on learning how to conduct background research, identify project constraints, and develop initial design specifications. Analytical skills should be fostered through simple modelling and simulations, encouraging an analysis-driven design approach over trial and error. Planning skills should be developed through basic project scheduling, work breakdown structures, and progress tracking. At the end the students should start preparing for Patent documentation.

TOTAL = 60 PERIODS

COURSE OUTCOMES

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

1. Demonstrate foundational knowledge of engineering design principles, including problem definition and solution formulation, and apply them to generate simple design alternatives.
2. Conduct basic research and design methodologies to inform project proposals and design solutions, including formulation of problem statements and specifications.
3. Function effectively as part of a team, demonstrating collaboration and communication skills, and contribute to team decision-making processes.
4. Understand and incorporate practical constraints such as budget, materials, time, safety, usability, and feasibility into design solutions.
5. Prepare and present a detailed report and project summary, demonstrating documentation and presentation skills.

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															
CO2															
CO3															
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

PR23D02	CAPSTONE PROJECT - II	L	T	P	C
		0	0	12	6

COURSE OBJECTIVES:

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

1. Employ advanced problem-solving techniques to develop and evaluate complex design alternatives.
2. Collaborate effectively in interdisciplinary design projects that reflect current engineering practices.
3. Conduct a comprehensive literature review and utilize advanced research methodologies in design projects.
4. Analyze and integrate realistic constraints, including economic factors, sustainability, and global and social impacts, in design solutions.
5. Produce detailed system descriptions and comprehensive documentation of the design process and outcomes.

Evaluation

As students progress to their sixth semester, the complexity and scope of their capstone projects should increase. They should enhance their understanding of the iterative design process by incorporating more sophisticated analysis, validation, and potential redesign phases. Projects at this level should challenge students' creative and technical abilities, pushing them to explore new technologies and innovative solutions. Students should refine their skills in defining user needs and constraints, developing detailed design specifications, and conducting comprehensive literature reviews. They should be capable of evaluating various design trade-offs, selecting the optimal solution, and performing detailed decompositions. Analytical calculations and simulations should be more rigorous, and students should aim to follow simulation-driven product development practices. Project planning should include more detailed scheduling, budget considerations, and progress tracking, with at least one subsystem designed and built from scratch. At the end the students should have applied for design Patent Documentation.

TOTAL: 60 PERIODS

COURSE OUTCOMES

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

1. Demonstrate advanced understanding of engineering design principles, including complex problem definition and solution formulation, and apply these skills to generate and evaluate multiple design alternatives.
2. Conduct thorough literature reviews and advanced research methodologies to inform project proposals and guide the development of design solutions.
3. Collaborate effectively with peers from various disciplines to tackle complex, interdisciplinary design projects that reflect modern engineering practices.
4. Analyze and integrate realistic constraints such as economic factors, sustainability, global, and social impacts into design solutions.
5. Prepare comprehensive documentation and professional-grade presentations that summarize the project process, outcomes, and impact, showcasing advanced communication skills.

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															
CO2															
CO3															
CO4															
CO5															
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

PR23D03	CAPSTONE PROJECT - III	L	T	P	C
		0	0	16	8

COURSE OBJECTIVES

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

1. Apply advanced engineering sciences and comprehensive knowledge in designing complex systems or components.
2. Generate and rigorously evaluate innovative design alternatives considering a wide range of complex constraints.
3. Conduct extensive research, literature reviews, and advanced design methodologies to inform project development.
4. Analyze and integrate extensive constraints, including economic, sustainability, global, and social impact, into design solutions.
5. Demonstrate exceptional teamwork, leadership, and project management skills, managing complex projects with a commitment to diversity, equity, inclusion, and belonging.

Evaluation

In their seventh semester, students are expected to tackle capstone projects that are highly challenging, innovative, and unique. These projects should push the boundaries of their creative, intellectual, and technical capabilities, addressing real-world problems with sophisticated solutions. Students should apply advanced iterative design processes, including extensive analysis, rigorous validation, and potential redesigns. They should demonstrate a thorough understanding of customer needs, constraints, and standards, developing complex design specifications and performing in-depth background research. The ability to evaluate and select among diverse design options, perform detailed decompositions, and use advanced simulations and analytical calculations is crucial. Planning should be comprehensive, covering all aspects of project implementation, including detailed schedules, work breakdown structures, budgets, and progress tracking. At this level, students should be capable of designing and building complex subsystems from scratch, showcasing their readiness to transition from academic learning to professional engineering practice. At the end the students should have applied for product Patent Documentation.

TOTAL = 60 PERIODS

COURSE OUTCOMES

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

1. Demonstrate the ability to apply advanced engineering sciences and comprehensive knowledge to design complex systems, components, products, or processes, considering innovative solutions and rigorous evaluation.
2. Conduct comprehensive research and advanced design methodologies to inform project development, including literature reviews, problem statement formulation, and specification creation.
3. Collaborate effectively in interdisciplinary teams, integrating diverse perspectives and expertise to tackle complex, real-world design challenges that reflect cutting-edge industrial and mechanical engineering practices.
4. Analyze and integrate extensive constraints such as economic factors, sustainability, global, and social impacts into design projects, ensuring alignment with ethical and environmental considerations.

5. Prepare comprehensive documentation and professional-grade presentations that showcase the advanced project process, detailed system descriptions, outcomes, and impact, demonstrating exceptional communication skills.

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															
CO2															
CO3															
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

GUIDANCE ON CAPSTONE PROJECTS

1. Capstone projects should follow

- Design, Analyze, verify/validate, Re-Design, Recommend
- An iterative engineering design process. Capstone projects should apply best practices for product design process, including understanding customer needs, defining product requirements, generating and selecting among concepts, detailed engineering design, costing and prototyping. Projects should apply these methods to real-world products or systems.

2. Capstone projects should be challenging, innovative, and unique

- Projects should challenge the creative, intellectual and technical abilities of the students.
- Student's success rate is high in areas where new technologies open opportunities for novel solutions. Students do not have the highly specialized knowledge to compete effectively with seasoned experts in a narrow area.
- Creativity is an important engineering skill, so projects should be amenable to multiple solutions. Without enforcing a specific solution on students but instead should guide them by providing all pertinent information about the problem, thus enabling students to make informed decisions in their project endeavors.
- Students should use analysis-driven design methodology and avoid trial and error. The best projects use analytical skills to model the problem and potential solutions to make the design and analysis driven process.

3. To successfully complete the project proposal, students are expected to:

a) Define an appropriate and manageable project that can be designed and built in a 15-week semester*.

*Possibility for multi-year projects – provided the project can be modularized to 15-week sub-projects.

b) State user or customer needs, identify project constraints and refer to appropriate standards.

c) Develop the requirements and design specifications.

d) Search for background history and current research literature on the topic. Look for current technologies, and lifecycle of similar products.

e) Evaluate various design options (design tradeoffs) and select the best option to satisfy design specifications.

f) Complete a detailed design (decomposition).
- Use of analytical calculations or simulations to verify design is required
- If possible, follow simulation driven product development.

g) Plan project implementation: schedule, work breakdown, progress tracking and budget.

Note: If the capstone project involves assembling sub-systems, at least one sub-system should be designed and built from scratch.

		L	T	P	C
PR23001	**DIRECT DIGITAL MANUFACTURING**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

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

1. To introduce the development of Additive Manufacturing (AM), various business opportunities and applications
2. To familiarize various software tools, processes and techniques to create physical objects that satisfy product development / prototyping requirements, using AM.
3. To be acquainted with vat polymerization and material extrusion processes.
4. To be familiar with powder bed fusion and direct energy deposition.
5. To gain knowledge on applications of binder jetting, material jetting and laminated object manufacturing processes

UNIT – I INTRODUCTION 9

Overview – Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling – Rapid Manufacturing – Additive Manufacturing. AM Process Chain- Classification– Benefits. Applications: Building Printing-Bio Printing- Food Printing-Printing Electronics. Business Opportunities and Future Directions - Intellectual Property.

UNIT – II DESIGN FOR ADDITIVE MANUFACTURING (DFAM) 9

Concepts and Objectives- AM Unique Capabilities: Part Consolidation-Topology Optimization-

Light weight Structure - DFAM for Part Quality Improvement. Data Processing - CAD Model Preparation -Part Orientation and Support Structure Generation -Model Slicing - Tool Path Generation-Customized Design and Fabrication for Medical Applications- Case Studies..

UNIT – III VAT POLYMERIZATION AND MATERIAL EXTRUSION 9

Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process -Advantages-

Limitations- Applications. Digital Light Processing(DLP) - Materials – Process - Advantages -

Applications. Extrusion Based System: Fused Deposition Modeling (FDM)- Process-Materials - Applications and Limitations.

UNIT – IV POWDER BED FUSION AND DIRECT ENERGY DEPOSITION 9

Powder Bed Fusion: Selective Laser Sintering (SLS): Process – Powder Fusion Mechanism –

Process Parameters – Typical Materials and Application. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials – Process - Advantages and Applications. Beam Deposition Process: Laser Engineered Net Shaping (LENS)- Process -Material Deliver - Process Parameters -Materials -Benefits -Applications.

UNIT – V OTHER ADDITIVE MANUFACTURING PROCESS 9

Binder Jetting: Three Dimensional Printing - Materials -Process - Benefits and Limitations. Material Jetting: MultijetModeling- Materials - Process - Benefits. Sheet Lamination Process: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding – Thermal Bonding- Materials-Application and Limitation.

TOTAL: 45 PERIODS

COURSE OUTCOMES

1. Understand the development of AM technology and how AM technology propagated into various businesses, while remembering the emerging opportunities it presented.
2. Evaluate the process of transforming a concept into the final product in AM technology, and apply that knowledge to acquire a comprehensive understanding.
3. Understand the vat polymerization and material extrusion processes in additive manufacturing, remember the key details and characteristics, and apply this knowledge to elaborate on their various applications.
4. Understand the processes of powder bed fusion and direct energy deposition in additive manufacturing, remember the key aspects and details, and apply this knowledge to explore their various applications.
5. Evaluate the advantages, limitations, and applications of additive manufacturing processes.

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	3	-	-	-	-	-	1	3	-	2	-	3	1	1	3
CO2	3	2	1	1	2	-	3	2	-	2	-	3	3	3	2
CO3	3	1	-	-	-	-	2	-	-	2	-	3	1	3	1
CO4	3	1	-	-	-	-	2	-	-	2	-	3	1	3	1
CO5	3	1	-	-	-	-	2	-	-	2	-	3	1	3	1
CO/PO & PSO Average	3.0	2.1	1.0	1.0	2.0	-	2.0	2.5	-	2.0	-	3.0	1.4	2.6	1.6
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Andreas Gebhardt and Jan-Steffen Hötter“Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1- 56990-582-1.
2. Ian Gibson, David W. Rosen and Brent Stucker “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, 2nd edition, Springer., United States,2015, ISBN-13: 978-1493921126.

REFERENCES

1. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.
2. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid
3. Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011,ISBN: 9783446425521. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer.,United States ,2006, ISBN: 978-1-4614-9842-1.
4. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press., United States, 2011, ISBN: 9780849334092.
5. Milan Brandt, “Laser Additive Manufacturing: Materials, Design, Technologies, and Applications”, Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.

PR23002	PRODUCTION OF AUTOMOTIVECOMPONENTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

- To impart knowledge in various manufacturing methods in developing automotive components
- To study the concepts of automobile engine components.
- To interpret different types of fuel and transmission systems.
- To understand the concepts of chassis and suspension system.
- To learn the recent developments in automobile industries.

UNIT – I INTRODUCTION TO AUTOMOIBLE AND MATERIALS 9

Classification of vehicles – Basis of load – wheels –fuel – body – transmission- position of engine –chasis and frames. Materials used in automobile – requirements, light weight, cost, safety, recycling. New grades of steels and alloys - plastics and composites – renewable martials – steel sheets – NANO-Hiten, SFG Hiten, Low carbon equivalent type hiten, coated steels.

UNIT – II PRODUCTION OF ENGINE PARTS 9

Production of Cylinder block, Cylinder head, liners, oil pan,pins, piston and piston rings and testing- thermal barrier coating of Engine head, Engine mounting pad,Auto locks, valves - Production of Connecting rod, Crankshaft, pushrod and rocker arm, valves, tappets, carburettors and spark plugs.

UNIT – III FUEL AND TRANSMISSION SYSTEM 9

Working principle and manufacturing of Fuel pumps – fuel injection pumps of diesel engines – multi point fuel injection system – Gearbox,IVT– clutch system – differential mechanism – steering system – braking system, control cable. Production of Friction lining materials for clutch,chain, propeller shaft, gear blank,gear box housing, steering column, Energy absorbing steering column-silencer-Emission control system – catalytic converter.

UNIT – IV CHASSIS, SUSPENSION SYSTEM AND TIRE MANUFACTURING 9

Working principle and manufacturing of Suspension system-Active suspension – Coil, leaf spring and shock absorbers – wheel housing –Manufacturing of Frame (aerodynamics and cross worthiness) - Production of brake shoes, break Drum, wheel disc, wheel rim, Disc brake –usage of non-metallic materials for chassis components-chassis grouping- types-chassis reverse- body - Production of tires and tubes.

UNIT – V RECENT ADVANCES 9

Application of sensors and actuators – Hydroforming of exhaust manifold and lamp housing – stretch forming of Auto body panels, Painting techniques – MMC liners— Selection of materials for Auto components. Manufacturing aspects in E-Vehicles-batteries and fuel cells, Hybrid Vehicles, Hydrogen, CNG-ADAS, diversless cars ,GPS in automobile –safety standards for vehicles

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Relate the production techniques to produce various automotive components.
2. Comprehend the working principles and components of automobile engines
3. Interpret and summarize different types of Fuel and Transmission System.
4. Explain basic concepts in the chassis and suspension system.
5. Acquire knowledge of recent developments in automobile industries.

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	3	2	2	-	-	-	-	-	-	1	-	1	1	-	2
CO2	3	2	2	-	-	-	-	-	-	1	-	1	1	-	2
CO3	3	2	1	-	-	-	1	-	-	1	-	1	1	-	2
CO4	3	2	1	-	-	-	-	-	-	1	-	1	1	-	2
CO5	3	2	1	-	-	-	-	-	-	1	-	1	1	-	2
CO/PO & PSO Average	3.0	2.0	1.4	-	-	-	1.0	-	-	1.0	-	1.0	1.0	-	2.0
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Jason Rowe, “Advanced Materials in Automotive Engineering", Woodhead Publishing Limited, Elsevier Science, 2012.
2. Mohammed A. Omar, “The Automotive Body Manufacturing System and Processes”, John Wiley Publications, 2013.

REFERENCES

1. Brian Cantor, P. Grant, C. Johnston, “Automotive Engineering Lightweight, Functional, and Novel Materials”, CRC Press, Taylor and Francis Group, 2008.
2. Garrett. T.K., Newton. K., Steeds. W., "The Motor Vehicle ", Butterworth-Heinemann, Oxford, 13th Edition, 2001.

3. Kirpal Singh, “Automobile Engineering, Vol. I and II”, Standard Publisher Distributors,14th Edition,2018.
4. SeropeKalpakjian and Steven R. Schmid, “Manufacturing Processes for Engineering Materials”, 5th Edition – Pearson Education publications, 2014.
5. V Ganesan, “Internal Combustion Engines”, Tata Mc Graw Hill Publications, 4th Edition, 2012.

PR23C02	COMPOSITE MATERIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. To introduce the concept of composites and various types of composites.
2. To familiarize about the types of fibres and matrix materials
3. To analyze different polymer matrix composites processing methods and their applications
4. To expose the students to the various metal matrix composite processing methods
5. To analyze the processing techniques of various ceramic matrix composites.

UNIT – I INTRODUCTION TO COMPOSITES 9

Definition and fundamentals of composites– Types - need for composites – enhancement of properties - commonly used reinforcement and matrix constituents, general characteristics, rule of the mixture – Theory of composites – Mechanical behaviour – Stress-strain relationships – Thermal properties. Applications of various types of composites. Fibres – Types, Fabrication, Structure, properties and applications – Glass, Boron, carbon, polyethylene, Kevlar, Aramid, Alumina, SiC, Si3, N4, B4C, ceramic and metallic fibres whiskers – Matrix materials structure – Polymers – metals and ceramics – Physical and chemical properties - Fiber surface treatments

UNIT – II POLYMER MATRIX COMPOSITES 9

Open mould process, bag moulding, Hand layup and spray up techniques, filament winding, compression and transfer moulding, BMC and SMC – pultrusion – centrifugal casting – injection moulding – structure, properties and application of PMC’s – Carbon Matrix Composites – Interfaces – Properties – recycling of PMC.

UNIT – III METAL MATRIX COMPOSITES 9

Processing of MMCs: Types, Important metallic materials, Processing – solid state, Liquid state, deposition, in-situ fabrication methods. Interfaces – diffusion bonding – powder metallurgy technique – Machining - properties - Applications.

UNIT – IV CERAMIC MATRIX COMPOSITES 9

Ceramic matrix materials – Need for CMC Ceramic matrix - Various types of Ceramic Matrix composites - Processing – Hot pressing, liquid infiltration techniques Lanxide process, In-situ, sol-gel, chemical reaction techniques - CVD, CVI process. Interface in CMCs. Thermal shock resistance - Applications, Properties, Surface treatment.

UNIT – V TESTING AND CHARECTERIZATION 9

Testing of composites: Mechanical testing of composites, tensile testing, compressive testing, Hardness testing, Impact testing, Intra-laminar shear testing, Inter-laminar shear testing, Fracture testing, wear testing, Fatigue testing.Thermal properties of composites – Thermal expansion – Specific heat – Phase transformations – Thermal conductivity – Thermal conductance of an Interface – Evaluating the thermal conduction – uses.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Acquire Knowledge about various composites and their properties
2. Classify fiber and matrix materials and select for its applications.
3. Discuss various polymer matrix composites, processing methods.
4. Analyze the various processing methods of metal matrix composites.
5. Interpret the various processing techniques of ceramic matrix composites.

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	-	1	1	-	1
CO2	2	-	-	1	-	-	1	-	-	1	-	1	2	-	2
CO3	2	-	-	1	-	-	1	-	-	1	-	1	2	-	2
CO4	2	-	-	1	-	-	-	-	-	1	-	1	2	-	2
CO5	2	-	-	1	-	-	-	-	-	1	-	1	2	-	2
CO/PO & PSO Average	2.0	1.0	-	1.0	-	-	1.0	-	-	1.0	-	1.0	1.8	-	1.8
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Hall, Wayne., Javanbakht, Zia, “Design and Manufacture of Fibre - Reinforced Composites”, Springer, 2021.
2. Krishan K Chawla, “Composite materials science and engineering”, Springer, 3rd Edition, 2021.

REFERENCES

1. Kenneth, Budinski.G and Michael K. Budinski, “Engineering Materials”, Prentice Hall of India pvt ltd., 4th Indian reprint, 2010
2. Mathews F.L. and Rawlings R.D., “Composite materials, Engineering and Science”, Chapman. Woodhead Publishing, 1999.
3. Strong. B, “Fundamentals of composite manufacturing”, SME, 2008
4. Sharma. S.C, “Composite materials”, Narosa publications, 2000
5. Weatherhead R.G., “FRP technology”, Applied Science Publishers Limited, 2012.

		L	T	P	C
PR23003	**ADVANCED FORMING**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES

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

1. Memorize and recall the various metal forming processes, their significance, and the challenges and limitations associated with conventional metal forming techniques.
2. Comprehend the formability and material behaviour of high-strength steels, aluminum alloys, and titanium alloys, and understand the tailored forming techniques used for advanced materials.
3. Apply experimental characterization and numerical modelling techniques to analyze and predict the behaviour of materials in advanced metal forming processes, such as hybrid forming.
4. Analyze the factors affecting superplastic behaviour, including microstructural characteristics and grain boundary sliding mechanisms, and evaluate the advantages, applications, and limitations of superplastic forming.
5. Evaluate the advantages, challenges, and significance of hybrid forming processes compared to conventional forming techniques, and critically assess the integration of additive manufacturing with conventional forming techniques in hybrid forming.

UNIT – I SUPERPLASTIC FORMING 9

Overview of metal forming processes and their significance - Challenges and limitations of conventional metal forming -Definition and characteristics of superplasticity - Advantages and applications of superplastic forming - Superplastic materials: alloys and composites - Metallurgical aspects of superplasticity - Microstructure and grain boundary sliding mechanisms - Factors affecting superplastic behaviour - Superplasticity Testing and Characterization - Flow curve analysis and strain rate sensitivity - Cavitation and rupture behaviour - Microstructural characterization techniques - Overview of superplastic forming techniques - Tooling Design and Considerations - Simulation and modelling advancements in Superplastic Forming- Applications

UNIT – II INCREMENTAL FORMING 9

Fundamentals of incremental forming processes, Types of incremental forming techniques, Single-point incremental forming (SPIF), Double-sided incremental forming (DSIF), Theory: Study the working principles, tooling, and process parameters for each method, Strain hardening and springback, Forming Analysis and Simulation for Incremental Forming - Applications and Case Studies in Incremental Forming- Applications

UNIT – III HYBRID FORMING 9

Definition and significance of hybrid forming processes - Comparison with conventional forming techniques - Advantages and challenges of hybrid forming - Overview of joining methods in hybrid forming - Additive Manufacturing in Hybrid Forming - AM processes and materials for hybrid forming - Integration of AM with conventional forming techniques - Design considerations for hybrid AM-forming - Joining Techniques in Hybrid Forming - Welding techniques - laser welding, friction stir welding– Hybrid hydroforming and additive manufacturing - Hybrid roll

forming and laser cutting - Hybrid spinning and 3D printing - Advanced Materials for Hybrid Forming - Material selection and properties optimization- Applications.

UNIT – IV MICROFORMING 9

Fundamentals of microforming processes, Material behaviour at microscale, Calculate the minimum feature size achievable in microforming based on material properties and process parameters (add shortcuts),Microforming-equipment and tooling, Microforming process parameters - Fundamentals of Nano Materials, Properties and synthesis of nano materials, Characterization techniques, Calculate the surface area-to-volume ratio of a nano material and explain its impact on its properties-ECAP- severe plastic deformation, high torsion- Applications.

UNIT – V ELECTROMAGNETIC FORMING 9

Overview of electromagnetic forming, Advantages and limitations of electromagnetic forming, Electromagnetic Forces, Review of Maxwell's equations, Lorentz force and its application in electromagnetic forming, Magnetic field distribution and its effect on forming processes, Force calculation and analysis, Electrical circuit analysis for energy storage and discharge, Capacitor bank design and charging strategies, Coil Design and Optimization-Printing- Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Demonstrate a comprehensive understanding of various advanced metal forming processes, their significance, and the challenges and limitations associated with conventional metal forming techniques.
2. Apply knowledge of formability and material behavior of high-strength steels, aluminum alloys, and titanium alloys to select appropriate forming techniques for advanced materials.
3. Utilize experimental characterization and numerical modeling techniques to analyze and predict the behavior of materials in advanced metal forming processes, such as hybrid forming.
4. Evaluate the advantages, applications, and limitations of superplastic forming, and assess the factors influencing superplastic behavior, including microstructural characteristics and grain boundary sliding mechanisms.
5. Critically evaluate the advantages, challenges, and significance of hybrid forming processes compared to conventional forming techniques, and assess the integration of additive manufacturing with conventional forming techniques in hybrid forming.

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	1	-	1
CO2	2	-	-	-	1	-	-	1	-	1	-	1	1	-	2
CO3	2	-	-	-	1	-	-	-	-	1	-	1	1	-	1
CO4	3	1	-	-	-	-	-	-	-	1	-	1	1	-	1
CO5	3	1	-	-	-	-	-	-	-	1	-	1	1	-	1
CO/PO & PSO Average	2.4	1.0	-	-	1.0	-	-	1.0	-	1.0	-	1.0	1	-	1.2
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. William F. Hosford, Robert M. Caddell, “Metal Forming: Mechanics and Metallurgy", Cambridge University Press, 4th Edition, 2014.
2. Jason Rowe, “Advanced Materials in Automotive Engineering", Woodhead Publishing Limited, Elsevier Science, 2012.
3. Taylan Altan and A. Erman Tekkaya, “Sheet Metal Forming: Processes and Applications”, ASM International, 2012.
4. Fu, Ming Wang; Chan, Wai Lun, “Micro-scaled Products Development via Micro-forming: Deformation Behaviours, Processes, Tooling and its Realization”, Springer London, 2014.
5. Yuriy Batygin, Marina Barbashova, Oleh Sabokar, “Electromagnetic Metal Forming for Advanced Processing Technologies”, Springer Cham, 2018.

REFERENCES

1. J.M. Wallace, G. Boothroyd, “Principles of Metal Manufacturing Processes", Elsevier 2012.
2. J.R. Johnson, “Fundamentals of Metal Forming”, Pearson, 2009.
3. Dorel Banabic, “Sheet Metal Forming Processes: Constitutive Modelling and Numerical Simulation”, Springer Berlin Heidelberg, 2010.
4. Alexander P. Zhilyaev, Farid Z. Utyashev, Georgy I. Raab, “Superplasticity and Grain Boundaries in Ultrafine-Grained Materials", Elsevier Science, 2nd Edition, 2020.
5. V. V. Kostin, “High Velocity Forming of Metals”, Springer, 2013.

PR23004	PRECISION MANUFACTURING AND NANO TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. To introduce students to the principles and techniques of precision manufacturing and nano manufacturing.
2. To develop an understanding of the importance of precision in manufacturing processes and the challenges associated with nano manufacturing.
3. To provide 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

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

1. Understand the principles and techniques of precision manufacturing and nano manufacturing, and apply them to solve manufacturing challenges.
2. Demonstrate proficiency in using precision machining techniques and tools, and apply them to produce high-quality components with tight tolerances and surface finishes.
3. Apply metrology techniques and quality control methods to assess and ensure the dimensional accuracy and surface quality of precision components.
4. Demonstrate knowledge of nanofabrication techniques and materials, and apply them to fabricate nanostructures and nanoscale devices.
5. Analyze and evaluate emerging trends and applications in precision and nano manufacturing, and identify potential areas for future research and development.

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	3	3	2	2	2	2	2	-	-	-	-	1	3	3	3
CO2	2	2	2	2	2	2	2	-	-	-	-	1	3	3	3
CO3	2	2	3	3	3	3	2	-	-	-	-	1	3	3	3
CO4	2	2	3	3	3	3	2	-	-	-	-	1	3	3	3
CO5	2	2	3	3	3	3	2	-	-	-	-	1	3	3	3
CO/PO & PSO Average	2.2	2.2	2.6	2.6	2.6	2.6	2					1	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial															

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

		L	T	P	C
PR23C03	**DESIGN OF JIGS, FIXTURES AND GUAGES**	**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.

PR23005	MATERIAL HANDLING AND STORAGE SYSTEMS	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 concepts and principles of material handling in industrial settings.
2. Identify and classify different types of material handling equipment and their applications.
3. Examine the factors that influence the selection of material handling equipment and systems.
4. Explore the components and attachments used in material handling, such as hoisting mechanisms and load handling appliances.
5. Analyze various material transport machinery and their working principles, including conveyors, elevators, and surface transport equipment.

UNIT – I	INTRODUCTION TO MATERIAL HANDLING	9

Types - Types of movements - methods of stacking - loading - unloading - principles - hoisting mechanism- lifting mechanism- travelling - slewing mechanism- cross - traverse mechanism - Factors affecting choice of material handling equipment - method of stacking at initial intermediate - final points- specific load conditions - economics of material handling systems.

UNIT – II	COMPONENTS OF MATERIAL HANDLING	9

Flexible hoisting appliances – fastening methods – Load handling attachments – Classification of hooks forged – eye hook – Appliances for suspending hooks – crane grab for unit and piece loads – electric lifting magnet – vacuum lifter – Grabbing attachment for loose materials – crane attachment for handling liquids – Arresting gear – brakes – construction – working – electromagnetic shoe brakes – construction – use – thruster operated shoe brakes – control brakes.

UNIT – III	MATERIAL TRANSPORT MACHINERY	9

Traction type conveyors – Working – belt conveyors – chain conveyors – bucket elevators-escalators Working of traction less type conveyors – gravity type conveyors, vibrating and oscillating conveyors, screw conveyors – pneumatic – hydraulic conveyors – hoppers – gates and feeders – Surface transport equipment – functions – working of trackless equipment – hand operated trucks – powered trucks – tractors, AGV (Automatic Guided Vehicle) – industrial trailers – functions – working – cross handling equipment – winches – capstans – turntables – transfer tables – monorail conveyors.

