ANNA UNIVERSITY, CHENNAI

UNDERGRADUATE CURRICULUM (UNIVERSITY DEPARTMENTS)

Campus: CEG Campus, Anna University

Department: Industrial Engineering

Programme: B.E. INDUSTRIAL 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	15	-	-	4	1	-	24
II	-	-	7	10	-	-	3	1	-	21
III	8	-	8	4	-	-	-	3	-	23
IV	18	-	3	-	-	-	2	-	-	23
V	22	-	-	-	-	-	1	3	-	26
VI	-	12	-	-	6	3	1	-	1	23
VII	12	6	-	-	-	3	1	3	-	25
VIII	-	-	-	-	-	-	8	-	-	8
Total	60	18	22	29	6	6	20	11	1	173
% of Category	34.68	10.40	12.71	16.76	3.46	3.46	11.56	6.35	0.578	

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).

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	PH23C01	Engineering Physics	LIT	3-0-2	5	4	HSMC
4	ME23C01	Engineering Drawing and 3D Modelling	LIT	2-0-4	6	4	SDC
5	CY23C01	Engineering Chemistry	LIT	3-0-2	5	4	HSMC
6	CS23C02	Computer Programming in Python	LIT	3-0-2	5	4	ESC
7	UC23H01	தமிழர் மரபு / Heritage of Tamils	T	1-0-0	1	1	UC
8		NCC/NSS/NSO/YRC	L	0-0-2	2	0	UC
TOTAL CREDITS						**24**	

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	PH23C03	Material Science	T	3-0-0	3	3	HSMC
	EE23C03	Basics of Electrical and Electronics Engineering	LIT	2-0-2	4	3	ESC
	ME23C04	Makerspace	L	1-0-4	5	3	SDC
6	ME23C03	Engineering Mechanics	LIT	3-1-0	4	4	ESC
7	UC23H02	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	T	1-0-0	1	1	UC
8	-	Audit Course I	T	2-0-0	2	0	UC
TOTAL CREDITS						**21**	

SEMESTER – III							
S.NO	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE #**	**PERIODS/ WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP**		
1	MA23C05	Probability and Statistics	T	3-1-0	4	4	HSMC
2	IE23301	Work System Design	LIT	3-0-2	5	4	PCC
3	ME23C02	Manufacturing Processes	LIT	3-0-2	5	4	PCC
4	CE23C02	Fluid Mechanics and Machinery	LIT	3-0-2	5	4	ESC
5	CE23C01	Mechanics of Materials	LIT	3-0-2	5	4	ESC
6	IE23U01	Industrial Standards for Industrial Engineering	T	1-0-0	1	1	UC
7	UC23U01	Universal Human Values	T	1-0-2	3	2	UC
TOTAL CREDITS						**23**	

SEMESTER – IV							
S.NO	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE #**	**PERIODS/ WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1	CE23C01	Mechanics of Machines	T	3-0-2	5	3	PCC
2	ME23C14	Thermodynamics	T	3-0-0	3	3	PCC
3	IE23401	Applied Ergonomics	LIT	3-0-2	5	4	PCC
4	IE23C06	Operations Research	LIT	3-0-2	5	4	PCC
5	IE23402	Manufacturing Automation	LIT	3-0-2	5	4	PCC
6	ME23C06	Design Thinking	T	3-0-0	3	3	ESC
7		Skill Development Course - II	T	2-0-0	2	2	SDC
8		Audit Course II	T	2-0-0	2	0	UC
TOTAL CREDITS						**23**	