UNIT – IV	CRANES, HOISTS AND MONORAILS	9

Jib cranes, wall mounted and travelling type, stability criteria, wheel loads, wheel trucks and bogeys, number of mechanisms in jib crane, jib construction, Harbour cranes, luffing and level luffing cranes, shipyard gantry cranes, portal frames and slewing rings, types of hoists-Safety standards.

UNIT – V	STORAGE SYSTEMS	9

Introduction, Types of storage system, Automated Storage and Retrieval systems, carousel storage systems, Large Products Storage System, Pallet Storage Systems Selection, Layout of High Rack Storage,cold and controlled storage-components identification system-bar,QR,RFID code.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Demonstrate an understanding of the principles and concepts of material handling and its significance in industrial operations.
2. Identify and evaluate appropriate material handling equipment based on specific requirements and load conditions.
3. Analyze and compare the characteristics and functionalities of different material transport machinery and conveyance systems.
4. Design and analyze the components and attachments used in material handling, ensuring optimal performance and safety.
5. Apply knowledge of cranes, hoists, and monorails to design and select suitable lifting solutions for different industrial applications.

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	-	1	1	-	1
CO2	2	-	-	-	-	1	-	-	-	1	-	1	1	-	2
CO3	2	-	-	-	-	1	-	-	-	1	-	1	1	-	2
CO4	2	-	-	-	-	1	-	-	-	1	-	1	1	-	2
CO5	2	-	-	-	-	1	-	-	-	1	-	1	1	-	2
CO/PO & PSO Average	2.0	-	-	-	-	1.0	-	-	-	1.0	-	1.0	1.0	-	1.8
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Allegri S.R., “Materials Handling Principles and Practice”, ED-TECH, 2018.
2. Siddharta Ray, “Introduction to Materials Handling”, New Age International Publishers,2007

REFERENCES

1. Deshmukh, D. J., “Elements of Mining Technology Vol. 1”, India, Denett& Company, 8th Edition, 2010.
2. Peter Darling, “SME Mining Engineering Handbook”, Society for Mining, Metallurgy, and Exploration, 2011.
3. Syd S. Peng, “Advances in Coal Mine Ground Control”, Elsevier Science, 2017.
4. Walker, S.C., “Mine Winding and Transport”, Elsevier Science, 2012.
5. Fruchtbaum, Jacob, “Bulk Materials Handling Handbook”, Springer, 2013.

		L	T	P	C
PR23006	**DIGITAL MANUFACTURING**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

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

1. To use engineering application software CAD/CAM/CAE skill fully to accomplish a digital manufacturing/validation of mechanical parts.
2. To use engineering application software skills fully to design an optimum factory layout.
3. To understand the components of virtual testing.
4. To establish a comprehensive understanding on modern manufacturing systems.
5. To understand Industry 4.0 concepts.

UNIT – I BASICS OF DESIGN AND MANUFACTURING 9

Digital Technologies in manufacturing - Basic terminologies: CAD, CAE, CAPP, CAM - Digital twin - Digital thread - NX for Design - NX CAM: NC programming - post processing - machine simulation - NX CAE: Nastran - Basics - Finite element analysis - meshing - solving - integration - case examples.

UNIT – II PROCESS SIMULATION AND PLANT DESIGN 9

Digital twins of production facilities - virtual commissioning of automation systems - human centered design and planning - assembly simulation for virtual process verification - robotics programming - optimization of production logistics and material flow - configuration of digital factory layout - case studies involving Tecnomatix.

UNIT – III VIRTUAL TESTING AND OPTIMIZATION 9

Innovation through design exploration - Simulation of actuators and controls - Acoustics - Durability - Model based system - Rotating machinery - Structural dynamics - Transfer path analysis - SCADAS - Sound and vibration analysis - case studies involving simcenter.

UNIT – IV INDUSTRIAL INTERNET OF THINGS 9

Basics of Internet of Things - outline of IoT architecture - networking and communication - technology roadmap - challenges - future and potential of IoT - application in manufacturing industry - case studies.

UNIT – V INDUSTRY 4.0 9

Industry 4.0 - Introduction to Industrial revolution - Components of Industry 4.0: Digital manufacturing, augmented reality, Industrial Internet of Things, Big data analytics, cyber physical systems, cloud computing, artificial intelligence, cognitive computing, machine learning, cyber security.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Apply digital technologies in manufacturing processes, including CAD, CAE, CAPP, CAM, and digital twin concepts
2. Design and simulate the process for improving productivity in digital manufacturing.
3. Make smarter decisions using virtual testing and optimization methods.
4. Apply the principles of IOT in the manufacturing industry.
5. Implement Industry 4.0 concepts on any existing systems.

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	-	3	1	2	-	-	-	-	1	-	1	1	-	1
CO2	2	-	-	1	2	-	-	-	-	1	-	1	1	-	1
CO3	2	-	-	1	2	-	-	-	-	1	-	1	1	1	1
CO4	2	-	2	1	2	1	-	-	-	1	-	1	1	-	2
CO5	2	-	2	1	2	1	-	-	-	1	-	1	1	-	2
CO/PO & PSO Average	2.0	-	2.3	1.0	2.0	1.0	-	-	-	1.0	-	1.0	1.0	1.0	1.4
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Divya Zindani, J. Paulo Davim, Kaushik Kumar, "Digital Manufacturing and Assembly Systems in Industry 4.0", CRC Press, 2021.
2. S. Jeschke, C. Brecher, H. Song, and D. B. Rawat, “Industrial Internet of Things: Cyber manufacturing Systems”, Springer, 1st Edition, 2017.

REFERENCES:

1. Zhuming Bi, Xiaoqin Wang, "Basics of Design and Manufacturing", Wiley, 2020.
2. We-Min Chow, "Assembly Line Design: Methodology and Applications", CRC Press, 1st Edition, 2020.
3. Giacomo Veneri, Antonio Capasso, "Hands-on Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0", Packt Publishing, 2018.
4. Noor Zaman, R. Anandan, Souvik Pal, Suseendran Gopalakrishnan, "Industrial internet of things (IIoT): intelligent analytics for predictive maintenance", Wiley, Scrivener Publishing, 2022.
5. Sudip Misra, Chandana Roy, Anandarup Mukherjee, "Introduction to Industrial Internet of Things and Industry 4.0", CRC Press, 1st Edition, 2021.

IE23C04	PRODUCT LIFECYCLE MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. To provide the students with knowledge about how a Product Lifecycle Management (PLM) system is used to structure and manage the information which guides the product during its lifecycle.
2. Identifies different stakeholders which both generates and consumes information related to the product and its manufacturing system over the lifecycle.
3. The course also presents an overview of integration of PLM with other applications.

UNIT I INTRODUCTION TO PLM 9

Background, Overview, Need, Benefits, Concept of Product Life Cycle. Components / Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement. Product Data and Product Workflow, Company's PLM vision, The PLM Strategy, Principles for PLM strategy, Preparing for the PLM strategy, Developing a PLM strategy, Strategy identification and selection, Change Management for PLM

UNIT II PRODUCT DEVELOPMENT 9

Product Development Approaches: Bottom-up design, Top-down design, Front-loading design workflow, Design in context, Modular design. Concurrent engineering, partnership with supplier, collaborative and Internet based design, work structuring and team deployment, Product and process systemization, problem, identification and solving methodologies, improving product development solutions

UNIT III PRODUCT MODELLING 9

Product Modelling - Definition of concepts - Fundamental issues – Role of Process chains and product models -Types of product models – model standardization efforts-types of process chains - Industrial demands. Foundation technologies and standards (e.g. visualization, collaboration and enterprise application integration),

UNIT IV PRODUCT DATA MANAGEMENT 9

Product Data Management (PDM) –Benefits and Terminology, PDM functions, definition and architectures of PDM systems, product data interchange, portal integration, PDM acquisition and implementation. Information authoring tools (e.g., MCAD, ECAD, and technical publishing), Corefunctions (e.g., data vaults, document and content management, workflow and program management), Functional applications (e.g., configuration Management).

UNIT V INTEGRATION OF PLM WITH OTHER APPLICATIONS, PLM SOFTWARE 9

Different ways to integrate PLM systems, Transfer file, Database integration, System roles, ERP, Optimization of ERP for PLM and CAD. Different ways to integrate PLM systems, Transfer file, Database integration, System roles, ERP, Optimization of ERP for PLM and CAD. PLM Softwares-Basic features and modules of ENOVIA and Windchill.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Explain basic concepts of product life cycle management.
2. Demonstrate product development approaches.
3. Explain elements of product modelling.
4. Discuss in detail the concept of product data management.
5. Discuss about integration of PLM with other applications.

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	2	1	-	-	-	-	-	-	-	-	-	-	1	1
CO2	3	3	1	1	1	-	-	-	-	-	-	-	-	1	1
CO3	3	3	1	1	1	-	-	-	-	-	-	-	-	1	1
CO4	3	3	1	1	1	-	-	-	-	-	-	-	-	1	1
CO5	3	3	1	1	3	-	-	-	-	-	-	-	-	1	1
CO/PO & PSO Average	**2.6**	**3**	**1**	**1**	**1.5**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Michael Grieves, "Product Lifecycle Management", Tata McGraw Hill, 2006
2. Saaksvuori Antti / ImmonenAnselmie, product Life Cycle Management Springer,Dreamtech

REFERENCES:

1. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realisation, Springer-Verlag, 2004.
2. Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006.

		L	T	P	C
PR23007	**VALUE ADDED ENGINEERING**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

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

1. Understand the concept, objectives, and applications of reverse engineering in the field of value-added engineering.
2. Explore the legal and ethical considerations associated with reverse engineering.
3. Acquire knowledge and skills in data acquisition techniques, including scanning, imaging, and measurements for reverse engineering.
4. Develop proficiency in metrology and measurement techniques used in reverse engineering, such as coordinate measuring machines (CMM), laser scanning, and photogrammetry.
5. Gain expertise in reverse engineering methodologies for mechanical components, complex surfaces, electrical and electronic systems, and manufacturing and repair processes.

UNIT – I VALUE ENGINEERING BASICS 9

Origin of Value Engineering, Meaning of value, Definition of Value Engineering and Value analysis, Difference between Value analysis and Value Engineering, Types of Value, function – Basic and Secondary functions, concept of cost and worth, creativity in Value Engineering.

UNIT – II VALUE ENGINEERING JOB PLAN AND PROCESS 9

Seven phases of job plan, FAST Diagram as Value Engineering Tool, Behavioural and organizational aspects of Value Engineering, Ten principles of Value analysis, Benefits of Value Engineering.

UNIT – III FUNDAMENTALS OF REVERSE ENGINEERING 9

The generic process-Three phases of reverse engineering-Phase I: Scanning, Phase II: Point processing, Phase III: Geometric model development.

UNIT – IV TECHNIQUES OF REVERSE ENGINEERING 9

Computer aided reverse engineering, Computer vision and reverse engineering, Structured light range imaging, Scanner pipeline.

UNIT – V HARDWARE AND SOFTWARE FOR REVERSE ENGINEERING 9

Introduction, Reverse engineering hardware, Reverse engineering software, Selection of a reverse engineering system, Case studies with implementation.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Demonstrate a clear understanding of reverse engineering principles, processes, and applications.
2. Apply appropriate data acquisition techniques and effectively process and manipulate acquired data for reverse engineering purposes.
3. Utilize CAD modelling techniques to create parametric models from scanned data and validate the accuracy of reconstructed models.
4. Apply reverse engineering methodologies to extract design intent, analyze functional aspects, and optimize the design of mechanical components and systems.
5. Evaluate and select advanced tools and technologies for reverse engineering, such as computed tomography, virtual reality, and augmented reality, and understand their applications in various industries.

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	1	-	1
CO2	2	-	-	-	-	-	-	-	-	1	-	1	1	-	1
CO3	2	-	-	-	-	-	-	-	-	1	-	1	1	-	1
CO4	2	-	1	1	1	-	-	-	-	1	-	1	1	-	2
CO5	2	-	1	1	1	-	-	-	-	1	-	1	1	-	2
CO/PO & PSO Average	2.0	-	1.0	1.0	1.0	-	-	-	-	1.0	-	1.0	1.0	-	1.4
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Wang, Wego, “Reverse Engineering: Technology of Reinvention”, CRC Press, 2011.
2. Meadows, James D., “Geometric Dimensioning and Tolerancing: Applications, Analysis, Gauging and Measurement”, American Society of Mechanical Engineers, 2020.

REFERENCES

1. Kiran J. Fernandes, Vinesh Raja, “Reverse Engineering: An Industrial Perspective”, Springer, 2012.
2. Schodek, Danie, “Digital Design and Manufacturing: CAD/CAM Applications in Architecture and Design”, Wiley, 2005.
3. Enrico Baccarini and Kavya Vaddadi, “Reverse Engineering Vedic Vimanas”, Enigma Edizioni, 2017.
4. James, Ray., Englehardt, Elaine., Pritchard, Michael S.., Harris, Jr., Charles E.., Rabins, Michael J., “Engineering Ethics: Concepts and Cases”, Cengage Learning, 6th Edition 2019.
5. Younker, Del, “Value engineering: Analysis and Methodology”, Taylor & Francis, 2003.

PR23008	DESIGN FOR MANUFACTURING AND ASSEMBLY	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 basics of engineering design and tolerance.
2. Familiarize with the steps involved in the design process for cast and weld parts.
3. Gain knowledge of design process for formed and forged parts.
4. Learn the design consideration for various machined parts and clamps.
5. Understand design procedures for assembling and disassembling.

UNIT – I BASICS OF DESIGN AND TOLERANCE **9**

Engineering design – Kinds of design – Design process steps – Factors influencing design – Concurrent Engineering – Material selection process – Evaluation methods for material selection – design standards. Process capability analysis – Cumulative effect of tolerances – Centrality analysis –Compound assembly – Selective and Interchangeable assembly – Grouped Datum systems.

UNIT – II DESIGN FOR CASTINGS AND WELDINGS **9**

Design for castings - 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. Design for weldments - Design considerations for Cost reduction, Minimizing distortion and weld strength - Arc welding, Resistance welding, Spot welding and Seam welding - case studies.

UNIT – III DESIGN FOR FORMING AND FORGING **9**

Design considerations for forged parts, powder metallurgy parts, injection moulded parts, Extruded parts, sheet metal formed parts – requirements, rules and case studies.

UNIT – IV DESIGN FOR MACHINING **9**

Design for machining – turned parts, drilled parts, milled parts, planed parts, shaped parts, slotted parts and ground parts. Design for clampability- case studies.

UNIT – V DESIGN FOR ASSEMBLY **9**

Design guidelines for manual assembly, large assemblies, analysis of an assembly – Design for disassembly- effect of part symmetry and weight on handling time, effect of chamfer design on insertion operations. Design considerations for: Rivets – Screw fasteners – Gasket & Seals – Press fits – Snap fits – Automatic assembly. Advances in DFMA- Design for robustness – Axiomatic design – Design for environment – DFA index – Design for economy – Computer aided DFA using software-case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Apply the principles of engineering design in various design scenarios.
2. Follow a systematic approach to the design process, considering the factors that influence design decisions of cast and weld parts.
3. Design formed and forged parts by considering the design criteria.
4. Adopt a methodical approach to the design machined parts and clamps.
5. Perform the assembling and disassembling by adopting the design considerations.

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	-	1	1	-	1
CO2	2	1	1	1	-	-	-	-	-	1	-	1	1	-	1
CO3	2	-	1	-	-	-	1	-	-	1	-	1	1	-	2
CO4	2	-	1	-	-	1	1	-	-	1	-	1	1	-	2
CO5	2	1	1	1	1	1	1	-	-	1	-	1	1	-	2
CO/PO & PSO Average	2.0	1.0	1.0	1.0	1.0	1.0	1.0	-	-	1.0	-	1.0	1	-	1.6
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Warman, E.A.Tilley S, Molloy O., “Design for Manufacturing and Assembly: Concepts, Architectures and Implementation”, Springer, 2012.
2. James G. Bralla, “Handbook of Product Design for Manufacturing”, McGraw Hill, 2nd Edition, 2004.

REFERENCES

1. CorradoPoli, “Design for Manufacturing: A Structured Approach”, Elsevier, 2001.
2. David M. Anderson, “Design for Manufacturability and Concurrent Engineering”, CIM Press, 2nd Edition, 2020.
3. Erik Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, “Manufacturing and Design: Understanding the Principles of How Things Are Made”, Elsevier, 1st Edition, 2014.
4. Harry Peck, “Designing for Manufacture”, Sir Isaac Pitman and Sons Ltd., 1973.
5. Matousek, “Engineering Design”, Blackie and Sons, 1956.

		L	T	P	C
PR23009	**INDUSTRIAL SAFETY AND MANAGEMENT**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

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

1. To understand the need for developing Environment, Health, and Safety systems in workplaces.
2. To familiarize students with occupational health hazards and the methods of controlling and reducing risks.
3. To explore the principles and practices of work safety and safety systems in different work environments.
4. To develop skills in hazard and risk management techniques and accident investigation.
5. To analyze and learn from real-life accident case studies

UNIT – I INTRODUCTION 9

Need for developing Environment, Health and Safety systems in workplaces – Accident Case Studies –National level Acts and State rules – Regulations and Codes of Practice – Role of trade union, employers, Government agencies. International initiatives – Ergonomics and workplace. Role of Engineers in accident prevention. Road safety . Awareness campaigns

UNIT – II OCCUPATIONAL HEALTH AND HYGIENE 9

Definition of the term occupational health and hygiene – Categories of health hazards - Exposure pathways and human responses to hazardous and toxic substances – Advantages and limitations of environmental monitoring and occupational exposure limits – Hierarchy of control measures for occupational health risks – Role of personal protective equipment and the selection criteria – Effects on humans - control methods and reduction strategies for noise, radiation and excessive stress.

UNIT – III WORK SAFETY AND SAFETY SYSTEMS 9

Features of Safe design of work premises – good housekeeping/5S - lighting and colour, Ventilation and Heat Control – Electrical Safety – Fire Safety – Safe Systems of work for manual handling operations – Machine guarding – Process safety and System Safety. Construction safety.

UNIT – IV HAZARDS AND RISK MANAGEMENT 9

Safety Management, Safety Audit, Plant safety inspection – Accident investigation, root cause identification and Corrective action-Hierarchy of risk controls – Safety Pyramid – Incident Analysis and reporting, – Hazard and Risk Management Techniques – major accident hazard control – Onsite and Offsite emergency Plans

UNIT – V ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT 9

Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and methods of its effective implementation and review – Elements of Management Principles – Education and Training – Employee Participation. Introduction to ISO 14001/ 1SO 45001 and Sustainability and ESG

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Explain the importance of implementing Environment, Health, and Safety systems in workplaces.
2. Analyze and draw lessons from accident case studies to prevent similar incidents in the future.
3. Identify different categories of health hazards and apply control measures to minimize risks.
4. Assess work premises for safety and design systems to ensure the well-being of workers.
5. Develop and implement effective environmental health and safety management policies in organizations.

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	1	-	1	-	1	1	-	1
CO2	2	-	-	-	-	2	2	1	-	1	-	1	1	-	1
CO3	2	-	-	-	-	2	1	1	-	1	-	1	1	-	1
CO4	2	-	-	-	-	2	2	1	-	1	-	1	1	-	2
CO5	2	-	-	-	-	2	1	1	-	1	-	1	1	2	1
CO/PO & PSO Average	2.0	-	-	-	-	2.0	1.4	1.0	-	1.0	-	1.0	1.0	2.0	1.2
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Constantin Stephan, “Industrial Health, Safety and Environmental Management”,E Publications, 2016.
2. Ron C. McKinnon, "The Design, Implementation, and Audit of Occupational Health and Safety Management Systems", CRC Press, 2023

REFERENCES

1. Robert H. Friis, "Occupational Health and Safety for the 21st Century", Jones and Bartlett, 2015
2. Kohn, J. P., Friend, M. A, “Fundamentals of Occupational Safety and Health”, BernanPress, 2018.
3. Brauer, R. L, “Safety and Health for Engineers”, Wiley, 2022.
4. Cahill, Lawrence B., “Environmental Health and Safety Audits: A Compendium of Thoughts and Trends”, Bernan Press, 2017.
5. J Maiti, Pradip Kumar Ray, “Industrial Safety Management”, Springer, 2017.
6. https://corporatefinanceinstitute.com/resources/esg/esg-environmental-social-governance
7. https://www.epa.gov/sustainability

		L	T	P	C
PR23010	**EXPERIMENTAL DESIGN TECHNIQUES**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

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

1. To familiarize the concepts of Single Factor Experiment
2. To gain knowledge of Factorial experiments
3. To enable students with the concepts of blocking, confounding and fractional factorial.
4. To provide an understanding of the Taguchi methods
5. To provide students with an understanding of response surface methods and multi-response optimization techniques

UNIT – I SINGLE FACTOR EXPERIMENTS 9

Introduction to Hypothesis testing – Experimentation – Need, Conventional test strategies, terminology, basic principles of design – steps in experimentation – Completely Randomized Design- effect of coding the observations- model adequacy checking - estimation of model parameters, residuals analysis- treatment comparison methods – Duncan's multiple range test, Newman-Keuel's test, Fisher's LSD test, Tukey's test- Testing using contrasts-Randomized Block Design – Latin Square Design- Graeco Latin Square Design – Applications

UNIT – II FACTORIAL DESIGNS 9

Main and Interaction effects - Two and three factor full factorial designs- Fixed effects and random effects model – Rule for sum of squares and Expected Mean Squares - 2^K Design with two and three factors– Yate's Algorithm – Fitting regression model– Randomized Block Factorial Design- Introduction to MANOVA & ANCOVA.

UNIT – III BLOCKING, CONFOUNDING AND FRACTIONAL FACTORIAL 9

Blocking and Confounding in 2^K Designs- blocking in replicated design – 2^K Factorial Design in two blocks– Complete and partial confounding – Confounding 2^K Design in four blocks – Two level Fractional Factorial Designs - Construction of one-half and one-quarter fraction of 2^K Design.

UNIT – IV TAGUCHI DESIGN OF EXPERIMENTS 9

Taguchi's Quality Loss Function- Philosophy- Design of Experiments using Orthogonal Arrays, Data analysis from Orthogonal experiments - Response Graph Method- ANOVA- Attribute data analysis- Robust design- noise factors, Signal to Noise ratios, Inner/outer OA design- case studies.

UNIT – V RESPONSE SURFACE METHODS AND MULTI RESPONSE OPTIMIZATION 9

Introduction to Response Surface Methods- Designs for fitting First –order Model -Central Composite Design – Box- Behnken Designs. Introduction to MULTI RESPONSE

OPTIMIZATION, Engineering judgment, weightage assignment, DEAR approach, Grey relational analysis, Factor Analysis.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Plan and structure experiments to evaluate the impact of different factors on a system
2. Interpret data by applying single factor experiment
3. Identify and address blocking, confounding variables to ensure the validity of their experimental results.
4. Analyse the data using the Taguchi's approach.
5. Apply the Response Surface Method and multi response optimization techniques to identify the optimal response.

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	-	-	-	2	-	3	1	3	2	1
CO2	2	3	3	2	2	-	-	-	2	-	3	1	3	2	1
CO3	2	3	3	3	2	-	-	-	2	-	3	1	3	2	1
CO4	2	3	3	2	2	-	-	-	2	-	3	1	3	2	1
CO5	2	3	3	2	2	-	-	-	2	-	3	1	3	2	1
CO/PO & PSO Average	2	3	3	2	2	-	-	-	2	-	3	1	3	2	1.0
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Krishnaiah K, and Shahabudeen P, "Applied Design of Experiments and Taguchi Methods", PHI, 1st Edition, 2011.

REFERENCES

1. Douglas C. Montgomery, "Design and Analysis of Experiments", John Wiley & sons, 2012.
2. Krishnaiah K, "Applied Statistical Quality Control and Improvement",1st Edition, 2014
3. Box, G. E., Hunter,W.G., Hunter, J.S., Hunter,W.G., "Statistics for Experimenters: Design, Innovation, and Discovery", 2nd Edition, Wiley, 2005.
4. Phillip J. Ross, "Taguchi Techniques for Quality Engineering", Tata McGraw-Hill, India, 2005

		L	T	P	C
IE23C07	**TOTAL QUALITY MANAGEMENT**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

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

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

1. Explain the evolution of Quality Management and its impact on organizations
2. Apply TQM concepts and principles in an enterprise.
3. Understand and apply TQM tools and techniques in a given situation.
4. Understand how to operationalize the concept of quality using QFD and TPM.
5. Understand the challenges and benefits of applying QMS and EMS in an organization.

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															
CO2															
CO3															
CO4															
CO5															
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. 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.
2. Kiran. D. R, Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 2016.

REFERENCES

1. Joel. E. Ross, Total Quality Management – Text and Cases, Routledge, 2017
2. Oakland, J.S. “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, Third Edition, 2003.
3. Suganthi,L and Anand Samuel, “Total Quality Management”, Prentice Hall (India) Pvt. Ltd., 2006 .

PR23011	SUPPLY CHAIN INVENTORY MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. To describe the role and drivers of supply chain management in achieving competitiveness.
2. To explain about supply chain network design and inventory.
3. To illustrate about the issues related to logistics in supply chain.
4. To appraise about sourcing and coordination in supply chain
5. To apply information technology concepts in supply chain

UNIT – I INTRODUCTION 9

Role of Logistics and Supply chain Management: Scope and Importance - Evolution of Supply Chain – Examples of supply Chains - Decision Phases in Supply Chain - Competitive and Supply chain Strategies – Drivers of Supply Chain Performance and Obstacles – Supply Chain Performance Measures – Enhancing Supply Chain Performance Measures-Challenges in maintaining Supply Chain in India.

UNIT – II NETWORK DESIGN AND IVENTORY 9

Role of Distribution in Supply Chain – Factors influencing Distribution network design – Design options for Distribution Network- Distribution Network in Practice - Role of network Design in Supply Chain – Framework for network Decisions. Managing inventories in Supply Chain: Single stage inventory control, inventory control policies, impact of service level on safety stock.

UNIT – III LOGISTICS IN SUPPLY CHAIN 9

Role of transportation in supply chain – Factors affecting transportations decision – Design option for transportation network – Tailored transportation – Vehicle Routing and scheduling in transportation - 3PL- 4PL- Global Logistics - Reverse Logistics; Reasons, Activities and issues- Closed Loop Supply Chain

UNIT – IV SOURCING AND COORDINATION 9

Role of transportation in supply chain – Supplier selection – Design collaboration – Sourcing planning and analysis – Types of supply chain contracts and its types – Supply chain co-ordination – Bull Whip Effect – Effect of lack of co-ordination in supply chain and obstacles – Remedial measures to overcome Bull Whip Effect - Building strategic partnerships and trust within a supply chain.

UNIT – V IT AND EMERGING CONCEPTS IN SUPPLY CHAIN 9

The role IT in supply chain-The supply chain IT framework - Customer Relationship Management – Internal Supply Chain Management – Supplier Relationship Management – Future of IT in supply chain – E-Business in Supply Chain- Introduction to Warehouse Management, Risks in Supply Chain, Lean Supply Chains, Sustainable supply Chains – Block Chain and its applications in Supply Chain.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Understand the scope of Supply Chain Management (SCM) and the drivers of supply chain performance.
2. Design suitable Supply Chain network and inventory for a given situation
3. Solve the issues related to Logistics in SCM
4. Understand sourcing, coordination and current issues in SCM
5. Appraise about the applications of IT in SCM and apply SCM concepts in selected enterprise

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	2	1	-	-	-	-	-	-	-	-	-	1	-	1
CO2	3	3	1	1	1	-	-	-	-	-	-	-	1	-	1
CO3	3	3	1	1	1	-	-	-	-	-	-	-	1	-	1
CO4	3	3	1	1	1	-	-	-	-	-	-	-	1	-	1
CO5	3	3	1	1	3	-	-	-	-	-	-	-	1	-	1
CO/PO & PSO Average	2.6	1.0	1.0	10	1.5	-	-	-	-	-	-	-	1.0	-	1.0
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Sunil Chopra, Peter Meindl and D.V. Kalra, “Supply Chain Management: Strategy, Planning and Operation", Pearson Education,7th Edition 2020.
2. Mason Harris, “Global Logistics and Supply Chain Management”, Willford Press, 2020

REFERENCES

1. Ravi Ravindran A, Donald P. Warsing, Jr, “Supply Chain Engineering: Models and Applications”, CRC Press, 2023.
2. Srinivasan G.S, “Quantitative models in Operations and Supply Chain Management”, PHI, 2010.
3. Thomas E. Vollmann, William Lee Berry, David Clay Whybark and F. Robert Jacobs, “Manufacturing Planning and Control Systems for Supply Chain Management”, McGraw Hill., 2014.
4. Joseph J, Massie, “Essentials of Management”, Prentice Hall of India Pvt. Ltd., 1985
5. Donald J. Bowersox, David J. Closs, M. Bixby Cooper, John C. Bowersox, “Supply Chain Logistics Management”, McGraw Hill, 2023

		L	T	P	C
IE23C03	**LEAN MANUFACTURING AND SIX SIGMA**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

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

1. To know the basics of Lean and Six Sigma.
2. To analyse the process of integrating Lean and Six sigma
3. To identify and select the resources required for LSS Projects and selection of projects including Team building.
4. To infer the DMAIC process and study the various tools for undertaking LSS projects.
5. 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

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

1. Understand what is Lean and Six Sigma and their importance in globalized competitive world
2. Understand the importance of integrating Leand and Six Sigma and also the process of their interation
3. Plan the resources required to undertake the LSS projects and also acquire how to select suitable projects and the teams
4. Apply DMAIC methodology to execute LSS projects and they will be acquainted with various LSS tools
5. Understand the process of institutionalizing the LSS effort and also understand the design for LSS

TEXT BOOKS

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

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	3	3	3	3	3	1	1	-	-	-	-	2	1	-	1
CO2	3	3	3	3	3	2	2	-	-	-	-	3	1	-	1
CO3	3	3	3	3	3	2	2	-	-	-	-	2	1	-	1
CO4	3	3	3	3	3	3	3	-	-	-	-	2	1	-	1
CO5	3	3	3	3	3	2	2	-	-	-	-	3	1	-	1
CO/PO & PSO Average	3.0	3.0	3.0	3.0	3.0	2.0	2.0	-	-	-	-	2.4	1.0	-	1.0
1 – Slight, 2 – Moderate, 3 – Substantial															

PR23012	ENGINEERING ECONOMICS AND COST ANALYSIS	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 key economic theories and concepts for managerial decision-making, including opportunity cost, marginal analysis, and demand elasticity.
2. Apply economic tools to analyze business scenarios, make strategic decisions, and allocate resources efficiently.
3. Analyze pricing and output decisions based on market conditions.
4. Learn demand forecasting methods, including determinants of demand, elasticity, and forecasting techniques.
5. Examine production functions, cost structures, economies of scale, and cost-output relationships to enhance production processes.

UNIT – I INTRODUCTION TO MANAGERIAL ECONOMICS AND DEMAND ANALYSIS 9

Definition of Managerial Economics - Nature and scope of Managerial Economics - Managerial

Economics and other disciplines. Objectives of the firm - Factors influencing Managerial decisions- Basic concepts of Managerial Economics. Demand Analysis – Defining demand, Types ofdemand and Determinants of demand, Elasticity of demand and demand forecasting.

UNIT – II PRODUCTION AND COST ANALYSIS 9

Production Analysis – Production function, Returns to a factor, Returns to scale, ISO quants andLeast cost combination of inputs. Cost Analysis – Cost concepts, Determinants of cost, Short-runcost-output Relationship, Long-run cost output relationship, Economies and Diseconomies of scaleand Estimating cost – Output Relationship.

UNIT – III PRICING 9

Determinants of price – Pricing under different objectives – Pricing under different market structures – Price discrimination – Pricing of Joint products – Pricing methods in practice.

UNIT – IV ESTIMATION OF MATERIAL AND LABOUR COSTS 9

Introduction to Estimation and Costing – Elements of costs – Allocation of overheads – Estimationof Material cost – Estimation of Labour cost, Indirect Expenses and Depreciation.

UNIT – V ESTIMATION OF OPERATIONAL COST 9

Estimation in Machine shop – Estimation in Forging shop –Estimation in welding shop.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Understand economic theories and concepts effectively
2. Analyze business scenarios and apply economic tools efficiently.
3. Analyze market conditions to make informed pricing and output decisions,
4. Predict market trends, plan production schedules, and manage inventory levels effectively.
5. Apply production functions, cost structures, economies of scale, and cost-output relationships to optimize production processes.

TEXT BOOKS

1. R.Paneerselvam, “Engineering Economics”, PHI, 2013.
2. R. Kesavan, C.Elanchezhian and T.Sundar Selwyn, "Engineering Economics and Financial Accounting", Laxmi Publications 2011./

REFERENCES

1. James. C., Vanhorn, "Fundamentals of Financial Management" PHI, 2012
2. Charles T.Homgren, "Cost Accounting", PHI, 2012

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															
CO2															
CO3															
CO4															
CO5															
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

PR23C08	PROCESS PLANNING AND COST ESTIMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. To select the process, equipment and tools for process planning
2. To explain the concept of cost estimation and its elements.
3. To compute the overhead and depreciation cost.
4. To learn to estimate production cost for casting, forging and welding processes.
5. To calculate the machining time and cost for various machining operations.

UNIT – I INTRODUCTION TO PROCESS PLANNING **9**

Drawing interpretation –Material selection process and methods – Selection of Production Processes from Tables – Factors to be considered in selecting: Processes; Process Sequencing; Operation Sequencing; Equipment & Tool Selection; Tool Holding Devices; Measuring Instruments –Computer Aided Process Planning – Retrieval / Variance CAPP and Generative CAPP - Case Study in Process Planning.

UNIT – II COST ESTIMATION **9**

Concept and Purpose of Estimating, Functions of Estimating Department, Concept of Costing, Costing versus Estimating, Types of Estimates, Importance of Estimates, Estimating Procedure, Cost Estimators and their Qualifications, Principal Constituents in a Cost Estimate – Elements of Cost – Introduction, Material Cost, Labour Cost, Expenses and Cost of Product (Ladder Cost).

UNIT – III ESTIMATION OF OVERHEADS AND DEPRECIATION **9**

Overhead, Allocation or Distribution of Overhead Cost , Depreciation and Methods to Calculate it, Interest on Capital, Idleness Costs, Repair and Maintenance Cost

UNIT – IV ESTIMATION OF CASTING, FORGING AND WELDING COSTS **9**

Estimation of cost for Casting processes, Welding processes and Forging processes.

UNIT – V ESTIMATION OF MACHINING COST **9**

Estimation of Machining Time and Cost – Drilling, Milling, Shaping Planning, Grinding operations.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Select the process, equipment and tools for various process planning
2. Apply the various elements of cost and its types for product costing.
3. Determine the overhead and depreciation cost for industrial products.
4. Estimate production cost for casting, forging and welding processes.
5. Evaluate the machining time and cost for various machining operations.

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	3	1	-	1	-	-	-	-	-	1	-	1	1	1	1
CO2	3	1	-	1	-	-	-	-	-	1	-	1	1	1	1
CO3	3	1	-	1	-	-	-	-	-	1	-	1	1	1	1
CO4	3	1	-	1	-	-	-	-	-	1	-	1	1	1	1
CO5	3	1	-	1	-	-	-	-	-	1	-	1	1	1	1
CO/PO & PSO Average	3.0	1.0	-	1.0	-	-	-	-	-	1.0	-	1.0	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Panneer Selvam, Sivasankaran P, "Process planning and Cost Estimation", Prentice-Hall of India, 2016
2. S.C.Sharma, T.R.Banga, "Mechanical Estimating and Costing", Khanna Publishers, 2011.

REFERENCES

1. Chitale A.V. and Gupta R.C., “Product Design and Manufacturing”, 2nd Edition, PHI, 2002.
2. Ostwalal P.F. and Munez J., “Manufacturing Processes and Systems”, John Wiley, 9th Edition, 1998.Russell R.S and Tailor B.W, “Operations Management”, PHI, 4th Edition, 2003.
3. Mikell P. Groover, “Automation, Production, Systems and Computer Integrated Manufacturing”, Pearson Education, 2001.
4. K.C. Jain & L.N. Aggarwal, “Production Planning Control and Industrial Management”, Khanna Publishers, 1990.

PR23013	NON-DESTRUCTIVE TESTING AND EVOLUTION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. To understand the principle behind various NDT techniques.
2. To learn working procedures of various NDT techniques.
3. To understand the concepts of NDT in various manufacturing processes.
4. To impart the knowledge in selection of required NDT for specific applications.
5. To learn the importance of inspection and its techniques.

UNIT – I INTRODUCTION 9

NDT Versus Mechanical testing - Overview of the Non-Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT-NDT standards- Visual inspection – Unaided and aided.

UNIT – II SURFACE NDT METHODS 9

Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetisation Methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

UNIT – III THERMOGRAPHY AND EDDY CURRENT TESTING 9

Thermography- Principles, Contact and non-contact inspection methods, Techniques for applying liquid crystals, Advantages and limitations - infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

UNIT – IV ULTRASONIC TESTING AND ACOUSTIC EMISSION 9

Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A-Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique – Principle, AE parameters, Applications

UNIT – V RADIOGRAPHY 9

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrometers, Exposure charts, Radiographic equivalence. Fluoroscopy - Xero-Radiography, Computed Radiography, Computed Tomography

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Classify different NDT methods based on their applications and distinguish NDTmethods and mechanical testing methods.
2. Explain the principles and procedures of liquid penetrant testing and magnetic particle testing and discuss the interpretation of results for both methods.
3. Explore the techniques thermography, eddy current testing and discuss their advantages and limitations.
4. Summarize ultrasonic testing and the acoustic emission technique, including their principles, parameters, and applications.
5. Discuss radiography principles and imaging techniques and their latest advancements.

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	-	1	-	-	-	1	-	2	1	-	1
CO2	2	1	-	1	-	1	-	-	-	1	-	2	1	-	2
CO3	2	1	-	1	-	1	-	-	-	1	-	2	1	-	2
CO4	2	1	-	1	-	1	-	-	-	1	-	2	1	-	2
CO5	2	1	-	1	-	1	-	-	-	1	-	2	1	-	2
CO/PO & PSO Average	2.0	1.0	-	1.0	-	1.0	-	-	-	1.0	-	2.0	1.0	-	1.8
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Baldev Raj, Jeyakumar. T, Thavasimuthu. M., “Practical Non-Destructive Testing”, Narosa
   Publishing house, New Delhi, 3rd Edition, 2015.
2. Nathan Ida, Norbert Meyendorf, “Handbook of Advanced Nondestructive Evaluation”, Springer, 2020.

REFERENCES

1. Baldev Raj and B.Venkataraman, “Practical Radiology”, Narosa Publishing House, 2011.
2. Birchan.B, “Non-Destructive Testing”, Oxford, London, 1975.
3. Krautkramer. J, “Ultrasonic Testing of Materials”, Springer – Verlag Publication, 4th Edition, 1996.
4. Prasat.J and Nair C.G.K, “Non Destructive Test and Evaluation of Materials”, Tata McGraw Hill Education, 2nd Edition, 2011.
5. Raj.B, Jayakumar.T and Thavasimuthu. M, “Practical Non Destructive Testing”, Alpha Science International Limited, 3rd Edition, 2002.

PR23C09	CONDITION MONITORING	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 importance of machinery maintenance and the different maintenance approaches, including reactive, preventive, and predictive maintenance.
2. Gain knowledge of condition monitoring techniques in manufacturing industries, both online and offline, and their significance in detecting and diagnosing faults.
3. Learn about measurement standards, sources of errors, and calibration in condition monitoring, and become familiar with basic measurement equipment for various parameters such as vibration, force, speed, noise, temperature, laser-based measurements, current, chemical analysis, and ultrasound.
4. Understand the principles of vibration monitoring and its application in detecting and analyzing various faults in machinery, including misalignment, eccentricity, cracked shaft, bowed and bent shaft, unbalanced shaft, bearing defects, and gear faults.
5. Explore the principles of noise monitoring, acoustical terminology, noise sources, sound fields, and techniques for identifying and mitigating noise-related issues in machinery.

UNIT – I CONDITION MONITORING NEED AND TECHNIQUES 9

Introduction to Machinery Maintenance – Reactive maintenance, Preventive maintenance, Predictive maintenance, Condition Monitoring in manufacturing industries – Online and Offline condition monitoring, Measurement Standards-Errors – Calibration – Basic Measurement Equipment – Vibration, Force, Speed, Noise, Temperature, Laser – Based, Current, Chemical, Ultrasound Measurement

UNIT – II VIBRATION AND NOISE MONITORING 9

Vibration Monitoring –Principles of Vibration Monitoring, Misalignment Detection, Eccentricity Detection, Cracked Shaft, Bowed and Bent Shaft, Unbalanced Shaft, Bearing Defects, Gear Fault Noise Monitoring – Acoustical Terminology, Noise Sources, Sound Fields, Noise Source Identification – Applications

UNIT – III ELECTRICAL, THERMAL AND MAGNETIC EMISSION MONITORING 9

Faults in Electric Motor – Motor Current Signature Analysis, Thermography –Thermal Imaging Device – Application of thermography in condition monitoring, Wear Debris Analysis, Eddy Current, Ultrasonic and Radiography methods in condition monitoring – Application

UNIT – IV MACHINE TOOL CONDITION MONITORING 9

Tool Wear-Sensor Fusion in Tool Condition Monitoring – Direct Tool wear measurement – Indirect Tool wear measurement in conventional and unconventional Machining – Application

UNIT – V SIGNAL PROCESSING AND CASE STUDIES 9

Study of periodic and random signals, probability distribution, statistical properties, auto and cross correlation and power spectral density functions, Time domain and Frequency domain and

Time – frequency domain analysis, Intelligent fault detection system using Machine Learning, Case studies

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Recognize the significance of machinery maintenance and the different maintenance approaches, and assess their suitability for specific operational requirements.
2. Apply measurement standards, minimize errors, and perform calibration of measurement equipment for accurate condition monitoring.
3. Utilize various condition monitoring techniques to detect and diagnose faults in machinery, and make informed maintenance decisions.
4. Analyze vibration patterns and characteristics to identify and assess different types of faults, such as misalignment, eccentricity, cracked shaft, unbalanced shaft, bearing defects, and gear faults.
5. Identify noise sources, understand acoustical terminology, and apply noise monitoring techniques to mitigate noise-related issues in machinery.

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	-	-	-	1	1	-	1
CO2	2	-	-	1	-	-	-	-	-	-	-	1	1	-	1
CO3	2	-	-	1	-	-	-	-	-	-	-	1	1	-	1
CO4	2	-	-	1	-	-	-	-	-	-	-	1	1	-	1
CO5	2	-	-	1	-	-	-	-	-	-	-	1	1	-	1
CO/PO & PSO Average	2.0	-	-	1.0	-	-	-	1.0	-	-	-	1.0	1.0	-	1.0
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Davies A, “Handbook of Condition Monitoring: Techniques and Methodology”, Springer, 2012.
2. Nakhaeinejad, Mohsen, and Bukowitz, David O., “Practical Vibration Analysis of Machinery: Case Studies”, CreateSpace Independent Publishing Platform, 2011.
3. Nandi, Asoke K., and Ahmed, Hosameldin., “Condition Monitoring with Vibration Signals”, Wiley, 2020.

REFERENCES

1. Tadeusz Uhl, “Condition Monitoring of Machinery in Non-Stationary Operations: Proceedings of the Second International Conference”, Springer, 2012
2. Clarence W. de Silva, “Vibration Monitoring, Testing, and Instrumentation”, CRC Press, 2007
3. Mohanty, Amiya R., “Machinery Condition Monitoring: Principles and Practices”, CRC Press, 2014.
4. Blitz, J., “Electrical and Magnetic Methods of Non-destructive Testing”, Springer, 2012.
5. Havens, Kirk J, and Sharp, Edward J., “Thermal Imaging Techniques to Survey and Monitor Animals in the Wild: A Methodology”, Elsevier Science, 2015.

		L	T	P	C
RA23C03	**VIBRATION ANALYSIS AND CONTROL**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

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

1. Analyze the fundamental principles and mathematical models of vibration.
2. Evaluate the response of single and multi-degree freedom systems to various excitations.
3. Apply vibration isolation methods and techniques for vibration and noise control.
4. Design and implement experimental methods for vibration analysis and measurement.
5. Interpret and analyze vibration data to identify system characteristics and behavior.

UNIT – I FUNDAMENTALS OF VIBRATION 9

Introduction -Sources of Vibration-Mathematical Models- Displacement, velocity and Acceleration Review of Single Degree Freedom Systems -Vibration isolation Vibrometers and accelerometers - Response to Arbitrary and non- harmonic Excitations – Transient Vibration – Impulse loads Critical Speed of Shaft-Rotor systems.

UNIT – II TWO DEGREE FREEDOM SYSTEM 9

Introduction-Free Vibration of Undamped and Damped - Forced Vibration With Harmonic Excitation System –Coordinate Couplings And Principal Coordinates.

UNIT – III MULTI-DEGREE FREEDOM SYSTEM AND CONTINUOUS SYSTEM 9

Multi Degree Freedom System –Influence Coefficients and stiffness coefficients- Flexibility Matrix and Stiffness Matrix – Eigen Values and Eigen Vectors-Matrix Iteration Method –Approximate Methods: Dunkerley, Rayleigh's, and Holzer Method -Geared Systems-Eigen Values &Eigenvectors for large system of equations using sub space, Lanczos method - Continuous System: Vibration of String, Shafts and Beams.

UNIT – IV VIBRATION AND NOISE CONTROL 9

Specification of Vibration Limits – Vibration severity standards- Vibration as condition Monitoring Tool-Vibration Isolation methods - Dynamic Vibration Absorber - Static and Dynamic Balancing machines – Field balancing - Major sources of noise – Noise survey techniques – Measurement technique for vehicular noise – Road vehicle noise standards – Industrial noise sources – Control Strategies – Noise control at the source and along the path – use of acoustic barriers – Noise control at the receiver.

UNIT – V EXPERIMENTAL METHODS IN VIBRATION ANALYSIS 9

Vibration Analysis Overview - Experimental Methods in Vibration Analysis-Vibration Measuring Instruments - Selection of Sensors- Accelerometer Mountings. -Vibration Exciters-Mechanical,

Hydraulic, Electromagnetic and Electrodynamics –Frequency Measuring Instruments-. System Identification from Frequency Response -Testing for resonance and mode shapes.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Demonstrate a comprehensive understanding of the fundamental concepts and mathematical models of vibration.
2. Apply mathematical techniques to analyze the response of single and multi-degree freedom systems.
3. Evaluate and select appropriate vibration isolation methods for specific applications.
4. Design and conduct experiments using vibration measuring instruments and sensors.
5. Analyze and interpret vibration data to identify system parameters and behavior.

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	3	2	2	1	2	1	-	-	-	1	-	1	1	-	1
CO2	2	3	3	3	1	2	-	-	-	1	-	1	1	-	1
CO3	2	2	2	2	3	1	-	-	-	1	-	1	1	-	1
CO4	1	2	2	2	2	2	-	-	-	1	-	1	1	-	1
CO5	2	3	2	2	2	1	-	-	-	1	-	1	1	-	1
CO/PO & PSO Average	**2**	**2.4**	**2.2**	**2**	**2**	**1.4**	**-**	**-**	**-**	**1**	**-**	**1**	**1**	**-**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. William T. Thomson, “Theory of Vibration with Applications”, Taylor & Francis, 2003.
2. V.P. Singh, Mechanical Vibrations, Dhanpat Rai & Co, 2016.

REFERENCES:

1. Graham Kelly. Sand Shashidhar K. Kudari, “Mechanical Vibrations”, Tata McGraw –Hill Publishing Com. Ltd., 2007.
2. Singiresu S. Rao,” Mechanical Vibrations,” Pearson Education Incorporated, 2017.
3. Ramamurti. V, “Mechanical Vibration Practice with Basic Theory”, Narosa Publishing House, 2000

		L	T	P	C
PR23C04	**GD&T IN DESIGN AND MANUFACTURING**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

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

1. Understand GD & T principles and their importance in interpreting engineering drawing
2. Interpret symbols and terminology used in GD&T for effective communication of geometric properties
3. Apply controls for forms, datums, orientation, position, concentricity, symmetry, runout and profile in GD&T
4. Perform tolerance calculations and analyze worst case scenarios for different GD&T controls
5. Apply GD&T principle in integrated product design and manufacturing processes for improved producibility and process efficiency

Unit I NEED FOR GD&T AND BASIC CONCEPTS 9

Engineering drawings and tolerancing - Dimensioning, dimensioning standards and rules, Geometric properties of a surface - Coordinate tolerancing system and its shortcomings, Geometric dimensioning and tolerancing system - benefits, Symbols &terms as per ASME Y14.5M, rules and concepts, virtual condition and bonus tolerance

Unit II FORM, DATUMS, AND ORIENTATION CONTROLS 9

Flatness, Straightness, Circularity and Cylindricity control; Datums - Implied datums, Planar datums, datum targets, FOS datum features, FOS datum features applications RFS, at MMC and LMC, Orientation controls - Perpendicularity, Angularity and parallelism control of axis / midplane;

UNIT – III POSITION, CONCENTRICITY, SYMMETRY, RUNOUT AND PROFILE CONTROLS 9

Tolerance of position - Position vs Coordinate conversion, Tolerance of position RFS, at MMC and LMC, TOP calculations, fixed and floating fastener calculations; Runout control - circular, total and runout calculations, Profile control - surface, line, Profile modifiers, Derived element controls - Straightness derived median line, Flatness derived median plane, Concentricity control, Symmetry control

UNIT – IV GD&T FOR INTEGRATED PRODUCT DESIGN AND MANUFACTURING I 9

Concurrent engineering in Y14.5M, Datum reference frames, Foundation of geometric control: interrelated features, the boundary concept, Taylor’s principle, and refinement of controls; Application considerations, Product and process design - The six step methodology, Developing the tooling and gaging designs needed to create a producible product

UNIT – V GD&T FOR INTEGRATED PRODUCT DESIGN AND MANUFACTURING II 9

Producibility design cycle, datum - specification, selection, qualification, and identification; Phantom gage dimensioning, Dimensional measurements, Inspection and verification, functional gaging, functional gage tolerancing, functional inspection techniques, functional workholding and fixturing, Implementation and process improvement.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Explain why geometric tolerancing is superior to coordinate Tolerancing
2. Interpret the symbols and material modifiers used in GD&T
3. Define the key terms used in GD&T
4. Interpret applications of datum targets, size datum features, and size datum features
5. Interpret the various types of tolerance (flatness, circularity, cylindricity, straightness, perpendicularity, parallelism, angularity, position, runout, and profile)

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	-	-	-	1	-	1	-	1	2	-	1
CO2	2	1	-	1	-	-	-	-	-	1	-	1	1	-	1
CO3	3	1	1	1	-	-	-	1	-	1	-	1	1	-	1
CO4	2	1	-	1	-	-	-	-	-	1	-	1	1	-	1
CO5	2	1	-	1	1	-	-	-	-	1	-	1	1	-	1
CO/PO & PSO Average	2.2	1.0	1.0	1.0	1.0	-	-	1.0	-	1.0	-	1.0	1.2	-	1.0
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Alex Krulikowski, “Fundamentals of Geometric Dimensioning and Tolerancing” 3rdEdition, 2013, Cengage Learning, ISBN: 9781111129828.
2. Bob Campbell, “Integrated Product Design and Manufacturing Using Geometric Dimensioning and Tolerancing”, 2003, Marcel Dekker.

REFERENCES:

1. Georg Henzold, “Geometrical Dimensioning and Tolerancing for Design, Manufacturing and Inspection A Handbook for Geometrical Product Specification Using ISO and ASME Standards”, Butterworth-Heinemann, 3rd Edition, 2021.
2. ASME Y14.5-2018, “Dimensioning and Tolerancing - Engineering Product Definition and Related Documentation Practices”, ASME, 2018.
3. James D. Meadows, “Geometrical Dimensioning and Tolerancing - Application, Analysis and Measurement”, ASME Press, 2009.
4. David A. Madsen and David P. Madsen, “Geometrical Dimensioning and Tolerancing”, 9thEdition, The Goodheart-Willcox Company, Inc., 2013.
5. Gene R. Cogorno, “Geometrical Dimensioning and Tolerancing for Mechanical Design”, McGraw-Hill, 2006.

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 and SAS Business Series

PR23014	STATISTICAL QUALITY CONTROL AND RELIABILITY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

- Understand the principles and concepts of statistical process control (SPC) and its application in quality control.
- Learn about acceptance sampling techniques and their role in determining product quality.
- Gain knowledge of experimental design and Taguchi methods for optimizing process parameters and improving product quality.
- Explore reliability analysis techniques and methods for predicting and improving product reliability.
- Develop skills in analyzing failure data and selecting appropriate statistical distributions for reliability analysis.

UNIT – I STATISTICAL PROCESS CONTROL 9

Quality control – Definition – Quality Assurance Variation in process – Factors – control charts – variables XR and Xσ, - Attributes P, C and U-Chart Establishing and interpreting control charts process capability – Quality rating – Short run SPC.

UNIT – II ACCEPTANCE SAMPLING 9

Lot by lot sampling types – probability of acceptance in single, double, multiple sampling plans – OC curves – Producer's risk and consumer's risk. AQL, LTPD, AOQ, AOQL, Concepts Design of sampling plan – single, double, multiple- standard sampling plans for AQL and LTPD – Use of standard sampling plans – Sequential sampling plan.

UNIT – III EXPERIMENTAL DESIGN AND TAGUCHI METHODS 9

Fundamentals – fractional, factorial experiments – random design, Latin square design – Taguchi method –Quality Loss function – experiments – S/N ratio and performance measure – Orthogonal array.

UNIT – IV RELIABILITY AND ITS PREDICTION 9

Life testing – Failure characteristics – Meantime to failure – maintainability and availability – reliability – system reliability – OC curves – reliability improvement techniques – Reliability testing techniques – Pareto analysis. MTBF, MTTF, MTTR – System reliability – OC curve Availability and Maintainability – Reliability Improvement techniques.

UNIT – V FAILURE DATA ANALYSIS 9

Real time distribution, exponential, normal, log normal, gamma and Weibull – reliability data requirements – Graphical evaluation.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- Apply statistical process control techniques to monitor and control process variation, and interpret control charts effectively.
- Design and implement acceptance sampling plans based on given quality requirements and understand the associated risks.
- Design and conduct experiments using factorial and fractional factorial designs, and apply Taguchi methods to optimize process parameters.
- Analyze reliability data, calculate reliability metrics, and evaluate the performance and availability of systems.

- Perform failure data analysis and select appropriate statistical distributions for reliability modeling.

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	3	2	-	1	-	1	-	1	-	1	-	1	1	1	2
CO2	3	2	-	1	-	1	-	1	-	1	-	1	1	1	2
CO3	3	2	-	1	-	1	-	1	-	1	-	1	1	1	2
CO4	3	2	-	1	-	1	-	1	-	1	-	1	1	1	2
CO5	3	2	-	1	-	1	-	1	-	1	-	1	1	1	2
CO/PO & PSO Average	3.0	2.0	-	1.0	-	1.0	-	1.0	-	1.0	-	1.0	1.0	1.0	2.0
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Modares, “Reliability and Risk Analysis”, Marcel Decker Inc. 4th Edition, 2014.
2. Besterfield D.H., “Quality Control”, Prentice Hall, 3rd Edition 2011.

REFERENCES

1. Amitava Mitra, “Fundamentals of Quality Control and Improvement”, Pearson Education Asia, 5th Edition,2021.
2. Manohar Mahajan, “Statistical Quality Control”, Dhanpat Rai and Sons, 2007.
3. Sharma S.C., “Inspection Quality Control and Reliability”, Khanna Publishers, 1998.
4. Ross, S.M., “Introduction to Probability and Statistics for Engineers and Scientists”, Elsevier, 6th Edition, 2021.
5. Krishnaiah K., “Applied Statistical Quality Control and Improvement”, PHI, 2014

PR23015 ELECTRICAL DRIVES AND ACTUATORS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

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

1. To familiarize a relay and power semiconductor devices
2. To get a knowledge on drive characteristics
3. To obtain the knowledge on DC motors and drives.
4. To obtain the knowledge on AC motors and drives.
5. To obtain the knowledge on Stepper and Servo motor.