SEMESTER – V							
S.NO	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE #**	**PERIODS/ WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP**		
1	IE23501	Production and Operations Management	LIT	3-0-2	5	4	PCC
2	IE23C01	Engineering Quality Control	LIT	3-0-2	5	4	PCC
3	IE23C07	Total Quality Management	T	3-0-0	3	3	PCC
4	ME23C17	Machine Design	T	3-0-2	5	4	PCC
5	IE23502	Design of Experiments	LIT	3-0-2	5	4	PCC
6	IE23503	Reliability Engineering	T	3-0-0	3	3	PCC
7		Industry Oriented Course- I		1-0-0	1	1	SDC
8	UC23U01	Engineering Entrepreneurship Development	LIT	2-0-2	4	3	UC
TOTAL CREDITS						**26**	
COURSES FOR HONOURS DEGREE							
S.NO	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE #**	**PERIODS/ WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP**		
1.	IE23D01	Capstone Design Project – Level I	CDP	0-0-12		6	SDC
OR							
1.		Honours Elective – I	T	3-0-0	3	3	SDC
2.		Honours Elective – II	T	3-0-0	3	3	SDC
COURSES FOR MINOR DEGREE(OPERATIONS AND SUPPLY CHAIN MANAGEMENT)							
S.NO	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE #**	**PERIODS/ WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1.		Minor Elective – I	T	3-0-0	3	3	SDC
2.		Minor Elective – II	T	3-0-0	3	3	SDC

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 Course- I	T	3-0-0	3	3	PEC
2	-	Professional Elective Course- II	T	3-0-0	3	3	PEC
3	-	Professional Elective Course- III	T	3-0-0	3	3	PEC
4	-	Professional Elective Course- IV	T	3-0-0	3	3	PEC
5	-	Emerging Technology Course I	T	3-0-0	3	3	ETC
6	-	Open Elective – I	T	3-0-0	3	3	OEC
7	-	Emerging Technology Course II	T	3-0-0	3	3	ETC
8	-	Industry Oriented Course- II		1-0-0	1	1	SDC
9	IE23L01	Self-Learning Course	T	1-0-0	1	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.	IL23D02	Capstone Design Project – Level II	CDP	0-0-12		6	SDC
OR							
1.	-	Honours Elective – III	T	3-0-0	3	3	SDC
2.	-	Honours Elective – IV	T	3-0-0	3	3	SDC
COURSES FOR MINOR DEGREE (OPERATIONS AND SUPPLY CHAIN MANAGEMENT)							
S.NO.	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE #**	**PERIODS/ WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP**		
1.	-	Minor Elective – III	T	3-0-0	3	3	SDC
2.	-	Minor Elective – IV	T	3-0-0	3	3	SDC

SEMESTER – VII							
S.NO	COURSE CODE	COURSE NAME	COURSE TYPE #	PERIODS/ WEEK		CREDITS	CATEGORY
				L-T-P	TCP		
1	IE23701	Applied Multivariate Analysis	LIT	3-0-2	5	4	PCC
2	IE23702	Simulation Modelling and Analysis	LIT	3-0-2	5	4	PCC
3	IE23703	Supply Chain Management	LIT	3-0-2	5	4	PCC
4	-	Professional Elective Course- V	T	3-0-0	3	3	PEC
5	-	Professional Elective Course- VI	T	3-0-0	3	3	PEC
6	IE23U02	Perspective of Sustainable Development	T	2-0-2	4	3	UC
7	-	Open Elective - II	T	3-0-0	3	3	OEC
8	-	Industry Oriented Course- III		1-0-0	1	1	SDC
TOTAL CREDITS						25	
COURSES FOR HONOURS DEGREE							
S.NO	COURSE CODE	COURSE NAME	COURSE TYPE #	PERIODS/ WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1.	IE23D03	Capstone Design Project – Level III	CDP	0-0-12		6	SDC
OR							
1.	-	Honours Elective – V	T	3-0-0	3	3	SDC
2.	-	Honours Elective – VI	T	3-0-0	3	3	SDC
COURSES FOR MINOR DEGREE (OPERATIONS AND SUPPLY CHAIN MANAGEMENT)							
S.NO	COURSE CODE	COURSE NAME	COURSE TYPE #	PERIODS/ WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1.	-	Minor Elective – V	T	3-0-0	3	3	SDC
2.	-	Minor Elective – VI	T	3-0-0	3	3	SDC

SEMESTER – VIII							
S.NO	COURSE CODE	COURSE NAME	COURSE TYPE #	PERIODS/ WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1	IE23801	Project Work / Internship cum Project Work	IPW	0-0-20		8	SDC
TOTAL CREDITS						8	

TOTAL CREDITS RANGE:173

HUMANITIES AND SOCIAL SCIENCES INCLUDING MANAGEMENT COURSES (HSMC)