UNIT – I RELAY AND POWER ELECTRONIC DEVICES 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 - Introduction to Driver and Snubber Circuits.

UNIT – II DRIVE CHARACTERISTICS 9

Electric Drive – Equations Governing Motor Load Dynamics – Steady State Stability – Multi Quadrant Dynamics: Acceleration, Deceleration, Torque, and Direction. Starting & Stopping – Selection of Motor.

UNIT – III DC MOTORS AND DRIVES 9

Types of PMDC & BLDC Motors - Principle of Operation- EMF and Torque Equations - Characteristics and Control – Drives - H Bridge - BLDC Motors - Single and Three Phases – 4 Quadrant Operation - Linear Motors– Electrical vehicles-Applications.

UNIT – IV AC MOTORS AND DRIVES 9

Introduction – Induction Motor Drives – Speed Control of 3-Phase Induction Motor – Stator Voltage Control – Stator Frequency Control – Stator Voltage and Frequency Control - Servo Mechanism –- AC Servo Motor and Drive – Applications.

UNIT – V DC SERVO AND STEPPER MOTOR 9

DC Servo Motor- Applications- Stepper Motor: Classifications- Construction and Principle of Operation – Modes of Excitation-Drive System-Logic Sequencer - Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Recognize the principles and working of relays, power electronic drives and motors.
2. Explain the working characteristics of various drives and motors.
3. Apply the solid-state switching circuits to operate various types of Motors.
4. Interpret the working of Motors and Driver circuits.
5. Suggest the Motors and Drivers for given applications.

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	-	-	-	-	-	1	-	1	-	-	2
CO2	2	1	-	1	-	-	-	-	-	1	-	1	-	-	2
CO3	2	1	-	1	-	-	-	-	-	1	-	1	-	-	2
CO4	2	1	-	1	-	-	-	-	-	1	-	1	-	-	2
CO5	2	1	-	1	-	-	-	-	-	1	-	1	-	-	2
CO/PO & PSO Average	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**	**-**	**-**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. Bimbhra B.S., "Power Electronics", 5th Edition, Kanna Publishers, New Delhi, 2012.
2. Mehta V.K. & Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S.Chand& Co. Ltd., New Delhi, 2016.

REFERENCES:

1. Gobal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House, New Delhi, 2001.
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, 2008

PR23016	IMMERSIVE TECHNOLOGIES AND HAPTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. Define and explain the fundamental concepts and components of haptics technology.
2. Analyze the role and importance of touch in human perception and interaction.
3. Explore and evaluate different types of haptic sensing and their applications.
4. 4Apply principles of haptic design and psychophysics to create immersive experiences.
5. Investigate and assess the integration of haptics technology with virtual, augmented, and mixed reality environments.

UNIT – I INTRODUCTION TO HAPTICS 9

Definition - Importance of Touch - Tactile Proprioception - Tactual Stereo Genesis - Kinesthetic Interfaces - Tactile Interfaces - Human Haptics - Overview of Existing applications - Basics of Force Feedback Devices - Kinesthetic Vs. Tactile Haptic Devices - Configurations of Kinesthetic Devices -Types of Kinesthetic Devices.

UNIT – II KINESTHETIC HAPTIC DEVICES AND TELEOPERATION 9

Mechatronics in Haptics System - Haptic Kinematics - Haptic Dynamics - Existing Kinesthetic Devices - Haptic Device Static Rendering - Haptic Device Dynamic Rendering - Control of Haptic Devices - Stability Analysis of Haptic Devices - Stability Analysis of the Rendered Model - Passivity of the Rendered Model. Types of Sensors - Measurement of Haptic Parameters - Types of Actuators - Types of Transmission - Admittance Type Kinesthetic Device - Admittance Control - Comparison of Impedance and Admittance Type Devices - Genesis of Tele-Operation - Tele-Operation Controllers -Tele-Operator Transparency - Stability Analysis of Tele-operator - Tracking and Transparency - Surface Haptic - Exogenous Force Inputs.

UNIT – III HUMAN HAPTICS ITS PLATFORM 9

Introduction - Types of Haptic Sensing - Active vs. Passive Touch - Mechanoreception- Mechanoreceptive Afferents - Kinesthetic Sensing - Force Sensing and Proprioception- Introduction to Psychophysics - Measurement Thresholds - Laws of Psychophysics - Weber's Law - Fechner's Law - Fitt's Law - Psychophysical Methods of Limit, Constant Stimuli and Adjustment - Introduction to Virtual Reality Modelling Language (VRML) – Open Haptic Platform - OpenGL- Virtual Environment Manager - Modelling of Simple Haptic System.

UNIT – IV VIRTUAL AND AUGMENTED REALITY 9

The Reality – Virtuality Continuum - Virtual Reality Definitions - Software, Hardware, Sensation and Perception - Multi-Modal Interaction Challenges - System Architecture of Virtual Reality. Aspects of Geometrical Modelling and Environmental Modelling General Solution for Calculating Geometric &Illumination Consistency in the Augmented Environment. Usability Guidelines - Design and Implementation of an Immersive User Experience - Case Study for VR and AR.

UNIT – V MIXED REALITY 9

System Architecture of a Mixed Reality System - Common Interaction Techniques for Mixed Reality Environments - Common Navigation Techniques - Common Interface for MR - Menu Design Directions - Haptic Control Panel - Performance of an Interaction Techniques, Advanced Interaction Techniques, Design and Implementation of an Immersive User Experience - Case Study for MR.

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 terminology of haptics technology.
2. Recognize the significance of touch and its impact on human perception and interaction.
3. Differentiate between various haptic sensing techniques and their applications.
4. Design and develop haptic systems that effectively engage users in immersive experiences.
5. Evaluate the integration of haptics technology in virtual, augmented, and mixed reality environments for enhanced user interaction.

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	-	1	1	-	1
CO2	2	1	-	1	1	-	-	2	-	1	-	1	1	-	1
CO3	2	2	-	2	1	-	-	2	-	1	-	1	1	-	1
CO4	2	2	2	1	1	-	-	2	-	1	-	1	1	2	1
CO5	2	2	1	1	1	-	-	2	-	1	-	1	1	2	1
CO/PO & PSO Average	2	1.7	1.5	1.2	1	-	-	2	-	1	-	1	1	2	1
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Burdea, G. C. and P. Coffet. “Virtual Reality Technology”, 3rd edition, Wiley-Interscience, Hoboken New Jersey, 2012.
2. Eckehard Steinbach et al, “Haptic Communications”, Vol. 100, 4:937-956, 2012
3. Hannaford B and Okamura A. M “Haptics: Handbook of Robotics”, Springer, pp. 718-735, 2008.

REFERENCES

1. Kenneth Salisbury, Francois Conti and Federico Barbagli, “Haptic Rendering: IEEE Computer Graphics and Applications”, v24 n2 (200403): 24-32, 2004.
2. Jean-Pierre Bresciani, Knut Drewing and Marc O. Ernst. “Human Haptic Perception and the Design of Haptic-Enhanced Virtual Environments: The Sense of Touch and Its Rendering”,STAR 45, pp. 61–106, 2008.
3. MacLean K. E, “Haptic Interaction Design for Everyday Interfaces: Reviews of Human Factors and Ergonomics”, 4:149-194, 2008.
4. Weir D. W and Colgate J. E “Stability of Haptic Display: Haptic Rendering: Foundations, Algorithms, and Applications”. AK Peters, 2008.
5. Sherman, William R. and Alan B. Craig. “Understanding Virtual Reality – Interface, Application, and Design” 2nd edition, Morgan Kaufmann, Cambridge U.S 2019.
6. Yuichi Ohta, Hideyuki Tamura, “Mixed Reality: Merging Real and Virtual Worlds”, Springer Verlag, Berlin, 2014.

PR23017	EMBEDDED SYSTEMS AND PROGRAMMING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. To familiarize the architecture and fundamental units of microcontroller.
2. To know the microcontroller programming methodology and to acquire the interfacing skills and data exchange methods using various communication protocols.
3. To design the interface circuit and programming of I/O devices, sensors and actuators.
4. To acquaint the knowledge of real time embedded operating system for advanced system developments.
5. To familiar RTOS based I/O interfacing

UNIT I MICROCONTROLLER 9

Microprocessor vs Microcontroller overview - Functions of ALU – CISC and RISC – Types Microcontroller - 8051 Microcontroller– Architecture, Peripheral Features and Specifications - Memory Organization - Timing Diagram- Instruction Sets – Addressing Modes.

UNIT II PROGRAMMING AND COMMUNICATION 9

Fundamentals of Assembly Language Programming – Instruction to Assembler – Compiler and IDE - C Programming for 8051 Microcontroller – Basic Arithmetic and Logical Programming - Timer and Counter - Interrupts – Interfacing and Programming of Serial Communication, I^2C, SPI and CAN of 8051 Microcontroller – Bluetooth and WI-FI interfacing of 8051 Microcontroller.

UNIT III PERIPHERAL INTERFACING 9

I/O Programming – Interfacing of Memory, Key Board and Displays – Alphanumeric and Graphic, RTC, Interfacing of ADC and DAC, Sensors, Relay, Solenoid, Heater, Stepper Motors, DC Motors - PWM Programming – Closed Loop Control Programming of Servomotor – Overview of Advanced Microcontrollers.

UNIT IV SINGLE BOARD COMPUTERSAND OPERATING SYSTEMS 9

Single Board Computers - Architecture Overview, Hardware Considerations: GPIO, Logic States, CPU, Internal and External Memory, Network and Peripheral Features – Camera, Ethernet, WIFI - Real Time Embedded Operating Systems - RTOS Concepts and Definitions, Real-Time Design Issues, RTOS Building Blocks, Real-Time Kernel– Supported OS and Libraries Overview.

UNIT V INTERFACING WITH RTOS 9

Real Time Programming Languages – Comparative Overview of C and Python for Embedded Systems- Interfacing I/O with Single Board Computers - GPIO Programming- Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. State the basic terminologies of microcontroller and SBC.
2. Express the architecture, functions and features of microcontroller and SBC.
3. Design the microcontroller/SBC for interfacing the sensors, actuators and other I/O’s for automation.
4. Programming the microcontroller and SBC.

5. Evaluate the design, interfacing and programming of microcontroller and SBC for the given application.

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	-	1	-	-	2
CO2	2	-	-	1	-	-	-	-	-	1	-	1	-	-	2
CO3	2	-	3	1	-	-	-	-	-	1	-	1	-	-	2
CO4	2	2	-	1	-	-	-	-	-	1	-	1	-	-	2
CO5	2	-	3	1	-	-	-	-	-	1	-	1	-	-	2
CO/PO & PSO Average	**2**	**2**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**	**-**	**-**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Frank Vahid and Tony Givagis, “Embedded System Design”, Wiley, 2011.
2. James W. Stewart, “The 8051 Microcontroller Hardware, Software and Interfacing”, Regents Prentice Hall, 2003.
3. John B. Peatman, “Design with Microcontrollers”, McGraw Hill International, USA, 2005.
4. Kenneth J. Aylala, “The 8051 Microcontroller, the Architecture and Programming Applications”, 2005.

REFERENCES:

1. Muhammad Ali Mazidi and Janice GillispicMazidi, “The 8051 Microcontroller and Embedded Systems”, Pearson Education, 2014.
2. Simon Monk, Programming the Raspberry Pi, Second Edition: Getting Started with Python McGraw Hill TAB; 2nd edition,2015

PR23018	MICRO ELECTRO MECHANICAL SYSTEMS	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 impact of miniaturization on the performance and characteristics of MEMS (Micro-Electro-Mechanical Systems) and Microsystems.
2. Familiarize with the materials used in MEMS and Microsystems, including semiconductors (Si, GaAs), piezoelectric crystals, polymers, and their properties.
3. Gain knowledge of micro-fabrication processes such as photolithography, ion implantation, oxidation, chemical and physical vapor deposition, etching, and surface micromachining.
4. Explore the working principles of micro-sensors, micro actuators, and microfluidics in MEMS systems, including optical sensors, pressure sensors, micro-grippers, micro-valves, and microfluidic channels.
5. Understand the design considerations and constraints in the development of MEMS systems, including mechanical design, thermo-mechanical stress analysis, dynamic analysis, and simulation of microfabrication processes.

UNIT – I EFFECT OF MINIATURISATION AND MATERIALS FOR MEMS 9

Definition – historical development – fundamentals – Scaling laws in miniaturization – Rigid Body dynamics, Electrostatic Forces, Electromagnetic properties, Electricity, diffusion property, optical property and Heat Transfer, Materials for MEMS and Microsystems – Si, Si compounds, Si Piezo resistors, GaAs, Quartz, Piezoelectric Crystals and Polymers –Doping of semiconductors– diffusion process

UNIT – II MICRO-FABRICATION PROCESSES 9

Photolithography – photoresist applications, light sources and post baking – Ion implantation – diffusion process –oxidation – thermal oxidation, silicon dioxide, oxidation rate, oxide thickness by colour – chemical vapour deposition – enhanced CVD – Physical vapour deposition – sputtering – deposition by epitaxy – etching – chemical and plasma etching. Bulk micro manufacturing – wet etching, dry etching and etch stop – surface micromachining – LIGA process – SLIGA process.

UNIT – III MICROSYSTEM–WORKING PRINCIPLE, ASSEMBLYAND PACKAGING 9

Microsensors–Optical,Pressure,AcousticwaveandThermalsensors–Micro actuation–thermal forces, shape memory alloys, piezoelectric crystals and Electrostatic Forces – MEMS with micro actuators– Micro gripper, Micro motor, micro-valves and micro pumps – Micro accelerometers – gyroscope- Microfluidics – micro mirror array for video projection – Micro system packaging – die level, device level and system level – Interfaces – Die preparation – surface bonding- wire bonding – sealing – Assembly of Microsystems–selection of packaging materials –signal mapping and transduction– pressure sensors packaging.

UNIT – IV MICROSYSTEMS DESIGN 9

Static bending of thin plates–Mechanical Vibration–thin film mechanics –Design considerations – constraints, selection of materials, selection of Manufacturing processes, selection of signal

transduction, electromechanical system and packaging – Process design – Mechanical Design Thermo mechanical loading, Thermo mechanical stress analysis, Dynamic Analysis and Interfacial fracture Analysis – Design of a Si die for a micro pressure sensor – Fluid resistance in Micro channels – capillary electrophoresis network systems – Design of MEMS cell gripper – Micro Optical Electro Mechanical System –Complementary Metal Oxide Semiconductor.

UNIT – V FABRICATION OF MEMS SYSTEMS AND TESTING 9

Gas sensor - Accelerometer- Pressure sensor- Gyroscope- BioMEMS - Optical MEMS – Visual Display– Optical Data Switching – RF MEMS – MEMS Variable Capacitors – MEMS Switches – Resonators -Inch Worm, Zipper and Scratch Drive. Thermal Actuation-Bimorph-Buckle Beam -- Electro thermal Actuator - Electro Thermal Relay with Mechanical Latch – Piezoelectric Actuator- Shock- Parametric testing- Testing during assembly -Thermal shock –Thermal cycle- Burn-in test- Self Test.Introduction to NEMS and its applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Develop a comprehensive understanding of the fundamentals and scaling laws in miniaturization and the impact on the performance of MEMS and Microsystems.
2. Acquire practical skills in micro-fabrication processes such as photolithography, oxidation, deposition, etching, and surface micromachining.
3. Apply the knowledge of materials for MEMS and select appropriate materials for specific applications.
4. Analyze the working principles of micro sensors, micro actuators, and microfluidics and their applications in MEMS systems.
5. Design MEMS systems considering mechanical and thermal constraints, material selection, manufacturing processes, signal transduction, and packaging.

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	-	-	1	-	1	1	-	1
CO2	2	-	-	-	-	-	1	-	-	1	-	1	1	-	1
CO3	2	1	-	-	-	-	1	-	-	1	-	1	1	-	1
CO4	2	1	1	1	-	-	-	-	-	1	-	1	2	-	1
CO5	2	-	-	1	-	-	-	-	-	1	-	1	1	-	2
CO/PO & PSO Average	2.0	1.0	1.0	1.0	-	-	1.0	-	-	1.0	-	1.0	1.2	-	1.2
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Krzysztof Iniewski, Vikas Choudhary, "MEMS: Fundamental Technology and Applications", CRC Press, 1st Edition, 2017.
2. Tai-Ran Hsu, "MEMS and Microsystems: Design, Manufacture, and Nanoscale Engineering", John Wiley, 2020.

REFERENCES

1. Anantha Suresh G.K., “Micro and smart systems: Technology and Modeling”, John Wiley and Sons, 2012.
2. Charles P Poole, Frank J Owens, “Introduction to Nanotechnology”, Wiley India (Student) Edition, 2006.
3. Julian W. Gardner, “Micro Sensors: Principles and Applications”, John Wiley and Sons Ltd, 2nd Edition, 2020.
4. Marc J. Madou, “Fundamentals of microfabrication and nanotechnology”, CRC Press, 3rd Edition, 2012.
5. Nadim Maluf, Kirt Williams, “An Introduction to Microelectromechanical Systems Engineering”, Artech House, Inc., 2nd Edition, 2004.

RA23C02	INDUSTRIAL AUTOMATION	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 fundamentals of automation systems and their role in various industries.
2. Familiarize students with different automation components and control systems used in industrial settings.
3. Gain knowledge of programmable logic controllers (PLCs), their architecture, programming languages, and applications.
4. Explore operation and material handling systems, including SCADA, DCS, and network management in industrial automation.
5. Develop an understanding of plant design and simulation, including digital twin technologies and smart factories.

UNIT – I INTRODUCTION 9

Automation overview, Types of Industrial Automation, Requirement of automation systems, Architecture of Industrial Automation system, Sensors used for Industrial Automation – Pressure sensor, Temperature Sensor, Flow Sensor, Level Sensor, force, speed and displacement sensor

UNIT – II ELEMENTS OF PLC 9

Servo Hydraulic and Pneumatic Drive- Electric Drives- Piezoelectric Drives- Power electronics devices – DIAC, TRIAC, power MOSFET and IGBT, Digital Communication Protocols – MODBUS,Profibus, Open and Closed control system.

UNIT – III PLC CONTROLLER 9

PLC architecture, memory, PLC Programming languages, input and output modules, timer and counter, PLC programming

UNIT – IV OPERATION AND MATERIAL HANDLING 9

SCADA-DCS – NetworkManagement-process control systems – Energy Management – Material Handling and Storage System– Containerization and Robot Palletizing – safety standards

UNIT – V PLANT DESIGN AND SIMULATION 9

Plant Layout – Digital Twin – Plant design and simulation – Plant simulation basics and modelling – attributes for plant control and statistics – smart factories – Industry 4.0 –Case study

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Demonstrate a comprehensive understanding of the principles and concepts of industrial automation.
2. Identify and analyze different automation components and control systems for specific industrial applications.

3. Program and operate programmable logic controllers (PLCs) using various programming languages.
4. Evaluate and implement operation and material handling systems, including SCADA and DCS, in industrial environments.
5. Apply plant design and simulation techniques, including digital twin technologies, for efficient and optimized industrial processes.

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	-	1	-	1	1	-	2
CO2	2	1	1	1	-	-	-	1	-	1	-	1	1	-	1
CO3	2	-	-	1	1	-	-	1	-	1	-	1	1	-	1
CO4	2	-	1	1	-	-	-	1	-	1	-	1	1	-	1
CO5	2	-	-	1	-	-	-	1	-	1	-	1	1	-	2
CO/PO & PSO Average	2.0	1.0	1.0	1.0	1.0	-	-	1.0	-	1.0	-	1.0	1.0	-	1.4
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Frank Lamb, "Industrial Automation: Hands On", McGraw Hill LLC, 2013.
2. A.K. Gupta, S.K. Arora, Jean Riescher Westcott, “Industrial Automation and Robotics: An Introduction”, Mercury Learning and Information, 2017.

REFERENCES

1. W. Bolton, "Programmable Logic Controllers", Elsevier Science, 2011.
2. Satpute, Ajay S., “Process Plant Design and Simulation Handbook”, Independently Published, 2021.
3. Deshmukh L M, “Industrial Safety Management”, Tata McGraw-Hill Publishing Company Ltd., 2005
4. Safety Manual, “EDEL Engineering Consultancy”, 2000.
5. StamatiosManesis, George Nikolakopoulos, “Introduction to Industrial Automation”, CRC Press, 2018

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.

REFERENCES

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.

PR23019	PARTICULATE PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main objective of the course is

1. To offer a comprehensive understanding of various Particulate production techniques.
2. To provide the knowledge of different methods for characterizing Particulate.
3. To educate the principles and techniques of Particulate compaction.
4. To introduce to principles and techniques of sintering techniques.
5. To explain the major applications of Particulate metallurgy components in industries.

UNIT I INTRODUCTION TO PARTICULATE PREPARATION 9

Scope, advantages and limitations of Particulate metallurgical techniques. Mechanical fabrication techniques; Electrolytic fabrication techniques, Chemical fabrication techniques, Atomization techniques, Evaporation Techniques. Production of Ferrous powders, Nano powder production techniques. Powder handling, Mixing and Blending.

UNIT II CHARACTERISTICS AND TESTING OF PARTICULATES 9

Sampling, chemical composition, Particle Size measurement- Sieve analysis- Principle and procedure, Effect of particle size on the microstructure,Dynamic Light Scatteringsedimentation, elutriation & permeability, Particle size Topography, Surface area, BET surface area analysis, True, Apparent and Tap Density, Flow rate, Compressibility, Green Strength, Pyrophoricity and Toxicity, particle shape and its classifications

UNIT III PARTICULATE COMPACTION AND ITS CHARACTERISTICS 9

Particle deformation in compaction, Die compaction technology, cold isostatic compaction, design for compaction and economics of compaction. Compact characterization- Microstructural features, Pore structure characterization, Mechanical properties.

UNIT IV SINTERING 9

Stages of sintering, Mechanisms of sintering, liquid phase sintering and infiltration, Full density Processing-Activated sintering, Hot pressing and Hot Isostatic Pressing (HIP), Vacuum sintering, Sintering furnaces-batch and continuous-sintering atmosphere, Finishing operations – Heat treatment, Surface treatments, Impregnation, sizing, coining, Special sintering processes - Microwave sintering, Spark plasma sintering, Field assisted sintering, Reactive sintering, Sintering of nanostructured materials.

UNIT V APPLICATIONS OF POWDER METALURGY COMPONENTS 9

Major applications in Aerospace, Nuclear and Automobile industries- Bearing Materials-types,Self-lubrication and other types, Methods of production, Properties, Applications. Sintered Friction Materials-Clutches, Brake linings, Tool Materials- Cemented carbides, Oxide ceramics, Cermets- Dispersion strengthened materials.

TOTAL :45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to
CO1: Classify the various Particulate production techniques.
CO2: Characterize the metal Particulate with different testing methods.
CO3: Apply the principles of Particulate compaction to realize the green compacts.
CO4: Explain the sintering mechanisms and the various types of Sintering processes.
CO5: Discussthe applications of various Particulate metallurgy components.

TEXT BOOKS:

1. Randall M. German. “Powder Metallurgy and Particulate Materials Processing: The Processes, Materials, Products, Properties and Applications”, Metal Powder Industries Federation, 2005.
2. Anish Upadhya and G S Upadhaya, “Powder Metallurgy: Science, Technology and Materials, Universities Press, 2011
3. P.C.Angelo and R.Subramanian.,“ Powder Metallurgy: Science, Technology and Applications” Prentice Hall, 2008

REFERENCES

1. ASM Handbook. Vol. 7, “Powder Metallurgy”, Metals Park, Ohio, USA, 1990.
2. Kempton. H Roll, “Powder Metallurgy”, Metallurgical Society of AMIE, 1988.
3. Ramakrishnan. P., “Powder Metallurgy-Opportunities for Engineering Industries”, Oxford and IBH Publishing Co., Pvt. Ltd, New Delhi, 1987.
4. Sands. R. L. and Shakespeare. C. R. “Powder Metallurgy”, George Newes Ltd. London, 1966
5. Sinha A. K., “Powder Metallurgy”, Dhanpat Rai & Sons. New Delhi, 1982

PR23C07	HUMAN FACTORS AND WORK DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. To understand the concepts of the concept of productivity and its related terms like performance and efficiency.
2. Expose the concepts of method study.
3. Develop skills in work measurement using time study, work sampling, and predetermined time standards.
4. To understand the concepts of production management techniques.
5. To integrate ergonomic principles into workplace design and work processes.

UNIT I PRODUCTIVITY 9

Productivity concepts and definitions, Productivity related terms – Performance, Efficiency, Productivity measurement - Productivity measurement Models – Kendrick -Creamer Model-Carig-Harris Model- APC Model- Total Productivity Model-Techniques for productivity improvement -Work Study - Procedure for work-study - influence of working conditions on work-study.Approaches – (Kurosawa &Goshi structural approach, Alan Lawlor's approach, Gold's approach). Productivity measure – (PPM, TPM, TFP, MFP)

UNIT II METHODS STUDY 9

Methods Engineering- Procedure –Record, Examine & Develop - Flow and Handling of Materials -Tools for Recording the movement of Workers- Methods and Movements at the workplace – Define – Install -Maintain-Motion study - Micromotion Study- Therbligs - SIMO chart- Principles of Motion economy.Recordings- (Charts – outline, flow process, two handed, multiple activity) - (Diagrams – flow, string, cycle graph, chrono cycle graph), recording techniques – (OITDS)

UNIT III WORK MEASUREMENT 9

Purpose of work measurement – Techniques of work measurement- Time study, analytical estimation, historic data- Equipment - selecting and timing the job - performance rating – allowances – Standard time – setting time standard for work with machines - learning effect.Work sampling and Standard Time Determination- Group Timing Technique– Development of Standard data- Synthetic Data- predetermined time standards (PTS), types- use of time standard - Methods-Time Measurement (MTM) - Introduction to MOST technique - Wage incentive plans.

UNIT IV PRODUCTION MANAGEMENT TECHNIQUE 9

Production design – Utilization of Material-Quality Control -Sequential Quality Control, Taguchi approach, Total quality control – Layout handling and process planning – Production planning and control – Continuous production, Intermittent production -Inventory control techniques-Traditional approach, just in time, Maintenance-Work Study.

UNIT V ERGONOMICS 9

Ergonomics – Types, Industrial ergonomics, Musculoskeletal disorders, Anthropometry,Standardization and method of setting standards- Form design and control.One case study on physical, organizational and cognitive.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Analyse and evaluate productivity levels in organizations using appropriate models.
2. Conduct comprehensive methods study, including the recording and analysis of workflows and the application of motion economy principles to enhance efficiency.
3. Apply work measurement techniques to determine standard time and improve work processes
4. Apply production management techniques to achieve efficient utilization of resources and ensure smooth production flow.
5. Design ergonomically sound workplaces that promote worker health, safety, and comfort.

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	3	2										3	2	1
CO2	2	3	2										3	2	1
CO3	2	3	2										3	2	1
CO4		3	2						1	1			3	2	1
CO5	2	3	2										3	2	1
CO/PO & PSO Average	2	3	2						1	1			3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. ILO, “Introduction to Work Study”, Oxford and IBH publishing, 2008.
2. Barnes, R.M, “Motion and Time Study, Design and measurement of work”, John Wiley sons (Asia), Seventh edition, 2003.

REFERENCES

1. Benjamin W.Niebel, AndrisFreivalds, “Methods, standards and Work Design”, McGraw hill, Eleventh edition, 2002.
2. Maynard H.B, “Industrial Engineering Hand book”, McGraw-Hill, 2008.

PR23020	DESIGN OF PRESS TOOLS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. Familiar with the various press and press tool accessories
2. Learn about the different types of Die construction.
3. Learn about the construction and operation of the different bending, forming, drawing, combination dies and other miscellaneous press working operations and other related processes.
4. Understand the safety of press working, production of sheet metal products and the machinery and tools involved in the production of the sheet metal products.
5. Analyse the tools for Bending, Forming and Drawing operations.

UNIT – I FUNDAMENTALS OF PRESS TOOLS 9

Theory of cutting sheet metal - Analysis of cutting, clearance, cutting terminology, stages of cutting, penetration, burr. Effects of clearance variation – Secondary shear, large clearance, clearance selection, typical force curves. Other cutting characteristic – Dish distortion, spacing distortion, typical wear. Forces for cutting sheet metal – Cutting with square faces, cutting with shear, shear on punch, slug bending force, shear on die steel, stripping force. Stock and Stock layouts. Press working operations - Safety in press working. Press working mechanism - Presses according to their functions – Energy supply – Construction – Operation –Press actuating mechanisms. Parts of press, Press operating parameters – Special purpose presses .

UNIT – II PRESS, PRESS TOOL ACCESSORIES AND TYPES OF DIE CONSTRUCTION 9

Types of presses – Press accessories – Computation of press capacity – Strip layout – Material Utilization - Press Work Materials – Center of pressure- Design of various elements of dies– Die Block – Punch holder, Die set, guide plates – Stops – Strippers – Pilots – Selection of Standard parts. Mechanical handling devices - Feeding and reeling mechanisms for coiled sheet metal – Reels and cradles (decoiler), roll feeds and its types, hitch feeds. Feeding mechanism for individual parts – Hopper feeds, dial feeds, chutes, slides, magazine feeds, step feeds, special feeds. Ejection and transfer mechanisms. Types of die construction - Function and nomenclature of die components. Types of stock stop. Attachment and Miscellaneous components. Commercially available die components – Die sets, die set attachment devices, punches, die buttons, retainers, springs, fluid springs, die cushion and its types.

UNIT – III DESIGN OF PRESS TOOLS 9

Elements of press tool – Selection of Materials – Selection of Heat treatment process - Methods of manufacturing - Surface requirements– design and preparation of manufacturing drawing of a tool and its process planning for industrial components and effect on service life of tools - Blanking, piercing, compound, Combination and progressive dies. Bending of sheet metal operations. Knockouts – direct and indirect – pressure pads – Ejectors – Bending and forming operations. Design and development of bending, forming dies – Blank development for axisymmetric, rectangular and elliptic parts in bending.

Miscellaneous press working operations. Forming dies. Assembly dies - Riveting, tab stake, upset stake,crimping.

UNIT – IV FUNDAMENDALS OFDIEDESIGN AND OPERATIONS 9

Drawing, Bending operations, straightening, friction, compression, tension, stretch forming. Variables of drawing - Bending and straightening, friction, compression and stretch forming variables, analysis of draw speed. Dies – Types, Construction and working principle – Conventional draw die, redrawing die, reverse re drawing die, drawing of square or rectangular shapes. Single and double action dies. Design and development of drawing, reverse redrawing and combination dies – Drawing with flexible tooling – Marform process, Hydro form process, Hydro dynamic process, Verson- wheelon process. Draw die details – Blank holders blank holding pressure and its importance, air vents, drawing inserts, draw beads,ironing. Variables affecting Metal flow in drawing operations - Drawing defects, causes and remedies. Dies for secondary operations - Construction and working principle of Semi piercing dies, shear form dies, dies for formed contours, notching die, shaving die, side piercing die.

UNIT – V SPECIALISED PRESS TOOLS AND APPLICATIONS 9

Fine blanking basics - Definition and applications, Working principle- V Ring – Function and Dimensions. Comparison of fine blanking with blanking - calculations. Tool life Factors - punch and die radius, Materials - steel, copper and copper alloys, aluminum and aluminum alloys. Fine Blanking Machines - Working principle, Components and Forces. Fine blanking – Tools – tooling systems, compound die tooling with fixed punch. Clearance calculation. Specialized Press Tool Applications - Construction, advantage and applications of advanced multistage tooling, unit tooling, angular piercing tools, CNC turret press. Principle of Quick Die Change (QDC) - Single Minute Exchange of Dies (SMED) – need and advantages. Press tool - Tool Life, Tool performance, Tool failure and Trouble shooting.

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. Learn about the concepts of SMED and quick die changes and its advantages in bringing down the press set up time.
2. Learn to trouble shoot in various press tools.
3. Know the basic concepts, the construction, working principle and the advantages of various fine blanking dies and process
4. Familiar with the specialized press tool applications.
5. Design and Drafting of press tools for considering real time issues of 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. Donald F. Eary., Edward A. Reed, Techniques of Press working sheet metal, Prentice-Hall,Inc., Second Edition, 1974
2. Cyril Donaldson, H. LeCain George, V. C. Goold and Joyjeet Ghose, Tool Design, 2017, Tata McGraw Hill.D.Eugene ostergaard, Advanced die making, McGraw-Hill Book company
3. Eugene Ostergard, “Advanced Die Design”, National Tooling & Machining Assn, 1993, ISBN 13: 9780070460935
4. Joshi P.H “Press tools - Design and Construction”, S. Chand & Co Ltd. 2001.
5. Paquin J.R. & Crowley, “Die Design Fundamentals”, Industrial Press Inc. 3rdEd. 2006. ISBN: 9780831131197
6. PSG Design Data Handbook - Data Book of Engineers - by PSG College of Technology, Coimbtore - 2024.

REFERENCES

1. Dr.John G.Nee, Fundamentals of Tool Design, Society of Manufacturing Engineers, Fourth Edition, 1998.
2. ASTME Fundamentals of Tool Design Prentice Hall of India.
3. J.R.Paquin, Die design fundamentals, Industrial Press Inc, 1990.
4. D.Eugene ostergaard, Basic die making, McGraw-hill Book company,1990.
5. American Society of Metals – Hand book – Volume 4 (Forming), 8th Edition
6. K. Venkataraman, “Design of Jigs Fixtures & Press Tools”, Anne Publications, 2015.
7. Ivana Suchy, “Handbook of Die Design”, New York-Mc GRAW-HILL: 2nd Edition, 2006, ISBN:9780071462716
8. www.metalformingmagazine.com
9. www.sme.org

PR23021	MANUFACTURING OF BIOMEDICAL COMPONENTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. To understand the fundamental of material interaction with host and testing
2. To present overview of manufacturing metallic implants
3. To present overview of manufacturing polymeric implants
4. To present overview of manufacturing ceramic implants
5. To introduce the steps of fabrication of medical devices and regulatory

UNIT – I INTRODUCTION TO BIOMATERIALS 9

Biocompatibility – Classification- Material response: swelling and leaching, corrosion and dissolution, deformation and failure, friction and wear – host response: the inflammatory process – coagulation and hemolysis – in vitro and in vivo evaluation of biomaterials- Biological evaluation process - category of medical device- Sterilization Techniques

UNIT – II METALLIC IMPLANTS 9

Dental and Orthopaedic implants- fixative - Hot isotatic pressing (HIP)- forging- forming- additive manufactured- laser processing– total hip replacement- Stents - Surface Engineering- Ti alloys- degradable metals (Mg, Ta)- corrosion and prevention-

UNIT – III POLYMERIC IMPLANTS AND SCAFFOLDS 9

Orthopedics, Cardio Vascular, Respiratory Patches and Tubes, eye lens- drug delivery system- adhesives- sutures- fabrication- injection moulding- compression moulding- additive manufacturing (AM)- Porous products -Solvent casting /particulate leaching- Gas foaming- Cryogelation- Freeze drying - electrospinning- scaffold for regeneration- wound- nerve- Synthetic and Biopolymers types

UNIT – IV CERAMIC IMPLANTS AND SCAFFOLDS 9

Bone and dental fillers – implants - Bio ceramics -Silicate glass - apatite/wollastonite-Alumina (Al_2O_3) -Zirconia (ZrO_2)- Calcium phosphates (CaP)- porous scaffold- machinable ceramics - bulk metallic glass. Powder processing-–- plasma spraying- AM- Spark plasma sintering – HIP

UNIT – V BIOMEDICAL DEVICES AND REGULATORY PERSPECTIVES 9

Cardiovascular Prostheses: Heart Valves and Stents- Blood Vessels- Musculoskeletal Soft Tissues: Meniscus, Inter vertebral Disk- Implants for Plastic Surgery- cochlear implants; Single-use Devices, Clean room assembly, Packaging- Reusable devices- Medical Device regulations - US FDA, Existing regulation in India for medical devices.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. To comprehend the material -host interaction and types of testing
2. To explain the manufacturing process of typical metallic implants
3. To select appropriate manufacturing methods for typical polymeric implants
4. To explain the use of ceramics and its manufacturing for medical implant application.
5. To brief on the features of common medical devices and their regulatory.

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															
CO2															
CO3															
CO4															
CO5															
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Sujata V., Bhat., “Biomaterials”, Narosa Publication House, New Delhi, 2012
2. Temenoff , J S and Mikos , A G ,Biomaterials: The Intersection of Biology and Materials Science, Pearson, 2012

REFERENCES

1. Paul H. King, Richard C. Fries, Arthur T. Johnson, Design of Biomedical Devices and Systems, Third Edition,
2. Buddy D. Ratner, Allan S. Hoffman, Frederick Schoen, Jack E. Lemons, Biomaterials Science: An Introduction to Materials in Medicine, Elsevier Academic Press, Third Edition, 2012.
3. Larry L. Hench, An introduction to Bioceramics, ICP, Second Edition, 2013.
4. Peter J. Ogrodnik, Medical Device Design: Innovation from Concept to Market, Academic Press Inc; 1 edition (2012),
5. Stefanos Zenios , Josh Makower , Paul Yock , Todd J. Brinton , Uday N. Kumar , Lyn Denend , Thomas M. Krummel, Biodesign: The Process of Innovating Medical Technologies, Cambridge University Press; 1 edition (2009)
6. Andrés D. Lantada. Handbook on Advanced Design and Manufacturing Technologies for Biomedical Devices. Springer London 2013
7. ASM Handbook Volume 23, Materials for Medical Devices

PR23022	REPROCESSING OF MATERIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. Understand the importance of recycling for sustainability and the concept of the circular economy.
2. Explore the principles, policies, and regulations governing recycling at national and international levels, including extended producer responsibility and product stewardship.
3. Gain knowledge of waste management and collection systems, including waste generation analysis, collection methods, and waste separation techniques.
4. Study the various recycling technologies and processes, including mechanical recycling, chemical recycling, and thermal recycling, for materials such as plastics, glass, metals, electronics, and organic waste.
5. Examine specific recycling processes for different materials, including polymer identification and sorting, glass re-melting, metal sorting and melting, e-waste management, and organic waste conversion.

UNIT – I INTRODUCTION TO RECYCLING 9

Importance of recycling for sustainability, The concept of the circular economy, Challenges and opportunities in recycling, Recycling Principles and Policies - Overview of recycling principles and practices, National and international recycling policies and regulations, Extended producer, responsibility and product stewardship

UNIT – II WASTE MANAGEMENT AND COLLECTION SYSTEMS 9

Waste generation and composition analysis, Collection methods: curbside, drop-off centers, reverse vending machines, Waste separation and sorting techniques - Recycling Technologies and Processes, Mechanical recycling: shredding, sorting, and size reduction, Chemical recycling: depolymerization, solvolysis, liquefaction, Thermal recycling: pyrolysis, gasification, incineration

UNIT – III RECYCLING OF PLASTICS AND GLASS 9

Plastic recycling technologies: mechanical, chemical, and thermal, Polymer identification and sorting methods, Challenges and considerations in plastic recycling - Recycling of Glass, Glass recycling process and technologies, Color sorting and glass re-melting, Applications of recycled glass

UNIT – IV RECYCLING OF METALS, ELECTRONICS AND E-WASTE 9

Metal recycling techniques: sorting, shredding, and melting, Ferrous and non-ferrous metal recycling processes, Applications of recycled metals - Recycling of E-waste management and recycling challenges, Disassembly and component recovery, Precious metal recovery and hazardous waste treatment-battery system.

UNIT – V RECYCLING OF ORGANIC WASTES AND BIOMASS 9

Composting and anaerobic digestion for organic waste, Biomass conversion into biofuels and bio-products, Applications of recycled organic materials - Recycling of Construction and Demolition

Waste, waste recycling methods, Concrete and asphalt recycling, Utilization of recycled construction materials

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Demonstrate a comprehensive understanding of recycling principles, the circular economy, and their significance for sustainable resource management.
2. Evaluate and analyze recycling policies, regulations, and initiatives at different levels, and assess their effectiveness in promoting recycling practices.
3. Identify and implement appropriate waste management and collection systems, considering waste generation, separation, and sorting techniques.
4. Apply knowledge of recycling technologies and processes to different materials, such as plastics, glass, metals, electronics, and organic waste, and evaluate their environmental and economic impacts.
5. Develop strategies and solutions for recycling challenges, including polymer identification, e-waste management, and organic waste conversion, and propose innovative approaches to maximize resource recovery and minimize environmental impact.

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	1
CO2	2	-	-	1	-	1	2	-	-	1	-	1	1	1	1
CO3	2	1	-	1	-	1	2	-	-	1	-	1	1	1	2
CO4	2	1	-	1	-	1	2	-	-	1	-	1	1	1	2
CO5	2	-	-	1	-	1	-	-	-	1	-	1	1	1	2
CO/PO & PSO Average	2.0	1.0	-	1.0	-	1.2	2.0	-	-	1.0	-	1.2	1.0	1.0	1.6
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. VannessaGoodship, "Recycling of Plastics: A Practical Guide", Smithers Rapra, 2007
2. Abhilash, Hossain Md Anawar, Vladimir Strezo, “Sustainable and Economic Waste Management: Resource Recovery Techniques”, CRC Press, 2022.

REFERENCES:

1. Ernst Worrell, Markus A. Reuter, “Handbook of Recycling: State-of-the-art for Practitioners, Analysts, and Scientists”, Elsevier Science, 2016.
2. Trevor Letcher, "Plastic Waste and Recycling: Environmental Impact, Societal Issues, Prevention, and Solutions", Elsevier Science, 2020
3. Ab Stevels, Jaco Huisman, VannessaGoodship, “Waste Electrical and Electronic Equipment (WEEE) Handbook”, Elsevier Science, 2nd Edition, 2019.
4. Stessel, Richard I., “Recycling and Resource Recovery Engineering: Principles of Waste Processing”, Springer, 2012.
5. Mukesh C. Limbachiya, Ravindra K. Dhir, Thomas D. Dyer, “Recycling and Reuse of Glass Cullet”, Thomas Telford, 2001.

6. Ginny Black, Jane Gilbert, Jean Bonhotal, Johannes Biala, Leslie Cooperband, Mary Schwarz, Robert Rynk, “The Composting Handbook: A How-to and why Manual for Farm, Municipal, Institutional and Commercial Composters”, Elsevier Science, 2022.

PR23023	HEAT AND MASS TRANSFER	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. Understanding the steady and transient heat conduction.
2. Comprehending the principles of convective heat transfer.
3. Outlining the facets of heat transfer for designing a heat exchanger
4. Inferring the fundamental concepts of radiation heat transfer.
5. Analyzing the relation between heat and mass transfer

UNIT I CONDUCTION 9

General Differential equation – Cartesian, Cylindrical and Spherical Coordinates – One Dimensional Steady State Heat Conduction —- plane and Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Semi Infinite and Infinite Solids –Use of Heisler's charts.

UNIT II CONVECTION 9

Conservation Equations, Boundary Layer Concept – Forced Convection: External Flow – Flow over Plates, Cylinders Spheres and Bank of tubes. Internal Flow – Entrance effects. Free Convection – Flow over Vertical Plate, Horizontal Plate, Inclined Plate, Cylinders and Spheres.

UNIT III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS 9

Nusselt's theory of condensation- Regimes of Pool boiling and Flow boiling, correlations in boiling and condensation. Heat Exchanger Types - Overall Heat Transfer Coefficient – Fouling Factors. LMTD and NTU methods. Introduction to TEMA Standards.

UNIT IV RADIATION 9

Radiation laws, Black Body and Gray body Radiation. Shape Factor. Electrical Analogy. Radiation Shields.

UNIT V MASS TRANSFER 9

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion. Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Summarize the mechanism of heat conduction under steady and transient conditions.
2. Elucidate the principles of convective heat transfer.
3. Design a heat exchanger for any specific application
4. Adopt the concept of radiation heat transfer in real time systems
5. Develop solutions to problems involving combined heat and mass transfer

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	3	3	2	2	2	-	-	-	-	-	-	1	1	-	1
CO2	3	3	2	2		-	-	-	-	-	-	1	1	1	1
CO3	3	3	2	2	2	-	-	-	-	-	-	1	-	1	1
CO4	3	3	2	2		-	-	-	-	-	-	1	-	1	1
CO5	3	3	1	1		-	-	-	-	-	-	1	-	1	1
CO/PO & PSO Average	**3**	**3**	**2**	**2**		**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**1**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. R.C. Sachdeva, “Fundamentals of Engineering Heat & Mass transfer”, New Age International Publishers, 2009.
2. Yunus A. Cengel, “Heat Transfer A Practical Approach” – Tata McGraw Hill, 5 thEdition – 2013.

REFERENCES

1. Frank P. Incropera and David P. Dewitt, “Fundamentals of Heat and Mass Transfer”, John
2. Wiley & Sons, 7th Edition, 2014.
3. Holman, J.P., “Heat and Mass Transfer”, Tata McGraw Hill, 2010
4. Kothandaraman, C.P., “Fundamentals of Heat and Mass Transfer”, New Age International,New Delhi, 2012
5. Ozisik, M.N., “Heat Transfer”, McGraw Hill Book Co., 1994.
6. S.P. Venkateshan, “Heat Transfer”, Ane Books, New Delhi, 2014

PR23024	ADVANCED CASTING AND JOINING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

- To understand the fundamental principles of solidification, casting, and welding processes.
- To learn about the various materials and equipment used in solidification, casting, and welding.
- To familiarize students with the design considerations and techniques for weldments and castings.
- To explore advanced casting techniques and their applications in industry.
- To develop skills in analyzing and solving problems related to solidification, casting, and welding processes.

UNIT – I SOLIDIFICATION AND GATING 9

Solidification principles – constitutional supercooling – Freezing of a pure metal – Freezing of alloys – Properties related to freezing mechanism - Directional solidification – progressive solidification - design principles, design of gating and riser - illustrative problems in riser and gating design-Characteristic of core and core sands-Types of cores- Advances in moulding. Solidification structure- Heat transfer, development of matrix structure, segregation

UNIT – II CASTING OF FERROUS AND NON-FERROUS ALLOYS 9

Melting equipment for foundries – Types of furnaces – Refractories for melting units - Casting of Aluminium, Magnesium, Copper and their alloys–Casting of steel, cast iron and greyiron. Zinc castings.

UNIT – III ADVANCES IN CASTING 9

Rheocasting - Thixo casting-thixo moulding - magnetic moulding - Impulse moulding- high pressure moulding– Stir casting - Squeeze casting – Application of ultrasonic cavitations to develop composites - mechanization and automation of foundries – Application of computers in foundries - product design and analysis- casting design and simulation – software packages for foundry use - pollution control in foundries – energy saving in foundries.

UNIT – IV SPECIAL WELDING PROCESSES 9

Submerged arc welding – Flux Cored Arc Welding – Electro slag welding – Explosive welding – Underwater welding – Diffusion bonding – EBW – LBW – PAW – Friction welding - Friction stir welding - Cold metal transfer welding, Ultrasonic welding, Atomic Hydrogen welding

UNIT –V WELDING METALLURGY 9

Heat flow -cooling temperature distribution rates - influence of heat input, joint geometry, plate thickness, preheat, significance of thermal severity number, Epitaxial growth – weld metal solidification - columnar structures and growth morphology effect of welding parameters - absorption of gases - gas/metal and slag/metal reactions, Phase transformations- weld CCT diagrams - carbon equivalent - preheating and post heating weldability of low alloy steels, welding

of stainless steels use of Schaffer and Delong diagrams, welding of cast irons-advances in welding and welding defects.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Explain solidification and gating principles in casting processes, including different solidification patterns and the freezing of metals and alloys
2. Acquire knowledge of casting techniques for various ferrous and non-ferrous alloys and learn about the equipment and materials used in the casting process.
3. Explore advanced casting methods and application of computer-aided design, simulation, and automation in foundries
4. Discuss metallurgical aspects of welding and the effects of welding parameters on weldability.
5. Design weldments and castings based on design considerations.

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	3	1	1	1	-	1	1	-	-	1	-	1	2	-	1
CO2	2	-	-	-	-	-	1	-	-	1	-	1	2	-	2
CO3	2	-	-	-	1	-	1	-	-	1	-	1	2	-	2
CO4	2	-	-	-	-	-	1	-	-	1	-	1	2	-	2
CO5	3	1	1	1	-	1	-	-	-	1	-	1	2	-	1
CO/PO & PSO Average	2.4	1.0	1.0	1.0	1.0	1.0	1.0	-	-	1.0	-	1.0	2.0	-	1.6
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Jain P.L., “Principles of Foundry Technology”, Tata McGraw Hill, 5th Edition, 2009.
2. Parmer R.S, “Welding Engineering and Technology”, Khanna Publishers, 2nd Edition, 2010.

REFERENCES

1. Howard B. Cary, “Modern Welding Technology”, Prentice Hall, 2011.
2. Richard W. Heine, Carl R. Loper Jr., Philip C. Rosenthal, “Principles of metal casting”, Tata McGraw Hill, 2nd Edition, 2002.
3. Richard Little, “Welding Technology”, Tata McGraw Hill Education, 2017.
4. Howard F. Taylor, Merton C. Flemings, John Wulff, “Foundry Engineering”, M.C. and Wiley Eastern Ltd., 2003.
5. Ramana Rao T. V., “Metal Casting – Principles and Practice”, New Age International Publishers, 2003.

PR23025	SURFACE COATING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. To understand the importance and necessity of surface engineering for improving surface properties and preventing surface degradation.
2. To explore different types of surface coatings and their applications in addressing surface-related engineering failures.
3. To study the principles, methods, and formulation of chemical conversion coatings, organic coatings, metallic coatings, and metallic deposition techniques.
4. To examine the principles and applications of surface modification techniques such as physical vapor deposition, chemical vapor deposition, and surface modification by directed energy beams.
5. To learn about the testing and evaluation methods used to assess the adhesion, corrosion resistance, and wear resistance of coatings.

UNIT – I NEED FOR SURFACE COATING 9

Surface dependent engineering properties, wear, friction, corrosion, fatigue, reflectivity, emissivity, etc.; common surface initiated engineering failures; mechanism of surface degradation;-surface preparation - importance and necessity of surface engineering – anti-reflectivity - Thermal Barrier Coatings, Hydrophobic – Transparent Conducting Coatings-need for coating.

UNIT – II CHEMICAL CONVERSION AND ORGANIC COATINGS 9

surface preparation - Chemical Conversion coatings - Types - phosphate, chromate, chemical oxide and anodized (Aluminum) coatings – Organic coatings-polymer coating-epoxy coating-powder coating- paint, vehicle or drying oil, thinners, driers - Formulation of paints, failure of paint film - Varnishes, Enamels, Lacquers, EPI coating, Emulsion Paints - types, advantages and disadvantages – Special paint - sol gel coating.

UNIT – III METALLIC COATINGS 9

surface preparation - Methods of metallic coating, hot dipping – galvanizing, tinning, metal cladding, electroplating, electroless plating. Various other metallic coatings – displacement plating- Kanigen process – metal spraying or metallised coating – cementation or diffusion coatings.

UNIT – IV METALLIC DEPOSITION AND SURFACE MODIFICATION 9

Principles and applications: Physical vapour deposition; Chemical vapour deposition; plasma spray coating; plasma assisted ion implantation; surface modification by directed energy beams like ion, electron and laser beams; energy transfer, beam configuration and modes-Electrophoretic deposition - Micro Oxidation - Arc spray, plasma spray, Flame spray, HVOF.

UNIT – V TESTING AND EVALUATION OF COATING 9

Interfacial adhesion of films – adhesion, interfacial delamination, adhesion measurement techniques, nanoindentation for assessing interfacial toughness of film/substrate system.

Mechanics of interface fracture. Coating adhesion evaluation methods - Typical corrosion testing and tests for assessment of wear.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Discuss the importance of surface engineering and how surface coatings enhance properties like wear, friction, corrosion, and fatigue.
2. Identify and explain different types of chemical conversion coatings, organic coatings, and their formulation.
3. Analyze various methods of metallic coating and evaluate their suitability for different applications.
4. Describe the principles and applications of various metallic deposition and surface modification techniques.
5. Explain testing and evaluation methods to assess coating performance, including interfacial adhesion measurement, corrosion testing, and wear assessment.

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	-	1	1	-	1
CO2	2	-	-	1	-	-	1	-	-	1	-	1	1	-	2
CO3	2	2	-	1	-	-	1	-	-	1	-	1	1	-	2
CO4	2	-	-	1	-	-	1	-	-	1	-	1	2	-	2
CO5	2	1	-	-	-	-	1	1	-	1	-	1	1	-	2
CO/PO & PSO Average	2.0	1.5	-	1.0	-	-	1.0	1.0	-	1.0	-	1.0	1.2	-	1.8
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Peter Dearnley, “Introduction to surface engineering”, Cambridge University Press, 2017.
2. Goutam Kumar Bose, Supriyo Roy, “Advanced Surface Coating Techniques for Modern Industrial Applications”, IGI Global, 2020.

REFERENCES

1. J. Paulo Davim, “Materials and Surface Engineering, Research and Development”, Woodhead Publishing, Oxford, 2016
2. Joseph R. Davis, “Surface Engineering For Corrosion And Wear Resistance”, ASM International, Materials Park, OH, 2010.
3. Parthasarathy. N.V., “Electroplating Handbooks”, Prentice Hall, 1992
4. “Metals HandBook” Vol.2 8th Edition, American Society of Metals 1994.
5. Gabe. D.R., “Principles of Metal surface treatment and protection”, Pergamon, 1990
6. Niku-Lavi, “Advances in surface treatments”, Pergamon, 1990.
7. Stand Grainger and J. Blunt, “Engineering coatings – design and application”, William Andrew Publishing, 1998.

PR23026	ADVANCED OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. Understand the principles of operations research and its application in optimization problems.
2. Learn the formulation and solution methods of linear programming problems, including the simplex algorithm and revised simplex method.
3. Explore the concepts of degeneracy and sensitivity analysis in linear programming.
4. Understand non-linear programming techniques, such as the Lagrangian method and Kuhn-Tucker conditions.
5. Study quadratic programming, separable programming, and stochastic programming.

UNIT – I LINEAR PROGRAMMING 9

Review of the principles of operations research; Linear programming: Formulation of linear programming problems, simplex algorithm, degeneracy, revised simplex method, duality; dual simplex method – primal dual method; sensitivity analysis.

UNIT – II NON LINEAR PROGRAMMING 9

Introduction – Lagrangian Method – Kuhn-Tucker conditions – Quadratic programming – Separable programming – Stochastic programming

UNIT – II INTEGER AND DYNAMIC PROGRAMMING 9

Integer Programming- Cutting plane algorithm – Branch and bound technique - Zero-one implicit enumeration; Geometric Programming- Dynamic Programming.

UNIT – IV NETWORK TECHNIQUES 9

Shortest path model- Minimum spanning tree- Maximal Flow problem-Project scheduling with constrained resources-Graphical evaluation and Review technique (GERT)-Project Management softwares

UNIT – V ADVANCEDOPTIMIZATION TECHNIQUES 9

Genetic algorithms, simulated annealing, particle swarm optimization, ant colony optimization, neural networks – algorithms and applications, case studies in industrial engineering using genetic algorithms and simulated annealing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Formulate linear programming problems and apply the simplex algorithm to find optimal solutions.
2. Identify and resolve issues related to degeneracy in linear programming models.
3. Conduct sensitivity analysis to evaluate the impact of changes in parameters on the optimal solution.

4. Apply non-linear programming techniques, including the Lagrangian method and Kuhn-Tucker conditions, to solve optimization problems.
5. Solve quadratic programming and separable programming problems using appropriate methods.

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	-	-	-	-	-	1	1	1	2	2	2
CO2	2	2	-	1	-	-	-	-	-	1	1	1	2	2	2
CO3	2	2	-	1	-	-	-	-	-	1	1	1	2	2	2
CO4	2	2	-	1	-	-	-	-	-	1	2	1	2	2	2
CO5	2	1	-	1	2	-	-	-	-	1	-	1	2	2	2
CO/PO & PSO Average	2.0	1.8	-	1.0	2.0	-	-	-	-	1.0	1.3	1.0	2.0	2.0	2.0
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Price, Camille C.., Rabadi, Ghaith., Carter, Michael, “Operations Research: A Practical Introduction”, CRC Press, 2023.
2. Sharma, S. D.., Sharma, Himanshu, “Operations Research: Theory, Methods and Applications”, Kedar Nath Ram Nath, 6th Edition, 2010.

REFERENCES

1. Poler, Raúl., Mula, Josefa., Díaz-Madroñero, Manuel, “Operations Research Problems: Statements and Solutions”, Springer, 2014.
2. Ravindran, Philips and Solberg, “Operations Research Principles and Practice”, John Wileyand Sons, 1992.
3. Sharma.J.K., “Operations Research Theory and Applications”, Macmillan India Ltd., 6th Edition 2017.
4. Hamdy A. Taha, “Operations Research – An Introduction”, Prentice Hall of India, 2022.
5. Srinivasan G, “Operation Research”, PHI, 3rdEdition, 2017.

PR23027	INDUSTRIAL TRIBOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. To introduce to need for tribology, role and nature of surfaces and contacts
2. To understand the sources and nature of friction and its measurement
3. To expose the various type of wear, their mechanisms and measurement
4. To apply knowledge on fluid mechanics to lubrications in hydrodynamic and hydrostatic bearings and introduce to design aspects of bearing.
5. To introduce the factors considered in design of bearing, gears and effect the size in tribology .

Unit I INTRODUCTION AND ENGINEERING SURFACES 9

History of tribology, Interdisciplinary Approach, Economic Benefits, Topography of Engineering surfaces- Contact between surfaces- Hertzian Contact–Chemical and physical state of surface- metals, metal oxides, polymers, ceramics- Stick slip motion- slip lines

Unit II FRICTION 9

Causes of Friction, Adhesion Theory, Abrasive Theory, Junction Growth Theory, Laws of Rolling Friction, Friction Instability, Measuring Friction - Friction tester under constant normal load Geometrically constrained system- and Nanoscale Friction – AFM- Aspects of frictional heating

UNIT – III WEAR, MECHANISM AND SURFACE FAILURES 9

Wear Mechanisms, Adhesive Wear, Abrasive Wear, Corrosive Wear, Hot corrosion, Fretting Wear, Galling wear - Erosive wear- Tool-wear mechanism- Wear Analysis- Wear Measurements

UNIT – IV LUBRICATION AND LUBRICANTS 9

Importance of Lubrication, Boundary Lubrication, Mixed Lubrication, Full Fluid Film Lubrication, Hydrodynamic, Elasto hydrodynamic lubrication, Types and Properties of Lubricants, Lubricants Additives- Fluid mechanics concepts -. Equation of Continuity and Motion, Generalised Reynolds Equation with Compressible and Incompressible Lubricants. Friction forces and power loss in a lightly loaded journal bearing, Petroff's equation, mechanism of pressure development in an oil film, and Reynold's equation - Sommerfeld's number and its significance in 2D.

UNIT – V APPLICATION OF TRIBOLOGY 9

Introduction, Rolling Contact Bearings, Gears, Journal Bearings, Finite Bearings-Design of Low friction surface- undulated surfaces- Introduction to design of seals- Nanotribology – head–disk interaction (HDI)- Biotribology- bioimplants

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Write on issues in the field of tribology, characteristics of surfaces and contacts
2. Recognize and describe the origins of friction
3. Review the wear mechanisms and surface failures

4. Describe the lubrications hydrodynamic and hydrostatic bearings and design factors.
5. Identify salient features for design consideration of bearing, gears and appreciate the sizeeffects in tribology

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	2	-	-	1	1	-	1	-	1	-	1	1	1	1
CO2	2	2	-	-	-	-	-	-	-	1	-	1	2	1	2
CO3	2	2	-	-	-	-	-	-	-	1	-	1	2	2	2
CO4	2	2	1	-	-	-	1	-	-	1	-	1	2	2	2
CO5	2	1	1	-	1	-	-	-	-	1	-	1	2	1	2
CO/PO & PSO Average	1.8	1.8	1.0	-	1.0	1.0	1.0	1.0	-	1.0	-	1.0	2.0	1.4	2.0
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Kenneth C Ludema, Layo Ajayi, Friction, Wear, Lubrication: A textbook in Tribology, CRC Press, 2nd Edition, 2019
2. Prasanta Sahoo, “Engineering Tribology”, PHI Learning Private Ltd, New Delhi, 2011.

REFERENCES

1. J. A. Williams, “Engineering Tribology”, Oxford Univ. Press, 2005.
2. Stachowiak G N, Batchelor A W and Stachowick G B, "Experimental methods in Tribology", Tribology Series 44, Editor D Dowson, 2004.
3. Michael M Khonsari, “Applied Tribology (Bearing Design and Lubrication)”,John Wiley & Sons, 2001.
4. J Halling, “Principles of Tribology”, The Macmillan Press Ltd, London, 1975.
5. Stachowiak G W & Batchelor A W, “Engineering Tribology”, 3rdEdition, Elsevier Inc., 2005.
6. Peterson M B and Winer W O, “Wear control handbook”, ASME, 413-473, 1980.

PR23028	ROBOTICS ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. To study the constructional and fundamental features of robots
2. To study the basic robot kinematics and their degrees of freedom
3. To familiarize students with the concepts and techniques of robot manipulator and end effectors.
4. To familiarize students with the various sensors used in robotics.
5. To study programming and machine vision applications in robots.

UNIT – I FUNDAMENTALS OF ROBOT 9

Robot – Definition – Robot Anatomy – Coordinate systems, Work Envelope, types and classification – specifications – Pitch, yaw, Roll, Joint Notations, Speed of Motion, PayLoad – Robot Parts and their functions – Need for Robots

UNIT – II ROBOT KINEMATICS 9

Forward kinematics, inverse kinematics and the difference: forward kinematics and inverse Kinematics of Manipulators with two, three degrees of freedom (in 2 dimensional), four degrees of freedom (in 3 dimensional) – derivations and problems. Homogeneous transformation matrices, translation and rotation matrices Dennavit and Hartenberg transformation.

UNIT – III ROBOT DRIVE SYSTEMS AND END EFFECTORS 9

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of All These Drives. 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 of a gripper – gripper force calculation and analysis.

UNIT – IV SENSORS IN ROBOTICS 9

Force sensors, touch and tactile sensors, proximity sensors, non-contact sensors, safety considerations in robotic cells, proximity sensors, fail safe hazard sensor systems, and compliance mechanisms. Machine vision system - camera, frame grabber, sensing and digitizing image data – signal conversion, image storage, lighting techniques, image processing and analysis – data reduction, segmentation, feature extraction, object recognition, other algorithms, applications – Inspection, identification, visual serving and navigation.

UNIT – V PROGRAMMING AND ITS ADVANCES IN ROBOTICS 9

Programming, lead through programming, robot programming languages – VAL programming – Motion Commands, Sensors commands, End-Effector Commands, and

simple programs - Role of robots in inspection, assembly, material handling, underwater, space and medical fields – simulation for case studies .

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Describe the principles, features and specifications of robot and its kinematics and accessories.
2. Summarize the configurational and peripheral features of robot.
3. Solve robot kinematics to plan and control movements.
4. Suggest mechanical linkages,joints, sensors and actuators to configure robot.
5. Develop robot programming and application of robot for different scenarios.

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	-	1	1	-	1
CO2	2	2	1	2	1	-	-	-	-	1	-	1	1	-	2
CO3	2	1	1	1	-	-	-	-	-	1	-	1	1	-	1
CO4	2	1	1	2	1	-	-	-	-	1	-	1	1	-	1
CO5	2	-	1	1	1	-	-	-	-	1	-	1	1	-	2
CO/PO & PSO Average	2.0	1.3	1.0	1.5	1.0	-	-	-	-	1.0	-	1.0	1.0	-	1.4
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. John. J.Craig, “Introduction to Robotics: Mechanics and Control”, 2nd Edition, 2002.
2. Mikell.P.Groover, “Industrial Robotics: Technology, Programming, and Application”, McGraw-Hill, 2012.

REFERENCES

1. Fu K.S. Gonzalez R.C., “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill, 2007.
2. J. Srinivas, Dukkipati R.V, Ramji.K, “Robotics Control and Programming”, Narosa, 2009
3. S K Saha, Introduction to Robotics,McGraw Hill Education,2014.
4. Ed Sobey, “Robotics Engineering”, Capstone, 2017.
5. Janakiraman P.A., “Robotics and Image Processing”, Tata McGraw Hill, 2005.
6. Jazar, “Theory of Applied Robotics: Kinematics, Dynamics and Control”, Springer India reprint, 2010.

PR23029	PRODUCT DESIGN AND DEVOLPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. Relate product development integrated with value engineering.
2. Summarize the development of new products through conceptualization, design and development phases.
3. Relate various aspects of product development with industrial design and manufacturing.
4. Describe the value of a product using tools and techniques.
5. Design products which are suitable for the needs of the society.

UNIT – I IDENTIFYING CUSTOMER NEEDS AND PRODUCT SPECIFICATIONS **9**

Product Development process – Product development organizations. Gather raw data – Interpret raw data organize the needs into a hierarchy – Relative importance of the needs. Specifications – Refining specifications.

UNIT – II CONCEPT GENERATION, SELECTION AND PRODUCT ARCHITECTURE **9**

Clarify the problem – Search internally – Search externally – Explore systematically. Concept Screening –Concept scoring. Product architecture – Implication of architecture –Establishing the architecture – Related system level design issues.

UNIT – III INDUSTRIAL DESIGN, PROTOTYPING AND ECONOMICS OF PRODUCT DEVELOPMENT **9**

Need for industrial design – Impact of industrial design – Industrial design process – Management of industrial design process – Assessing the quality of industrial design.

UNIT – IV RAPID PROTOTYPING **9**

Development of RP systems, RP process chain, Impact of Rapid Prototyping and Tooling on Product Development, Benefits, Digital prototyping, Virtual Prototyping, Applications, Relationship between reverse engineering and rapid prototyping, Case studies with implementation.

UNIT – V DESIGN FOR ADDITIVE MANUFACTURING **9**

Overview – Need - Development of Additive Manufacturing (AM) Technology: Classification – Benefits. Concepts and Objectives- AM Unique Capabilities: Part Consolidation-Topology Optimization Light weight Structure - DFAM for Part Quality Improvement. Data Processing - CAD Model Preparation -Part Orientation and Support Structure Generation -Model Slicing - Tool Path Generation-Customized Design and Fabrication for Medical Applications- Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Define and explain the basic concept of product development.
2. Design and develop new products in a systematic manner considering the concept of value engineering.
3. Identify customer requirements and product specification based on raw data.
4. Clarify the problem and establish concepts with product architecture.
5. Recognize the importance of design in product development.

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	1
CO2	2	1	-	2	-	-	-	-	-	1	-	2	2	1	2
CO3	2	-	-	2	-	-	-	-	-	1	-	2	2	1	2
CO4	2	-	1	2	-	-	-	-	-	1	-	2	2	1	2
CO5	2	-	1	2	1	1	-	-	-	1	-	2	2	1	2
CO/PO & PSO Average	2.0	1.0	1.0	2.0	1.0	1.0	-	-	-	1.0	-	1.8	2.0	1.0	1.8
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Ulrich, Karl, and Eppinger, Steven., “Product Design and Development”, McGraw-Hill Education, 7th Edition, 2020.
2. Parker, Donald., Mandelbaum, Jay., Williams, Heather., Hermes, Anthony., “Value Engineering Synergies with Lean Six Sigma”, Taylor & Francis, 2017.

REFERENCES:

1. Charles Gevirtz, “Developing New products with TQM”, McGraw Hill, International Editions, 1994.
2. Rosenthal S, “Effective Product Design and Development”, Irwin, 1992.
3. Jamnia, A., “Introduction to Product Design and Development for Engineers”, CRC Press, 2018.
4. Belz A., “Product Development: 36 Hour Course”, McGraw-Hill, 2010.
5. Chitale, A. K. and Gupta, R. C., “Product Design and Manufacturing”, PHI Learning, 2013

PR23030	INTELLIGENT MANUFACTURING SYSTEMS	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 principles and key concepts of Petri Nets and their application in modeling and analyzing systems, particularly in manufacturing.
2. Examine the components and knowledge representation schemes used in Knowledge Based Systems and their role in decision-making processes.
3. Explore machine learning concepts, including artificial neural networks and their applications in manufacturing systems.
4. Gain knowledge of agent and multi-agent systems, their classification, communication protocols, and their use in manufacturing scenarios.
5. Study the fundamental concepts of blockchain technology, including trust, cryptography, and its applications in manufacturing systems.

UNIT – I PETRI NETS **9**

Key concepts and definitions, principles of net theory, Place/Transition Systems and Elementary Net (EN) Systems. Token game, reachability, state graph, behavioural properties like deadlock and boundedness, behavioural equivalence and normal forms. Elementary Net Systems: Causality, conflict, concurrency, and confusion. Examples of Petri net models. Examples in manufacturing Systems

UNIT – II COMPONENTS OF KNOWLEDGE BASED SYSTEMS **9**

Basic Components of Knowledge Based Systems, Knowledge Representation, Comparison of Knowledge Representation Schemes, Interference Engine, Knowledge Acquisition, Clustering. Examples in manufacturing Systems Cloud Manufacturing and Networking with TCP/IP: Introduction to cloud computing: cloud models, cloud service examples, cloud based services & applications. Introducing TCP/IP, IP Addressing and Related Topics, Data Link and Network Layer TCP/IP Protocols, Internet Control Message Protocol (ICMP), Transport Layer TCP/IP Protocols, Basic TCP/IP Services. Expert Systems

UNIT – III MACHINE LEARNING **9**

Machine Learning – Concept, Artificial Neural Networks, Biological and Artificial Neuron, Deep Nets, Applications in manufacturing; Use of probability and fuzzy logic for machine thinking, Examples in manufacturing Systems.

UNIT – IV AGENT AND MULTI-AGENT SYSTEMS **9**

Agents, agent definitions and classification, multi-agent systems, Models of agency, architectures and languages, Agent communication and interaction protocols. Examples in manufacturing Systems

UNIT – V BLOCKCHAIN TECHNOLOGY 9

Basic Concepts, Trust – The need for trust, Forms of trust, The problem space for block chain. Cryptography – Information security as a form of trust, Public and Private keys, Digital signatures, Hashing. Examples in manufacturing Systems

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Apply Petri Nets to model and analyze systems, and evaluate their behavioural properties such as deadlock, boundedness, and equivalence.
2. Design and develop knowledge-based systems by utilizing appropriate knowledge representation schemes and inference engines.
3. Apply machine learning techniques, including artificial neural networks, for pattern recognition and decision-making in manufacturing systems.
4. Design and implement agent-based systems, considering agent classification, communication protocols, and coordination in manufacturing scenarios.
5. Analyze and assess the potential applications of blockchain technology in manufacturing systems, considering trust, security, and data integrity.

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	1	-	-	1	-	1	-	1	1	-	1
CO2	2	1	1	1	-	-	-	-	-	1	-	1	1	-	1
CO3	2	2	2	-	1	1	-	-	1	-	1	-	1	-	2
CO4	2	-	1	1	1	-	-	1	-	1	-	1	1	-	1
CO5	2	-	-	1	-	-	-	1	-	1	-	1	1	-	-
CO/PO & PSO Average	2.0	1.7	1.3	1.0	1.0	1.0	-	1.0	1.0	1.0	1.0	1.0	1.0	-	1.2
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Pankaj C. Jena, D. R. K. Parhi, B. B. V. L. Deepak, “Innovative Product Design and Intelligent Manufacturing Systems”, Springer, 2021.
2. G.N. Carlson, Henry E. Kyburg Jr., R.P. Loui, “Knowledge Representation and Defeasible Reasoning”, Springer, 2012.

REFERENCES

1. Christopher M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.
2. Leyton-Brown, Kevin, and Shoham, Yoav., “Essentials of Game Theory: A Concise Multidisciplinary Introduction”, Springer, 2022.
3. Daniel Drescher, “Blockchain Basics: A Non-Technical Introduction in 25 Steps”, A Press, 2017.
4. Chao'an Lai, “Intelligent Manufacturing”, Springer Nature, 2022
5. Andrew Kusiak, “Intelligent Manufacturing Systems”, Prentice-Hall International, 1990

PR23031	PROCESSING OF SEMICONDUCTOR MATERIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. To introduce single crystal silicon manufacturing, silicon doping and compounds of silicon.
2. To impart knowledge on manufacturing process of Complementary Metal–Oxide–Semiconductor.
3. To familiarize the technology and challenges in assembly and packaging
4. To introduce tools and testing of microelectronics.
5. To introduce GaAs, bipolar transistors and micro electromechanical systems

UNIT – I INTRODUCTION TO SILICON AND ITS MANUFACTURING 9

Single crystal manufacturing-silicon ingot growth –directional solidification – Guttering-slicing – planarization- chemico mechanical polishing- Silicon -doping. Conductivity, charge densities, EK relation, Fermi level, continuity equation, Hall Effect and its applications. diffusion – ion implantation – thermal oxidation – polysilicon coating – precursors for chemical vapour deposition of silicon components – epitaxial coating- Properties of silicon and its compounds

UNIT – II COMPLEMENTARY METAL–OXIDE– SEMICONDUCTOR 9

Photolithography – Sources: optical- UV- X-ray photoresist –mask materials – coating – pattern transfer –etching – Back-end Technology – wet – dry – metallization – physical vapour deposition –– plasma science and types of generation – RF Magnetron – electron beam – laser beamAtomic Layer Deposition (ALD)of high-k dielectrics – Fabrication of metal oxide semiconductor field effect transistor (MOSFET) – illustration.

UNIT – III ASSEMBLY AND PACKAGING 9

Clean room, vacuum technology, short range force interaction, challenges in 2D/3D structures, bonding – silicon – silicon, silicon- silicon di-oxide, silicon – phosphate silicate glass – Device isolation – contacts- passive components – process integration – flux reactions and chemistry – solder paste composition, manufacturing, rheology – Wave soldering – applications and solder system variables - wire bonding – sealing – levels of packaging – role of fabrication in performance of electronic/electrical/ electromechanical functions – Through Hole Technology (THT) – TAB, Flip Chip, Chip on Board, Multi-chip Module, Direct Chip Array Module – Leaded, Leadless, Area Array and Embedded Packaging – Chip Shooter, IC Placer, Flexibility, Accuracy – Throughput, reflow soldering, adhesive, underfill and encapsulation process.

UNIT – IV INSTRUMENTS, TOOLS, INSPECTION AND TESTING 9

Handling of Components and Assemblies – Moisture Sensitivity and ESD, Safety and Precautions Needed, IPC and other standards - Microgripper/ manipulators – stage/ platform – tools – vision system – electrical testing - Parasitic components – Future trends and Challenges: Challenges for integration, system on chip – Testing of assemblies, In-circuit testing (ICT) – Functional Testing – Defects Corrective Action.

UNIT – V GaAs TECHNOLOGIES, SILICON BIPOLAR TECHNOLOGIES ANDMICROELECTROMECHANICAL SYSTEMS **9**

Metal–semiconductor field-effect transistor (MESFET) – modulation-doped field effect transistor (MODFET) – Monolithic Microwave IC (MMIC) – Bipolar Junction Transistors (BJT): basic principles and models of operation – bulk micromachining – 3D structure – DIRE – LIGA process – transducer – electro capacitive- micro accelerometer – illustration

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Discuss the science of single crystal silicon, doping and properties of silicon and its compounds.
2. Explain the manufacturing process involved in fabrication of Complementary Metal Oxide–Semiconductor.
3. List the technology and challenges in assembly and packaging
4. Discuss an overview of tools and testing of microelectronics.
5. Explain the fundamentals of GaAs, bipolar transistors and micro electromechanical systems: device and its fabrication.

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	1	-	-	-	-	-	1	-	1			
CO2	2	2	1	1	-	-	-	-	-	1	-	1			
CO3	2	2	1	1	-	-	-	-	-	1	-	1			
CO4	2	2	1	1	-	-	-	-	-	1	-	1			
CO5	2	2	1	1	-	-	-	-	-	1	-	1			
CO/PO & PSO Average	2.0	2.0	1.0	1.0	-	-	-	-	-	1.0	-	1.0			
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Hong Xiao, “Introduction to Semiconductor Manufacturing Technology”, Second Edition, , SPIE Press, 2013.
2. Gurnett K.W., “Surface Mount Handbook”, Newnes Elsevier, Netherlands, 1999.

REFERENCES:

1. Stephen A. Campbell, “The Science and Engineering of Microelectronic Fabrication”, Second Edition, Oxford University Press, 2001.
2. May, G. S. and Sze, S. M., “Fundamentals of Semiconductor Fabrication”, First Edition, Wiley India, 2007.
3. Mark Madou, “Fundamentals of Microfabrication", Second Edition, CRC Press, New York, 2017.
4. Prasad R.P., “Surface Mount Technology: Principles and Practice”, 2nd Edition, SpringerScience + business media, 2013.
5. Seraphim D., Lasky, R.C. and Che-Yu Li, “Principles of Electronic Packaging” Mcgraw Hill, India, 1989.

PR23E01	MACHINE LEARNING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. To introduce basic of machine learning techniques
2. To learn about classification methods
3. To learn about clustering methods
4. To learn about basics of neural networks
5. To learn about Deep learning and Reinforcement learning.

UNIT – I INTRODUCTION TO MACHINE LEARNING (ML) 9

Learning – Types of Machine Learning, Classifications vs. Regression, Evaluation Metrics and Loss Functions in Classification, Linear Regression, Evaluation Metrics and Loss Functions in Regression, Applications of AI in Robotics.

UNIT – II CLASSIFICATION METHODS 9

Support Vector Machine Algorithm, Learning with Trees-Using Decision Trees-Constructing Decision Trees-Classification Example-Decision by Committee: Ensemble Learning – Boosting – Bagging-Random Forests.

UNIT – III CLUSTERING 9

Introduction to Clustering, Types of Clustering, Agglomerative Clustering, K-Means Clustering, K-means Clustering Application study, Principle Component Analysis (PCA), PCA Application Case Study in Feature Selection for Robot Guidance.

UNIT – IV NEURAL NETWORKS (NN) 9

Neural Networks – Perceptron, Multi-Layer Perceptron – Back Propagation of Error-Multi-layer Perceptron in Practice – Deriving Back Propagation – Application Case Study of Neural Networks in Robotics.

UNIT – V DEEP LEARNING AND REINFORCEMENT LEARNING 9

Introduction to Deep Learning – CNN – RNN, Reinforcement Learning, Examples for Reinforcement Learning, Markov Decision Process, Major Components of RL, Application Case Study of Reinforcement Learning in Robotics.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Know the terms in machine learning and deep learning algorithms.
2. Recognize concepts and methods in machine learning and deep learning algorithms.
3. Practise the ML and DL Models and theoretical basis.
4. Deploy the ML and DL Models for given data/ applications.
5. Evaluate and analyse the ML and DL models and results.

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	1	-	-	-	-	-	1	-	1	-	-	2
CO2	2	1	1	1	-	-	-	-	-	1	-	1	-	-	2
CO3	2	1	1	1	-	-	-	-	-	1	-	1	-	-	2
CO4	2	1	1	1	-	-	-	-	-	1	-	1	-	-	2
CO5	2	1	1	1	-	-	-	-	-	1	-	1	-	-	2
CO/PO & PSO Average	**2**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**	**-**	**-**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
2. Tom M Mitchell, “Machine Learning”, McGraw Hill Education, 2013.

REFERENCES:

1. Peter Flach, “Machine Learning: The Art and Science of Algorithms that Make Sense of Data”, First Edition, Cambridge University Press, 2012.
2. Jason Bell, “Machine learning – Hands on for Developers and Technical Professionals”, First Edition, Wiley, 2014.
3. Ethem Alpaydin, “Introduction to Machine Learning”, Third Edition, Adaptive Computation and Machine Learning Series, MIT Press, 2014.

PR23E02	FLEXIBLE ELECTRONICS MANUFACTURING	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 need, fundamentals and materials for flexible electronics.
2. Familiarize with flexible electronics manufacturing on substrate.
3. Familiarize with flexible electronics manufacturing by printing process.
4. Explore the applications of flexible electronics.
5. Gain knowledge on current trends in flexible electronics manufacturing.

UNIT – I FUNDAMETALS AND MATERIALS FOR FLEXIBLE ELECTRONICS 9

History – Need for flexible electronics - Semiconducting Materials – Flexible Silicon, Organic Electronic Materials, Nano Structured Materials

UNIT – II BULK MICRO MANUFACTURING 9

Introduction - Substrate – Metal Foil, Flexible Glass, Polymers - Transfer Printing - Bonding – Barriers- Mechanism, Materials ,Insulators – Flexible Dielectrics, Packaging Strategies

UNIT – III PRINTING TECHNIQUES 9

Flexible Printed Circuit Boards – Materials, Fabrication Process – Printed Electronics – Ink Formulation, Inject Printing, Three Dimensional Printed Electronics

UNIT – IV APPLICATIONS OF FLEXIBLE ELECTRONICS 9

Flexible Energy Generation and Storage Devices- Inorganic Photovoltaics, Organic Photovoltaics - Flexible Sensors and Actuators – Flexible Display

UNIT – V CURRENT TRENDS IN FLEXIBLE ELECTRONICS MANUFACTURING 9

Fabrication on Sheet by Batch Processing – Fabrication on Web by Roll to Roll Processing – Additive Printing

TOTAL: 45 PERIODS

COURSE OUTCOMES

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															
CO2															
CO3															
CO4															
CO5															
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS:

1. Aftab M.Hussain, “ Introduction to Flexible Electronics”, CRC Press, 2022
2. William S. Wong and Alberto Salleo,“Flexible Electronics:Materials and Applications”, Springer, 2009

REFERENCES:

1. Colin Tong, "Advanced Materialsfor Printed FlexibleElectronics", Springer, 2022
2. Vinod Kumar Khanna, “Flexible Electronics - Mechanical Background, Materials and Manufacturing” , IOP Publishing Ltd.,2019.

PR23E03	LASER BASED MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

1. Know the basic components of laser and its working principle.
2. Familiarize mechanism of all laser assisted processing operations
3. Understand laser assisted welding process.
4. Learn various laser assisted surface treatment techniques.
5. Understand laser assisted forming and surface cleaning process.

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 OUTCOMES

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

1. The students will be able to understand the fundamentals of laser and its types
2. The students will be able to explain the laser assisted machining operations
3. The students will be able to describe laser assisted welding process.
4. The students will be able to elucidate the various laser assisted surface treatment techniques.
5. The students will be able to expound the laser assisted forming and surface cleaning process.

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	3	2	2	2	2	2	3	-	-	-	-	2	2	2	2
CO2	3	3	3	2	2	2	3	-	-	-	-	2	2	2	2
CO3	2	2	2	2	2	2	3	-	-	-	-	2	2	2	2
CO4	3	3	2	2	2	2	3	-	-	-	-	2	2	2	2
CO5	2	3	2	2	2	2	3	-	-	-	-	2	2	2	2
CO/PO & PSO Average	2.6	2.6	2.2	2.0	2.0	2.0	3.0	-	-	-	-	2.0	2.0	2.0	2.0
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Steen, William M., and Jyotirmoy Mazumder, “Laser material processing”, Springer Science &Business Media, 2010
2. Przemysław, and Tomasz Tański, "Advances in Laser and Surface Material Processing", Trans Tech Publications, 2020

REFERENCES

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 SandipHarimkar, “Laser fabrication and machining of materials”,
3. Springer Science & Business Media, 2008.
4. Migliore, Leonard R, “Laser materials processing”, CRC Press, 2018.
5. Crafer, Roger, and Peter J. Oakley, “Laser processing in manufacturing”, Springer Science& Business Media, 1992.
6. Akinlabi, Esther Titilayo, RasheedatModupeMahamood, and Stephen AkinwaleAkinlabi, eds,“Advanced manufacturing techniques using laser material processing”, IGI Global, 2016

PR23E04	INDUSTRIAL 4.0 AND IOT	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 concepts, principles, and technologies underlying Industry 5.0 and IoT.
2. Acquire knowledge of automation and control systems, including sensors, actuators, PLCs, and SCADA systems.
3. Develop proficiency in industrial robotics, including robot anatomy, kinematics, programming, and material handling.
4. Gain expertise in IoT, including its architectures, applications in various sectors, sensor implementation, communication protocols, and security considerations.
5. Explore advanced topics and emerging trends in Industry 5.0 and IoT, such as AI, machine learning, edge computing, cloud integration, and cyber-physical systems.

UNIT – I INTRODUCTION TO AUTOMATION AND CONTROL SYSTEMS 9

Introduction to automated manufacturing systems, Sensors and actuators in automation, Pneumatic and hydraulic systems, Control using PLCs, Introduction to SCADA, Experiments: Logical circuits, pneumatic and electro-pneumatic circuits, study of PLC and PLC-based electro-pneumatic sequencing circuits,

UNIT – II INDUSTRIAL ROBOTICS AND MATERIAL HANDLING 9

Detroit Automation and material handling systems, Mechanization devices and parts handling, Parts feeding and sensing, Automated Guided Vehicles (AGVs), Industrial robotics: anatomy, drive systems, sensors, kinematics, End effectors and robot programming, Experiments: Visual inspection using computer vision technology, robot programming for pick and place, stacking of objects

UNIT – III INTERNET OF THINGS 9

Introduction to Industry 4.0 and IoT, Digitization and drivers of Industry 4.0, End-to-end digital integration in smart factories, Introduction to IoT and its architectures, IoT applications: smart cities, connected vehicles, healthcare, process monitoring, Experiments: Implementation of IoT for temperature-dependent cooling system, engine management system, machine condition monitoring, and healthcare monitoring

UNIT – IV IOT SENSORS AND COMMUNICATION 9

IoT sensors: RF and wireless sensor modules, power management, IoT communication protocols and networks, Data acquisition and transmission in IoT, Security and privacy considerations in IoT, Experiments: Implementation of IoT sensors and communication for specific applications,

UNIT – V ADVANCED TOPICS AND EMERGING TRENDS 9

Industry 5.0: evolution and key principles, Advanced automation technologies: AI, machine learning, and robotics, Edge computing and cloud integration in IoT, Cyber-physical systems

and their applications, Emerging trends in Industry 5.0 and IoT, Experiments: Exploring advanced automation technologies and trends

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Demonstrate a comprehensive understanding of automation and control systems, including their components, operation, and applications in manufacturing systems.
2. Apply the principles of industrial robotics and material handling to design and implement efficient and reliable automated processes.
3. Design and implement Internet of Things (IoT) solutions, including sensor integration, data acquisition, communication protocols, and security considerations, for real-world applications.
4. Analyze and evaluate the impact of Industry 5.0 and IoT on various industries and sectors, including smart factories, connected vehicles, healthcare, and process monitoring.
5. Explore and assess advanced automation technologies and emerging trends in Industry 5.0 and IoT, such as AI, machine learning, edge computing, cloud integration, and cyber-physical systems.

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	-	-	-	-	-	-	1	-	1	1	-	1
CO2	2	1	1	-	-	-	-	-	-	1	-	1	1	-	2
CO3	2	1	1	-	1	-	-	-	-	1	-	1	1	-	2
CO4	2	1	1	-	1	-	-	-	-	1	-	1	1	-	2
CO5	2	1	1	-	2	-	-	-	-	1	-	1	1	-	2
CO/PO & PSO Average	2.0	1.0	1.0	-	1.3	-	-	-	-	1.0	-	1.0	1.0	-	1.8
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Frank Lamb, "Industrial Automation: Hands-On", McGraw Hill, 2013.
2. William Bolton, "Programmable Logic Controllers", Elsevier Science, 2011. Elsevier Science, 2018.

REFERENCES

1. Stamatio, Nikolakopoulos, "Introduction to Industrial Automation", CRC Press, 2018.
2. B.R. Mehta, Y. Jaganmohan Reddy, "Industrial Process Automation Systems", Elsevier Science,2014.
3. John J. Craig, "Introduction to Robotics: Mechanics and Control", Pearson Education, 2014.
4. Bruno Siciliano and Lorenzo Sciavicco, "Robotics: Modelling, Planning and Control", Springer, 2010.
5. Grossetete, P., Hanes, D., Henry, J., Barton, R., Salgueiro, G., “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, Pearson Education, 2017.

PR23032	MACHINING PROCESSES AND MACHINE TOOLS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. To analyze metal cutting mechanics and various aspects of tools in the process of machining.
2. To comprehend and classify various operations, attachments and its applications of lathe
3. To explain and distinguish different reciprocating machine tools.
4. To study the constructional features and various operations related to milling and drilling
5. To illustrate and differentiate various super finishing operations.

UNIT – I INTRODUCTION TO METAL CUTTING 9

Introduction - Metal Removal Processes, Types of Machine Tools – Theory of Metal Cutting - Chip Formation, Orthogonal Cutting- Oblique Cutting - Machinability of metal Cutting Tool - Classification of cutting tools - Single point Cutting Tool Geometry-Cutting Tool Materials, Tool Wear, Tool Life, and Cutting Fluids - Functions and properties.

UNIT – II LATHE AND IT'S OPERATIONS 9

Centre Lathe – Construction - Taper Turning Methods, Thread Cutting operation, Lathe Attachments & Accessories. Capstan and Turret Lathes – Automats – Single Spindle, Swiss Type, Multi Spindle Automatic lathe – Construction - Features – Advantages – Limitations – Applications- Material Removal Rate (MRR)

UNIT – III RECIPROCATING MACHINE TOOLS 9

Shaper - Principal parts, Classification, Specification of shaper, Shaper Mechanisms, Types - Gear Shaper - Cutting Speed, Feed, Depth of cut & machining time - Introduction to Planer - Principal parts and working of Double housing Planer, Principal parts of Slotter - Working of slotter - MRR

UNIT – IV DRILLING AND MILLING MACHINES 9

Drilling operations - Twist drill geometry – Radial drilling machine - Jigs and Fixtures – Locating devices - Milling - Classification - Milling cutters and classification - Milling operations - Indexing methods - Simple and compounding- Gear hobbing- Cutting speed, feed, depth of cut and machining time - MRR

UNIT – V GRINDING AND FINISHING PROCESSES 9

Grinding Wheel – Specifications and Selection, Types of Grinding Process – Cylindrical Grinding, Surface Grinding, Centre less Grinding – Features – Advantages – Limitations – Applications – Finishing process - Honing, Lapping, Polishing and Buffing – Features and Uses – Applications - MRR

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Analyze metal cutting mechanics, tool wear and lubrication
2. Comprehend and classify various operations of lathe
3. Distinguish reciprocating machine tools and operations.
4. Describe constructional features and various operations related to drilling, milling and gear manufacturing.
5. Select appropriate finishing operations for various needs.

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	-	-	-	-	1	-	1	1	1	-	1
CO2	2	1	-	1	-	-	-	-	1	-	1	1	1	-	1
CO3	2	1	-	1	-	-	-	-	1	-	1	1	1	-	1
CO4	2	1	-	1	-	-	-	-	1	-	1	1	1	-	1
CO5	2	1	-	1	-	-	-	-	1	-	1	1	1	-	1
CO/PO & PSO Average	2.0	1.0	-	1.0	-	-	-	-	1.0	-	1.0	1.0	1.0	-	1.0
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. K. L. Narayana, Swarna Venkata Ramana, P. Vamsi Krishna, "Production Technology", I.K. International Publishing House Pvt. Limited, 4th Edition, 2018
2. Sharma.P.C., “A Text Book of Production Technology”, S.Chand and Company, 11th Edition, 2010.

REFERENCES:

1. HajraChoudhary, “Elements of Production Technology –Vol.II”, Asia Publishing House, 2010.
2. SeropeKalpakjian, Steven R. Schmid, "Manufacturing Processes for Engineering Materials", Pearson, 2023
3. R. K Jain, "Production Technology", Khanna Publications, 2012
4. P N Rao, "Manufacturing Technology Vol 2", McGraw-Hill India, 2018.

PR23033 FOUNDRY AND WELDING PROCESSES

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

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

1. To interpret foundry practices like pattern making, mould making, core making etc.
2. To understand the basic principle, procedure and applications of special casting methods.
3. To have knowledge on basic metal joining processes
4. To familiarize on special welding processes
5. To have knowledge to casting and welding metallurgy

UNIT – I FOUNDRY 9

Introduction to casting – pattern – materials allowances – coding – types – moulds – mould making, sand – properties, types and testing of sands – core making – type of cores – single box, two box and three box moulding processes, runner, riser and gate and chills chaplets- Furnaces and atmosphere

UNIT – II SPECIAL CASTING PROCESSES 9

Pressure die, Centrifugal, Continuous, Investment, Shell moulding, Squeeze, Stir, electro slag casting – CO2 moulding – Plaster Mould castings – Antioch process – Slush casting- Counter gravity low pressure casting - Electro magnetic levitation casting.

UNIT – III METAL JOINING PROCESSES 9

Types of metal joining - soldering, brazing and welding – edge preparation – filler material – flux – shielding gases – fusion welding – gas welding – flame types – Manual arc welding – arc theory – power supply – braze welding – Thermit welding – High Frequency Resistance welding – spot, seam, projection, percussion and flash- Shielded Metal Arc welding, Gas Metal Arc Welding-Gas Tungsten Arc Welding- Weld symbols

UNIT – IV DESIGN OF WELDMENTS 9

Type of joints, joint efficiency, factor of safety, symbols, selection of edge preparation, design considerations, types of loading, Permissible stress, allowable defects, computation of stresses in welds, weld size calculation, code requirement for statically loaded structures

UNIT – V CASTING AND WELDING METALLURGY 9

Welding and Casting defects - Heat flow - temperature distribution-cooling rates - influence of heat input, joint geometry, plate thickness, preheat, significance of thermal severity number, Epitaxial growth - weld metal solidification - columnar structures and growth morphology effect of welding parameters - Solidification principles – planar and dendritic solidification – constitutional super-cooling - Freezing of a pure metal –Freezing of alloys – Properties related to freezing mechanism-Directional solidification – progressive solidification.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Elaborate the process of pattern making, moulding and core making
2. Select appropriate special casting processes for specific application

3. Describe different metal joining processes, including soldering, brazing, and welding
4. Identify and describe various special casting processes and their applications
5. Describe microstructural evolution during casting and welding

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	-	1	1	-	1
CO2	2	-	-	1	-	-	-	-	-	1	-	1	1	-	1
CO3	2	-	-	1	-	-	-	-	-	1	-	1	1	-	1
CO4	2	-	-	1	-	-	-	-	-	1	-	1	1	-	1
CO5	2	-	-	1	-	-	-	-	-	1	-	1	1	-	1
CO/PO & PSO Average	2.0	-	-	1.0	-	-	-	-	-	1.0	-	1.0	1.0	-	1.0
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. John Campbell, "Complete Casting Handbook: Metal Casting Processes, Techniques and Design", Elsevier Science, 2018.
2. David H. Phillips, "Welding Engineering: An Introduction", Wiley, 2023.

REFERENCES

1. Howard B. Cary, Scott C. Helzer "Modern Welding Technology" Prentice Hall, 2011.
2. Mahi Sahoo, Sam Sahu, Sudhari Sahu, “Principle of metal casting", McGraw Hill – Education, 2014.
3. J. Paulo Davim, "WeldingTechnology", Springer International Publishing, 2021
4. Robert Bruce Tuttle, "Foundry Engineering: The Metallurgy and Design of Castings", Create Space Independent Publishing Platform, 2012.
5. Dheerendra Kumar Dwivedi, "Fundamentals of Metal Joining: Processes, Mechanism and Performance", Springer Nature Singapore, 2022.

PR23901	BIOMIMETIC ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. To appreciate and follow nature's design
2. To understand living organism body interfaces with surrounding environment
3. To learn sensing organs and path navigation in vertebrates
4. To understand the working principles of mobility by various living organisms
5. To introduce the ways of recreating biomimetic structures

UNIT – I VERVIEW OF BIOMIMETICS 9

Basic principles, building blocks, material property charts, nature's designs, examples of successful biomimetic designs.Mechanical design – hierarchical construction, bio-composites, structure & properties of bamboo, silks, bones, teeth, shells, antlers and beaks, impact resistance, fracture mitigation, damping, self- healing.

UNIT – II BIO INSPIRED SURFACES 9

Biological information, Dealing with friction, Muscles and artificial muscles, lotus effect, gecko adhesion,Desert beetle, pitcher plants, bio-fouling, coating, Silver ant and heat dissipation, insulation of fur and feathers, constructal theory.

UNIT – III BIO INSPIRED SENSORS 9

Biological sensors, Bio-inspired sensors- structural colours, compound eyes, antireflection, stealth, imaging. Navigation – short & long range navigation techniques of bees, ants, turtles - migratory birds

UNIT – IV BIO INSPIRED MOBILITY 9

Mechanical stiffness and motion, Neural control, Robot controllers, Running, Robustness, Crawling– Soft robotics, Gliding and Flapping flight, Hydrostatic stiffness and motion - Swimming- Macroscale walking, Macroscale flying.

UNIT – V FABRICATION FOR MICRO/NANO STRUCTURES 9

Soft material – bottom up approach – Hard materials – top down approach – micro/nano structure in microelectromechanical (MEMS) – Macro components with micro/nano structures - Examples- Ethics.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. To describe the nature's design in damping, light weight high strength, self-healing etc.
2. To elucidate living organism physical interactions with environment
3. To relate the modern electronics to natural sensing organs and path navigation in vertebrates
4. To explain the conceptual working principles of mobility by various living organisms
5. To state the ways of manufacturing biomimetic nano/micro structures

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															
CO2															
CO3															
CO4															
CO5															
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Yoseph Bar-Cohen, Biomimetics: Nature-Based Innovation, CRC Press, 2016
2. Lakhtakia A, Martin-Palma RJ (eds); Engineered biomimicry; Elsevier, 2013

REFERENCES

1. Reich Y, A critical review of General Design Theory. Research in Engineering Design, 7 (1) 1-18 (1995).
2. Maria G. Trotta, Bio-inspired Design Methodology, International Journal of Information Science 1(1), pp 1-11 (2011).
3. Ashok K G, Daniel A McAdams, Robert B. Stone, Biologically inspired designs: computational methods and tools, Springer London, 2013

		L	T	P	C
PR23902	**RELIABILITY ANALYSIS AND MAINTAINABILITY**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

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

1. The ability to use statistical tools to characterize the reliability of an item.
2. The working knowledge to determine the reliability of a system and suggest. approaches to enhancing system reliability.
3. The ability to select appropriate reliability validation methods.
4. To identify and correct the causes of failures.
5. To improve effectiveness and efficiency of maintenance.

UNIT – I RELIABILITY BASICS 9

Basics of Reliability - Definition – Quality and Reliability – Reliability functions – Hazard rate – Measures of Reliability – Design life – A priori and posteriori probabilities – Mortality of a component – Bath tub curve – Useful life

UNIT – II LIFE DATA ANALYSIS 9

Data collection – Empirical methods: Ungrouped/Grouped, Complete/Censored data – Time to failure distributions: Normal, Exponential and Weibull – Design life – Hazard models – Hazard rate function.

UNIT – III RELIABILITY EVALUATION 9

Reliability of simple systems - Different configurations – Redundancy – m/n system – Complex systems: RBD – Boolean truth table – Cut and tie sets – Fault Tree Analysis – Standby system.

UNIT – IV RELIABILITY TRACKING 9

Life testing methods: Failure terminated – Time terminated – Sequential Testing –Reliability growth monitoring – Reliability allocation – Software reliability.

UNIT – V MAINTAINABILITY 9

Analysis of downtime – Repair time distribution – System MTTR – Maintainability – Factors affecting maintainability of systems – Design for maintainability – System Availability – Replacement theory.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Analyse the interference between strength and stress, or life data for estimating reliability;
2. Apply the appropriate methodologies and tools for enhancing the inherent and actual reliability of components and systems, taking into consideration cost aspects; specify life test plans for reliability validation
3. Assess reliability of simple and complex systems using configurations, redundancy strategies, RBD, fault tree analysis, and standby systems.
4. Implement life testing methods, monitor reliability growth, allocate reliability, and understand software reliability principles.

5. Analyze downtime and repair time distributions, calculate system MTTR, design for maintainability, and understand system availability and replacement theory

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															
CO2															
CO3															
CO4															
CO5															
CO/PO & PSO Average															
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Yoseph Bar-Cohen, Biomimetics: Nature-Based Innovation, CRC Press, 2016
2. Lakhtakia A, Martin-Palma RJ (eds); Engineered biomimicry; Elsevier, 2013

REFERENCES

1. Charles E. Ebeling, “An introduction to Reliability and Maintainability engineering”, TMH, 2000.
2. Roy Billington and Ronald N. Allan, “Reliability Evaluation of Engineering Systems”, Springer, 2007.

PR23903	SUPPLY CHAIN INVENTORY MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. To describe the role and drivers of supply chain management in achieving competitiveness.
2. To explain about supply chain network design and inventory.
3. To illustrate about the issues related to logistics in supply chain.
4. To appraise about sourcing and coordination in supply chain
5. To apply information technology concepts in supply chain

UNIT – I INTRODUCTION 9

Role of Logistics and Supply chain Management: Scope and Importance - Evolution of Supply Chain – Examples of supply Chains - Decision Phases in Supply Chain - Competitive and Supply chain Strategies – Drivers of Supply Chain Performance and Obstacles – Supply Chain Performance Measures – Enhancing Supply Chain Performance Measures-Challenges in maintaining Supply Chain in India.

UNIT – II NETWORK DESIGN AND IVENTORY 9

Role of Distribution in Supply Chain – Factors influencing Distribution network design – Design options for Distribution Network- Distribution Network in Practice - Role of network Design in Supply Chain – Framework for network Decisions. Managing inventories in Supply Chain: Single stage inventory control, inventory control policies, impact of service level on safety stock.

UNIT – III LOGISTICS IN SUPPLY CHAIN 9

Role of transportation in supply chain – Factors affecting transportations decision – Design option for transportation network – Tailored transportation – Vehicle Routing and scheduling in transportation - 3PL- 4PL- Global Logistics - Reverse Logistics; Reasons, Activities and issues- Closed Loop Supply Chain

UNIT – IV SOURCING AND COORDINATION 9

Role of transportation in supply chain – Supplier selection – Design collaboration – Sourcing planning and analysis – Types of supply chain contracts and its types – Supply chain co-ordination – Bull Whip Effect – Effect of lack of co-ordination in supply chain and obstacles – Remedial measures to overcome Bull Whip Effect - Building strategic partnerships and trust within a supply chain.

UNIT – V IT AND EMERGING CONCEPTS IN SUPPLY CHAIN 9

The role IT in supply chain-The supply chain IT framework - Customer Relationship Management – Internal Supply Chain Management – Supplier Relationship Management – Future of IT in supply chain – E-Business in Supply Chain- Introduction to Warehouse Management, Risks in Supply Chain, Lean Supply Chains, Sustainable supply Chains – Block Chain and its applications in Supply Chain.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Understand the scope of Supply Chain Management (SCM) and the drivers of supply chain performance.
2. Design suitable Supply Chain network and inventory for a given situation
3. Solve the issues related to Logistics in SCM
4. Understand sourcing, coordination and current issues in SCM
5. Appraise about the applications of IT in SCM and apply SCM concepts in selected enterprise

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	2	1	-	-	-	-	-	-	-	-	-	1	-	1
CO2	3	3	1	1	1	-	-	-	-	-	-	-	1	-	1
CO3	3	3	1	1	1	-	-	-	-	-	-	-	1	-	1
CO4	3	3	1	1	1	-	-	-	-	-	-	-	1	-	1
CO5	3	3	1	1	3	-	-	-	-	-	-	-	1	-	1
CO/PO & PSO Average	2.6	1.0	1.0	10	1.5	-	-	-	-	-	-	-	1.0	-	1.0
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Sunil Chopra, Peter Meindl and D.V. Kalra, “Supply Chain Management: Strategy, Planning and Operation", Pearson Education,7th Edition 2020.
2. Mason Harris, “Global Logistics and Supply Chain Management”, Willford Press, 2020

REFERENCES

1. Ravi Ravindran A, Donald P. Warsing, Jr, “Supply Chain Engineering: Models and Applications”, CRC Press, 2023.
2. Srinivasan G.S, “Quantitative models in Operations and Supply Chain Management”, PHI, 2010.
3. Thomas E. Vollmann, William Lee Berry, David Clay Whybark and F. Robert Jacobs, “Manufacturing Planning and Control Systems for Supply Chain Management”, McGraw Hill., 2014.
4. Joseph J, Massie, “Essentials of Management”, Prentice Hall of India Pvt. Ltd., 1985
5. Donald J. Bowersox, David J. Closs, M. Bixby Cooper, John C. Bowersox, “Supply Chain Logistics Management”, McGraw Hill, 2023

PR23904	LEAN SIX SIGMA	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. To introduce the Lean and Six Sigma approach
2. To impart knowledge about integration of lean and six sigma
3. To gain more knowledge on various Lean Manufacturing tools
4. To impart knowledge on various Six sigma tools
5. To analyze the application of Lean six sigma.

Unit I INTRODUCTION TO LEAN AND SIX SIGMA 9

Evolution of lean six sigma, the synergy of Lean and six sigma, Definition of lean six sigma, 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 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.

Unit II INTEGRATION OF LEAN AND SIX SIGMA 9

Definition of six sigma, origin of six sigma, six sigma concept and Critical success factors for six sigma; Case analysis.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 LEAN TOOLS 9

Introduction to LM Tools- Objectives of lean manufacturing-key principles and implications of lean manufacturing -traditional Vs lean manufacturing- flow-continuous improvement/Kaizen – worker involvement- 5S principles - elements of JIT, TPS - uniform production rate - Kanban system - Lean implementation, Reconciling lean with other systems - lean six sigma- lean and ERP - lean with ISO 9001:2015. Set up time reduction – Definition, philosophies and reduction approaches. Value stream mapping - Procedure and principles, EOQ, EPQ.

UNIT – IV SIX SIGMA TOOLS 9

Six sigma - lean manufacturing and six sigma- six sigma and process tolerance – Six sigma and cultural changes – six sigma capability – six sigma need assessments - implications of quality levels, Cost of Poor Quality (COPQ)- Six Sigma tools for DMAIC.

UNIT – V APPLICATIONS OF LEAN AND SIX SIGMA 9

Various case studies of implementation of lean manufacturing at industries.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Ability to have knowledge on lean and six sigma
2. Ability to integrate the knowledge on lean and six sigma.
3. Analyze and apply the knowledge on Lean tools.
4. Integrate six sigma tools.
5. Understand and interpret the knowledge on lean and six sigma in industries.

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	3	3	3	3	3	1	1	-	-	-	-	2	1	-	1
CO2	3	3	3	3	3	2	2	-	-	-	-	3	1	-	1
CO3	3	3	3	3	3	2	2	-	-	-	-	2	1	-	1
CO4	3	3	3	3	3	3	3	-	-	-	-	2	1	-	1
CO5	3	3	3	3	3	2	2	-	-	-	-	3	1	-	1
CO/PO & PSO Average	3.0	3.0	3.0	3.0	3.0	2.0	2.0	-	-	-	-	2.4	1.0	-	1.0
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Michael L.George, David Rownalds, Bill Kastle, What is Lean Six Sigma, McGraw – Hill 2005
2. Lonnie Wilson,“How to Implement Lean Manufacturing”, McGraw-Hill Professional; 1 edition, 2009.
3. Ronald G. Askin and Jeffrey B. Goldberg, “Design and Analysis of Lean Production Systems”, John Wiley and Sons, 2003

REFERENCES

1. Mikell P. Groover, “Automation, Production Systems and Computer-Integrated Manufacturing”, 3rd Edition, 2007.
2. Rother M. and Shook J, “Learning to See: Value Stream Mapping to Add Value and Eliminate Muda” , Lean Enterprise Institute, Brookline, MA.1999.
3. William M. Field, “Lean Manufacturing: Tools, Techniques and How to use them”,CRC Press, Taylor and Francis Group,2000.
4. Pascal Dennis, Lean Production Simplified- CRC press, 2007.

PR23905 MAINTENANCE ENGINEERING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

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

1. Explain maintenance concepts and maximize profit and minimize downtime in maintenance.
2. Summarize and take optimum maintenance decisions.
3. Plan analyze the root cause for maintenance problems.
4. Plan manage the spare parts for maintenance activity.
5. Define and describe the losses and improve the Overall Equipment Effectiveness.

Unit I MAINTENANCE CONCEPT 9

Maintenance definition – Maintenance objectives – Maintenance challenges – Tero Technology Maintenance costs – Scope of maintenance department.

Unit II MAINTENANCE MODELS 9

Proactive/reactive maintenance – Maintenance policies – Imperfect maintenance – Preventive/breakdown maintenance – Optimal PM schedule and product characteristics – Inspection decisions – Maximizing profit – Minimizing downtime – Replacement Models.

UNIT – III MAINTENANCE QUALITY 9

Five zero concept – FMEA- FMECA – Root cause analysis – Repair time distribution – Analysis of downtime – Maintainability prediction – Design for maintainability – Reliability Centered Maintenance.

UNIT – IV MAINTENANCE MANAGEMENT 9

Human factors – Maintenance staffing – Learning curves – Simulation – Optimal size of service facility – Optimal repair effort – Spare parts management – Maintenance planning – Maintenance scheduling.

UNIT – V TOTAL PRODUCTIVE MAINTENANCE 9

TPM philosophy – Chronic and sporadic losses – Equipment defects – Six major losses – Overall equipment effectiveness – TPM pillars – Autonomous maintenance

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Able to understand the equipment availability and downtime.
2. Able to implement maintenance policies for maximizing the profit .
3. Able to make a diagnosis of maintenance problems .
4. Able to improve uptime of machines by effective spare parts management .
5. Able to improve the overall Equipment Effectiveness.

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															
CO2															
CO3															
CO4															
CO5															
CO/PO & PSO Average															

1 – Slight, 2 – Moderate, 3 – Substantial

TEXT BOOKS

1. 1. Andrew K.S.Jardine& Albert H.C. Tsang, “Maintenance, Replacement and Reliability” Taylorand Francis, 2006.
2. 2. Mishra R C and Pathak K., “Maintenance Engineering and Management”, PHI,2012.

REFERENCES

1. BikasBadhury&S.K.Basu, “Tero Technology: Reliability Engineering and Maintenance Management”, Asian Books, 2003.
2. Seichi Nakajima, “Total Productive Maintenance”, Productivity Press, 1993.

PR23906	GREEN ELECTRONICS MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

1. To introduce the need for green electronics, regulatory bodies, re-cycling and environmental concern in electronic manufacturing.
2. To analyze the environmental pollution in electronic processing.
3. To review the counter measures in electronic processing by adaption of new
4. materials, eco-design and recycling.
5. To provide overview of life cycle assessment of electronics manufacturing and international standards.
   To appraise the reuse and recycle of electronic products based on case studies on typical Products

Unit I INTRODUCTION TO GREEN ELECTRONICS 9

Environmental concerns of the modern society- Overview of electronics industry and their relevant regulations in China, European Union and other key countries- global and regional strategy and policy on green electronics industry. Restriction of Hazardous substances (RoHS) - Waste Electrical and electronic equipment (WEEE - Energy using Product (EuP) and Registration - Evaluation, Authorization and Restriction of Chemical substances (REACH).

Unit II GREEN ELECTRONICS MATERIALS AND PRODUCTS 9

Basics of IC manufacturing and its process – Electronics with Lead (Pb) -free solder pastes, conductive adhesives, Introduction to green electronic materials and products - halogen-free substrates and components. Substitution of non-recyclable thermosetting polymer based composites with recyclable materials X-Ray Fluorescence (XRF) for identifying hazardous substances in electronic products

UNIT – III GREEN ELECTRONICS ASSEMBLY AND RECYCLING 9

Various processes in assembling electronics components - the life-cycle environmental impacts of the materials used in the processes - substrate interconnects. Components and process equipments used. Technology and management on e-waste recycle system construction, global collaboration, and product disassembles technology.

UNIT – IV PRODUCT DESIGN AND SUSTAINABLE ECO-DESIGN 9

Stages of product development process in green design: Materials- Manufacturing - Packaging and use - End of Life and disposal - Design for recycling - Life Cycle Assessment (LCA), and Eco-design tools - Environmental management systems, and International standards - Eco-design in electronics industry

UNIT – V CASE STUDIES 9

Reliability of green electronics systems , Reuse and recycle of End-of-Life(EOL) electrical and electronic equipment for effective waste management – Introduction of Green Supply Chain, and

Modelling green products from Supply Chain point of view - A life-cycle assessment for eco-design of Cathode Ray Tube Recycling.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

1. Spell out the regulatory bodies for re-cycling and end of use of electronic products.
2. Analyze the environmental pollution in electronic processing and reprocessing.
3. Describe the counter measures in electronic processing and recycling by adaption of new materials and eco-design.
4. Summarize of life cycle assessment of electronics manufacturing and international standards.
5. .Infer the reuse and recycle of typical electronic products.

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	-	-	-	-	-	3	-	-	-	1	-	2	1	2	2
CO2	1	-	-	1	-	-	-	-	-	1	-	2	1	3	2
CO3	2	-	-	1	-	-	-	-	-	1	-	2	1	3	2
CO4	1	-	-	1	-	3	2	-	-	1	-	2	1	3	2
CO5	1	-	-	1	-	2	3	-	-	1	-	2	1	3	2
CO/PO & PSO Average	1.0	-	-	1.0	-	2.6	2.5	-	-	1.0	-	2.0	1.0	3	2.0
1 – Slight, 2 – Moderate, 3 – Substantial															

TEXT BOOKS

1. Lee H.Goldberg and Wendy Middleton, “Green Electronics/ Green Bottom Line”, Newnes
2. Publications, 2000.
3. 2. Sammy G. Shina, “Green Electronics Design and Manufacturing”, McGraw Hill., 2008.

REFERENCES

1. David Austen, “Green Electronic Morning”, Ingleby Gallery, 2006.
2. John Hu. Mohammed Ismail, “CMOS High Efficiency on – Chip Power Management”, Springer Publications 4th edition, 2011.
3. Sanka Ganesan, Michael Pecht, “Lead-free Electronics”, John Wiley & Sons, 2006.
4. Yuhang yang and Maode Ma, “Green Communications and Networks”, Springer Publication., 2014.
5. Charles A. Harper, “Electronic Materials and Processes Hand book”, McGraw-Hill, 2010.

List of Industrial Oriented Courses							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.		Engineering Plastic Parts Design& Development	T	1-0-0	1	1	SDC
2.		Geometric Dimensioning and Tolerance	T	1-0-0	1	1	SDC
3.		Non-Destructive Evaluation	T	1-0-0	1	1	SDC
4.		Piping Design	T	1-0-0	1	1	SDC
5.		Marine Vehicles	T	1-0-0	1	1	SDC
6.		Marine Robotics	T	1-0-0	1	1	SDC

PRXXXX	ENGINEERING PLASTIC PRODUCT DESIGN & DEVELOPMENT	L	T	P	C
		1	0	0	1

COURSE OBJECTIVES:

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

1. To provide a foundational understanding of the diverse applications of plastics, differentiating between functional and decorative types
2. To introduce the principles and practices of designing plastic parts with a focus on safety, functionality and manufacturability.
3. To explore advanced techniques used in adding functional features and assemblies to plastic parts.
4. To examine methods for enhancing the visual appeal and surface finish of plastic products.
5. To provide an understanding of the processing techniques used in plastic manufacturing and their implications for sustainability.

UNIT – I Introduction **3**

Scope of plastics – standards- Functional Plastic & Decorative Plastic , applications

UNIT – II Design of Plastic Parts **3**

Design – Product Design with Safety requirements – Mold Design – Gate Design – Mold Flow Analysis

UNIT – III Secondary Process on Plastic Products **3**

Functional Printing – Forming – Ultrasonic Welding – Heat stake Welding – Hot Stamping – IMD/IML – Laser Marking – Graphic Overlay – RFT

UNIT – IV Decorative Plastic **3**

Decorative Plastic – Spray Painting – Electroplating – Pad Printing – Screen Printing – Digital Printing

UNIT – V Processing of Plastics **3**

Processing – 1K, 2K & 3K Injection Molding - Blow Molding – Insert Molding, Reprocessing of used plastics and sustainability

TOTAL: 15 PERIODS

COURSE OUTCOMES

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

1. Differentiate between Functional and Decorative Plastics
2. Design Safe and Functional Plastic Products
3. Implement Advanced Functional Printing and Assembly Techniques
4. Enhance Plastic Products through Decorative Techniques
5. Execute and Optimize Plastic Processing Methods

PRXXXX	Geometric Dimensioning and Tolerance	L	T	P	C
		1	0	0	1

COURSE OBJECTIVES:

The aims of the course is to:

1. Explain the benefits of geometric tolerancing
2. Identify datum features and determine their order of precedence
3. Identify and interpret each of the characteristic symbols
4. Describe the material condition modifiers and how “bonus” tolerance occurs
5. Correctly interpret GD&T feature control frames, and explain the impact on manufacturing and inspection

UNIT – I Introduction, Features and Rules of GD&T 3

GD&T Terminology & Basic Rules, Intro to Features and Material Conditions, Maximum Material Condition, Least Material Condition

UNIT -II Datum Control, Adding GD&T to a Design

Introduction to Datums, Datum Reference Frame, Brief Introduction to MMB and LMB, Feature Control Frame, SLOF for Drawings, Choosing Datum

UNIT – III Form Tolerances, Orientation Tolerances 3

Straightness, Flatness, Circularity, Cylindricity, Parallelism, Perpendicularity, Angularity

UNIT – IV Profile and Location Tolerances 3

Profile of a surface, Profile of a line, True position, Concentricity, Symmetry

UNIT – V Runout Tolerances, Conclusion 3

Runout – Circular Runout, Total Runout, Examples

TOTAL: 15 PERIODS

COURSE OUTCOMES

1. Contrast between conventional and GD&T tolerance zones, Explain MMC, LMC and RFS concepts
2. Explain the datum controls and selection of proper datum controls.
3. Explain the form and orientation tolerances
4. Explain the profile and location tolerances
5. Explain the runout and orientation controls

PRXXXX	NON-DESTRUCTIVE EVALUATION	L	T	P	C
		1	0	0	1

COURSE OBJECTIVES:

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

1. Provide a thorough understanding of materials, destructive testing, and non-destructive testing (NDT) methods
2. Introduce the concept of NDE 4.0, predictive maintenance, IoT, AI, ML, and automated defect detection
3. Teach measurement uncertainties, statistical tools, and frameworks for evaluating the reliability of NDT methods
4. Familiarize students with non-conventional NDT methods like thermography, shearography, leak testing, and more.
5. Examine advanced NDT methods and their applications across various industries, along with certification standards.

UNIT – I INTRODUCTION 3

Materials - Destructive testing-Non-destructive testing- Basic methods of NDT under various societies- Advent of digital Radiography and Computed Tomography – Integration of Advanced Sensors and Robotics.

UNIT – II NDE 4.0 AND BEYOND 3

Introduction – Predictive Maintenance – Internet of Things (IoT) – Integration of Artificial intelligence (AI) and Machine Learning (ML) – Automated Defect Detection – Robotic Inspection – Swarms of Miniature Robots – Multi-Modal Sensors – Portable and Wireless Sensors – Real-Time Monitoring – Remaining Useful Life Estimation.

UNIT – III RELIABILITY IN NDE 3

Measurements and uncertainties - Definitions and statistical tools - Statistical indicators to evaluate reliability in NDE - The standard framework - General overview - Deterministic and statistical approaches - Details on the main reference documents and standards (RSEM, ASME-BPVC, DNV OS F101, MH1823A, ENIQ RP41).

UNIT – IV NON-CONVENTIONAL NDT METHODS 3

Thermography-Shearography-Leak Testing-Magnetic Flux Leakage-Microwave Testing-Neutron Radiographic Testing-Vibration Analysis.

UNIT – V ADVANCED NDT METHODS APPLICATION ON VARIOUS INDUSTRIES AND CERTIFICATION 3

PAUT / TOFD / TFM- Eddy Current Array-Pulsed Eddy Current.Aviation-Marine-Oil & Gas-Mining-Automobiles-Petrochemical. Certification Levels-Standards

TOTAL: 15 PERIODS

COURSE OUTCOMES

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

1. Demonstrate Knowledge of NDT Fundamentals
2. Apply of predictive maintenance throughIoT, AI, and ML in NDT.
3. Use statistical tools to evaluate the reliability of NDT methods with standards.
4. Implement non-conventional NDT Methods.
5. Apply advanced NDT methods in industries like aviation, marine, oil & gas, mining, automobiles, and petrochemical sectors.

PRXXXX	PIPING DESIGN	L	T	P	C
		1	0	0	1

COURSE OBJECTIVES:

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

1. Understand Material Selection and Piping Basics
2. Comprehend Pipe and Pipe Fitting Components
3. Analyze Valves and Valve Actuators
4. Design and Implement Standard Piping Practices
5. Master Piping Elements and Support Systems

UNIT – I INTRODUCTION TO FUNDAMETALS OF PIPING 3

Material Selection, Types, Size, Schedule, Method of Joining, Drawing

UNIT – II PIPE AND PIPE FITTING 3

Types - Pipes, Bolts, Gaskets, Body, Bonnet, Trim, Disk & Seat, Stem, Actuator, Packing.

UNIT – III VALVES AND VALVE ACTUATOR 3

Valves and - types, selection criteria , construction . Valve actuator - types , selection criteria , construction

UNIT – IV STANDARD PIPING 3

Pipe Rack Spacing - Pipe Flexibility - Heat Expansion - Pipe Anchors - Pipe Insulation Shoes - Pipe Guides, Pipe Span, Pipe Support, Field Support, Dummy Support, Hanger Rods

UNIT – V PIPING ELEMENTS 3

Pipe Guides, Pipe Span, Pipe Support, Field Support, Dummy Support, Hanger Rods

TOTAL: 15 PERIODS

COURSE OUTCOMES

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

1. Demonstrate Material Selection Proficiency
2. Explain Pipe and Fitting Components
3. Evaluate and Select Valves and Actuators
4. Design Standard Piping Systems
5. Implement Effective Piping Supports

ROXXXX	MARINE VEHICLES	L	T	P	C
		1	0	0	1

COURSE OBJECTIVES:

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

1. Learn about different types of marine vehicles, including commercial vessels and submersibles.
2. Explore the design and construction principles of manned and unmanned submersibles like towed vehicles, gliders, and crawlers.
3. Understand the business, design theory, standards, control, and applications of Remotely Operable Vehicles (ROVs).
4. Study the design, construction, navigation, and control strategies of Autonomous Underwater Vehicles (AUVs) and their components and sensors
5. Gain insight into the design and operational considerations of manned submersibles, including pressure hull structures, ballasting, maneuvering, life support systems, and certification requirements.

UNIT – I MARINE VEHICLES 3

Types – general – by function – commercial marine vehicles- submersibles types – applications

UNIT – II SUBMERSIBLES 3

Manned and unmanned submersibles – towed vehicles – gliders – crawler – Design and construction

UNIT – III REMOTELY OPERABLE VEHICLE (ROV) 3

Remotely Operable Vehicles (ROV) – The ROV business – Design theory and standards – control and simulation – design and stability – components of ROV – applications

UNIT – IV AUTONOMOUS UNDERWATER VEHICLE (AUV) 3

UV – Design and construction – components – sensors – Navigation -control strategies – applications

UNIT – V MANNED SUBMERSIBLE 3

Introduction – Design and operational consideration – pressure hull exostructure – ballasting and trim – maneuvering and control – Life support and habitability – emergency devices and equipment's – certification and classification

TOTAL: 15 PERIODS

COURSE OUTCOMES

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

1. Identify and classify different marine vehicles based on their functions and applications.
2. Understand the design and construction processes for both manned and unmanned submersibles, including specialized types such as gliders and crawlers.
3. Apply knowledge of ROV design theory, standards, control mechanisms, and business

applications in practical scenarios.

4. Proficient in designing and controlling AUVs, emphasizing the importance of sensors and integrating control strategies.
5. Design and operate manned submersibles, ensuring compliance with safety standards and understanding the necessary life support and emergency systems

REFERENCES

1. Ferial L hawry, The ocean engineering handbook, CRC press,2000
2.Richard A Geyer, “Submersibles and their use in oceanography and ocean engineering”, Elsevier, 1997

TEXT BOOKS:

1. Jonathan M. Ross, human factors for naval marine vehicle design and operation
2. Robert D. Christ,Robert L. Wernli, Sr. “The ROV Manual A User Guide for Remotely Operated Vehicles”, Elsevier, second edition, 2014
3. Sabiha A. wadoo,pushkinkachroo, Autonomous underwater vehicles, modelling, control design and Simulation, CRC press, 2011
4. R. Frank Busby, Manned Submersibles, Office of the oceanographer of the Navy, 1976

ROXXXX	MARINE ROBOTICS	L	T	P	C
		1	0	0	1

OBJECTIVES:

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

1. Learn about the classification, design, and limitations of marine robots such as robotic sailing vessels, submersibles, and AUVs.
2. Explore the historical development and modern advancements in robotic sailing technology, including platforms like MOOP and autonomous sailing vessels.
3. Understand the design theory, business aspects, and application of unmanned submersibles and ROVs, with a focus on control, stability, and simulation.
4. Study the construction, components, and control strategies of gliders and AUVs, highlighting buoyancy and efficient underwater operation.
5. Gain knowledge of the modeling, kinematics, dynamics, and control mechanisms of underwater vehicles, emphasizing stability and hydrodynamic forces.

UNIT I MARINE ROBOTS 3

Types and classification of marine robots – robotic sailing – submersibles, applications of sailing robots and submersibles, Limitations in marine autonomy

UNIT II ROBOTIC SAILING 3

History and recent developments in robotic sailing – miniature sailing robot platform (MOOP) – autonomous sailing vessel – design, development and deployment

UNIT III SUBMERSIBLEs 3

Unmanned submersibles- towed vehicles – Remotely Operable Vehicles (ROV) – The ROV business – Design theory and standards – control and simulation – design and stability – components of ROV – applications

UNIT IV AUTONOMOUS UNDERWATER VEHICLE (AUV) 3

Gliders – construction – buoyancy driven – Control strategies, AUV – construction – components – control strategies

UNIT V UNDERWATER VEHICLE GUIDANCE AND CONTROL 3

Modelling of marine vehicles – kinematics – rigid body dynamics – hydrodynamic forces and moments – equation of motion – stability and control of underwater vehicles

TOTAL : 15 PERIODS

OUTCOMES:

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

1. Explain various marine robots, including their applications and limitations in marine autonomy.
2. Evolution and advancements in robotic sailing and demonstrate the design and development of autonomous sailing vessels.
3. Design principles and business applications of ROVs and apply control and simulation techniques for stable ROV design.
4. Construct and control buoyancy-driven gliders and AUVs, developing control strategies for efficient underwater operations.
5. Model marine vehicle kinematics and dynamics, designing stable and controllable underwater vehicles using hydrodynamic principles and equations of motion.

TEXT BOOKS:

1. Alexander schlaelfer and ole blaurock, Robotic sailing, Proceedings of the 4th International sailing conference, Springer, 2011
2. Sabiha A. wadoo,pushkinkachroo, Autonomous underwater vehicles, modelling, control design and Simulation, CRC press, 2011
3. Robert D. Christ,Robert L. Wernli, Sr. “The ROV ManualA User Guide for Remotely
4. Operated Vehicles”, Elsevier, second edition, 2014
5. Thor I Fossen, Guidance and control of ocean vehicles, John wiley and Sons, 1999

REFERENCES

1.Mae L. Seto, Marine Robot Autonomy, Springer, 2013

2.Richard A Geyer, “Submersibles and their use in oceanography and ocean engineering”, Elsevier, 1997

3.Gianluca Antonelli, Underwater robotics, Springer, 2014

PR23S01	ESSENTIALS FOR NX DESIGNERS	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

1. Understand the Basics of NX CAD Software
2. Learn Sketching and Sweeping Techniques in NX
3. Master Draft Features and Datum Geometry
4. Create and Edit Additional Features in NX
5. Perform Assembly and Drawing Operations in NX

UNIT – I INTRODUCTION TO NX 6

Introduction to cad - Introduction NX - Opening and closing parts and activity - User interface and working with interface and activity - Impact of datum coordinate systems.

UNIT – II SKETCHING AND SWEEPING IN NX 6

Sketching methods - Sketching constraints and activity –Sketch curve functions and activities - Sketching Exercises - Sweeping geometry and activity

UNIT – III DRAFT FEATURES IN NX 6

Concept of layers - Creating expressions for dimensions and activity -Creating datum geometry (planes) and activity - Examining structure of model - Editing and manipulating sketches - Trimming a solid body –Swept features offset and draft

UNIT – IV CREATING ADDITIONAL FEATURES IN NX 6

Creating and editing holes and activity - Manipulating shell features and activity - Creating pattern and mirrors in bodies - Blending and chamfering

UNIT – V ASSEMBLY IN NX 6

Measuring Techniques and Synchronous modelling – Loading assemblies -Working with assemblies - Simple drawings – Project

TOTAL: 30 PERIODS

COURSE OUTCOMES

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

1.Proficiency in NX Interface and Basic Operations
2. Apply the concepts of sketching
3. Recognize the concept of layers
4. Expose to various editing tools
5. Interpret the concepts of synchronous modelling

PR23S02	TURNING -NUMERICAL CONTROL PROGRAMMING	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

1. Understand CNC Technology Fundamentals
2. Learn CNC Controller Basics
3. Develop CNC Part Programming Skills
4. Master Turning Cycles and Milling Integration
5. Perform and Optimize Milling Program Simulations

UNIT – I INTRODUCTION TO CNC 6

Principles of CNC Machines, components, tools, drives, feedback systems, coordinate systems

UNIT – II INTRODUCTION TO CNC CONTROLLER (808D) 6

Overview of CNC controllers, components, basic operations, operator panel, interface, I/O modules.

UNIT – III INTRODUCTION TO CNC PART PROGRAMMING 6

Fundamentals, G codes, M Codes, programming structure, blocks, sequences, functions, tool paths, coordinate systems, work offsets and tool offsets, tool selection and tool path generation.

UNIT – IV STANDARD TURNING CYCLES FOR TURNING FUNCTIONS 6

Introduction to turning cycles, syntax and parametrs, roughing, finishing, threading and grooving, optimizing turning operations.

UNIT – V TURNING PROGRAM SIMULATION 6

Importance of program simulation, optimization of tools paths and cycle times, interpreting simulations results, practical exercises

TOTAL: 30 PERIODS

COURSE OUTCOMES

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

1. Explain applications and advantages of CNC machines and technology.
2. Demonstrate and explain various CNC control Calculate technological data for CNC machining and part programming.
3. Understand the importance and use of PPE's.
4. Expose with CNC turning operation
5. Simulate the turning machine with program

PR23S03	BASICS OF PLC	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

1. Understand the Fundamentals of Automation
2. Learn Digital Fundamentals Using TIA Portal
3. Explore PLC Devices and Networks
4. Master Advanced PLC Programming Techniques
5. Understand Blocks and Integration in Automation

UNIT – I INTRODUCTION TO AUTOMATION SYSTEMS 6

Automation Overview, system over view

UNIT – II DIGITAL FUNDAMENTALS AND TIA PORTAL SOFTWARE 6

Digital Fundamentals - Engineering Software TIA Portal

UNIT – III PLC DEVICES AND NETWORKS 6

Devices & Networks - PLC Tags - Program Blocks and Program Editor

UNIT – IV ADVANCED PLC PROGRAMMING 6

Binary Operations – Digital Operations - Data Blocks - Functions and Function Blocks

UNIT – V BLOCKS AND INTEGRATION 6

Organization Blocks - Connecting an HMI Device – Troubleshooting

TOTAL: 30 PERIODS

COURSE OUTCOMES

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

1. Understand the fundamental concepts of automation
2. Design and analyze the digital fundamentals using TIA portal
3. Explore the devices and networks in real time applications
4. Analyze the arithmetic operations and functional blocks
5. Perform block organization and troubleshooting

PR23S04	SYNCHRONOUS MODELING AND PARAMETRIC DESIGN	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

1. Master Parametric Modeling and Design Documentation
2. Explore Blending Techniques and Design Variation Capture
3. Develop Skills in Synchronous Modeling and Feature Operations
4. Understand Synchronous Modeling Relationships and Dimension Commands
5. Learn Cross Section Editing and Face Optimization

UNIT – I PARAMETRIC MODELING AND DESIGN DOCUMENTATION 6

Documenting design intent - Editing parametric models - Associative curve operations - Emboss geometry

UNIT – II BLENDING TECHNIQUES AND DESIGN VARIATION 6

Blending techniques - Interpret references - Capturing part shape variations when assembled - Design optimization

UNIT – III SYNCHRONOUS MODELING AND FEATURE OPERATIONS 6

Introduction to Synchronous Modelling and Modify Face - Detail Feature, Delete Face, Reuse commands

UNIT – IV SYNCHRONOUS MODELING AND DIMENSION COMMANDS 6

Synchronous Modelling relationships, Dimension commands – Adaptive Shell

UNIT – V CROSS SECTION EDITING AND FACE OPTIMIZATION 6

Edit Cross Section and Edit Section, Optimize Face

TOTAL: 30 PERIODS

COURSE OUTCOMES

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

1. Master documenting design intent and proficiently editing parametric models for flexible, adaptable designs.
2. Gain expertise in blending techniques, interpreting references, and optimizing designs to capture part shape variations in assemblies.
3. Develop advanced skills in synchronous modeling, including modify face, delete face, and reuse commands for streamlined design modifications.
4. Dimension Commands and Adaptive Techniques: Integrate synchronous modeling with dimension commands and adaptive shell techniques to optimize design integrity and performance.
5. Achieve competence in editing cross sections and optimizing faces to ensure final designs meet functional and aesthetic criteria.

PR23S05	MILLING -NUMERICAL CONTROL PROGRAMMING	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

1. Understand CNC Technology Fundamentals
2. Learn CNC Controller Basics
3. Develop CNC Part Programming Skills
4. Master Turning Cycles and Milling Integration
5. Perform and Optimize Milling Program Simulations

UNIT – I INTRODUCTION TO CNC **6**

Overview of CNC Technology – Components, Coordinate systems

UNIT – II INTRODUCTION TOE CNC CONTROLLER (808D) **6**

Basics of CNC controllers, interface and operation, programing setup

UNIT – III INTRODUCTION TO CNC PART PROGRAMMING **6**

CNC programming, Basic techniques, linear and circular interpolation, canned cycles, simple part programming.

UNIT – IV STANDARD TURNING CYCLES FOR MILLING FUNCTIONS **6**

Turning cycles, Codes, programming and integration with milling functions

UNIT – V MILLING PROGRAM SIMULATION **6**

CNC simulations, setup, running and optimization, examples.

TOTAL: 30 PERIODS

COURSE OUTCOMES

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

1. Explain applications and advantages of CNC machines and technology.
2. Demonstrate and explain various CNC control Calculate technological data for CNC machining.
3. Understand the importance and use of PPE's.
4. Expose with CNC milling operation
5. Simulate the milling machine with program

PR23S06	BASIC OF INDUSTRIAL ROBOTICS – KUKA ROBOTS	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

1. Understand the Basics of Robotics and KUKA Robots
2. Learn the Basic Components of Robots
3. Master the Operation and Safety of Robots
4. Explore Robot Motion and Coordinate Systems
5. Develop Skills in Robot Jogging and Tool Management

UNIT – I Introduction to Robotics

Introduction of Robots - Introduction of KUKA Robots

UNIT – II Basic Components of Robot **6**

KUKA Robot Components -1 - KUKA Robot Components -2

UNIT – III Operation of Robots **6**

Robot Safety - Robot Cell Demo - Robot Installation Phases

UNIT – IV Robot Motion - I **6**

Robot Coordinate Systems - KUKA Smart PAD - Robot Mastering - Robot Load

UNIT – V Robot Motion - II **6**

Robot Jogging - Robot Tool & Base

TOTAL: 30 PERIODS

COURSE OUTCOMES

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

1. Proficiency in Robotics and KUKA Robots
2. Knowledge of Robot Components
3. Skill in Robot Operation and Safety
4. Understanding of Robot Motion and Coordinate Systems
5. Competence in Robot Jogging and Tool Management

PR23S07	NX SHEET METAL	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

1. Understand the Basics of NX Sheet Metal
2. Learn Fundamental Operations in NX Sheet Metal
3. Master Intermediate Operations in NX Sheet Metal
4. Develop Skills in Advanced NX Sheet Metal Operations
5. Apply NX Sheet Metal to Industry-Specific Applications

UNIT – I Introduction to NX Sheet Metal **6**

Sheet Metal workflow - Establish basic part characteristics

UNIT – II Operation in NX Sheet Metal - I **6**

Define the basic shape of the part - Constructing base features - Sheet Metal corners

UNIT – III Operations in NX Sheet Metal - II **6**

Sheet Metal cut-outs - Sheet Metal deform features - Flat Solid and Flat Pattern

UNIT – IV Operations in NX Sheet Metal - III **6**

Advanced Sheet Metal commands - Analyse Formability – One step

UNIT – V Output of NX Sheet Metal **6**

Aerospace Sheet Metal - Working with non-sheet metal data

TOTAL: 30 PERIODS

COURSE OUTCOMES

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

1.Understand part characteristics
2. Construct base features
3.Expose to cut-outs
4. Apply sheet metal commands
5. Appraise aerospace sheet metal

PR23S08	RAPID PROTOTYPING TECHNOLOGY	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

1. Understand the Fundamentals of Additive Manufacturing
2. Learn Various Additive Manufacturing Processes
3. Explore Fused Deposition Modeling (FDM)
4. Master Post Processing Techniques
5. Understand Standards in Rapid Prototyping Technology (RPT)

UNIT – I INTRODUCTION TO RPT **6**

Introduction to Fundamentals of Additive Manufacturing

UNIT – II INTRODUCTION TO AM **6**

Additive manufacturing overview –Different types of Additive manufacturing processes

UNIT – III FUSED DEPOSITION MODELING **6**

Material Extrusion (FDM) - Basic manufacturing applications of Additive Manufacturing

UNIT – IV POST PROCESSING **6**

Post processing of Printed parts

UNIT – V STANDARDS IN RPT **6**

Standards & standardization bodies

TOTAL: 30 PERIODS

COURSE OUTCOMES,

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

1. Generating a good understanding of RP history, its development and applications. Expose the students to different types of Rapid prototyping processes, materials used in RP systems and reverse engineering.
2. Students will be exposed to different types of Rapid prototyping processes, materials used in RP systems and reverse engineering.
3. Students will understand steriolithography methods
4. Students learn processes of CAD
5. Students gain knowledge to develop prototypes CO6 Students learn the concepts of rapid tool processing

PR23S09	ADVANCED INDUSTRIAL ROBOTICS – KUKA ROBOTS	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

1. Understand the Fundamentals of Material Handling
2. Learn the Basics of MIG Welding Processes
3. Explore Spot-Welding Processes
4. Gain Proficiency in KUKA Robot Simulations
5. Develop Skills in KUKA Robot Programming

UNIT – I INTRODUCTION OF MATERIAL HANDLING 6

Introduction of Material Handling - Material Handling Cell Components - Material Handling Cell Demo

UNIT – II MIG WELDING PROCESSES 6

Introduction of MIG Welding Processes - MIG Welding Cell Components - MIG Welding Cell Demo

UNIT – III SPOT-WELDING PROCESSES 6

Introduction of Spot-Welding Processes - Spot Welding Cell Components - Spot Welding Cell Demo

UNIT – IV KUKA ROBOTS 6

Introduction to KUKA Simpro - Material Handling Layout - KUKA Simpro Spot Welding Cell - Simpro MIG Welding Cell Simpro Material Flow & Machine Tending Layout - KRL Logical Programming-1 - KUKA sim visualization with Mixed reality

UNIT – V KUKA PROGRAMMING 6

KRL Variables & Declaration of Variables - KRL Loop Programming - KRL Conditional Programming

TOTAL: 30 PERIODS

COURSE OUTCOMES

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

1. Understand about the concepts of KUKA sim
2. Understand the types of robots and layouts
3. Apply the supervised learning methods with various case studies
4. Compare the learning methodologies and dimensionality concepts
5. Visualization of the industrial Layout

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

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2. Bill Aulet (2024). Disciplined Entrepreneurship: 24 Steps to a Successful Startup. John Wiley & Sons.
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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.