SEMESTER – IV							
S.NO	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE #**	**PERIODS/ WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP**		
1		Foundation English		2-0-2	4	3	HSMC
2		தமிழர்மரபு / Heritage of Tamils		1-0-0	1	1	HSMC
3		Professional Communication		2-0-2	4	3	HSMC
4		தமிழரும்தொழில்நுட்பமும் / Tamils and Technology		1-0-0	1	1	HSMC

PROFESSIONAL ELECTIVE COURSES: VERTICALS

Professional Elective	Operations and Supply Chain Management	Quality Systems	Manufacturing Systems	Product And Process Development	Human Factors Engineering	Sustainable Systems
1.	Decisions Making Models	Quality Systems and Auditing	Facilities Planning And Design	Process Measurement Systems	Safety and Risk Analytics	Environmental Impact Assessment
2.	Engineering Economics and Costing	Metrology and Measurements	Operations Scheduling Algorithms	Product Life Cycle Management	Safety Engineering and Management	Circular Economy
3.	Supply Chain Analytics	Lean Manufacturing and Six Sigma	Computer Integrated Manufacturing Systems	Additive Manufacturing	Human Machine Interaction System	Life Cycle Assessment
4.	Sustainable Supply Chain Management	Maintenance Engineering and Management	Productivity Management and Re Engineering	Product Design and Development	Cognitive Ergonomics	Environmental Management Systems and Auditing
5.	Project Management	Software Engineering and Methodology	Decision Support and Intelligent System	Creativity, innovation and Value Engineering	Occupational Health And Safety	Systems Engineering and Management
6.	Logistics, Warehouse and EXIM Management	Software Quality Management	Smart Manufacturing And Robotics	Accounting and Finance For Management	Principles of Management	Waste Management
7.	Enterprises Resource Planning	-	-	-	-	-

VERTICAL 1: OPERATIONS AND SUPPLY CHAIN							
S.NO	COURSE CODE	COURSE NAME	COURSE TYPE #	PERIODS/ WEEK		CREDITS	CATEGORY
				L-T-P	TCP		
1	IE23001	Decisions Making Models	T	3-0-0	3	3	PEC
2	IE23C05	Engineering Economics and Costing	T	3-0-0	3	3	PEC
3	IE23C10	Supply Chain Analytics	T	3-0-0	3	3	PEC
4	IE23002	Sustainable Supply Chain Management	T	3-0-0	3	3	PEC
5	IE23C08	Project Management	T	3-0-0	3	3	PEC
6	IE23003	Logistics, Warehouse and EXIM Management	T	3-0-0	3	3	PEC
7	IE23004	Enterprises Resource Planning	T	3-0-3	3	3	PEC

VERTICAL 2: QUALITY SYSTEMS							
S.NO	COURSE CODE	COURSE NAME	COURSE TYPE #	PERIODS/ WEEK		CREDITS	CATEGORY
				L-T-P	TCP		
1	IE23005	Quality Systems and Auditing	T	3-0-0	3	3	PEC
2	IE23006	Metrology and Measurements	T	3-0-0	3	3	PEC
3	IE23C03	Lean Manufacturing and Six Sigma	T	3-0-0	3	3	PEC
4	IE23007	Maintenance Engineering and Management	T	3-0-0	3	3	PEC
5	IE23008	Software Engineering and Methodology	T	3-0-0	3	3	PEC
6	IE23009	Software Quality Management	T	3-0-0	3	3	PEC

VERTICAL 3: MANUFACTURING SYSTEMS							
S.NO	COURSE CODE	COURSE NAME	COURSE TYPE #	PERIODS/ WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1	IE23010	Facilities Planning And Design	T	3-0-0	3	3	PEC
2	IE23011	Operations Scheduling Algorithms	T	3-0-0	3	3	PEC
3	IE23012	Computer Integrated Manufacturing Systems	T	3-0-0	3	3	PEC
4	IE23013	Productivity Management and Re Engineering	T	3-0-0	3	3	PEC
5	IE23014	Decision Support and Intelligent System	T	3-0-0	3	3	PEC
6	IE23015	Smart Manufacturing And Robotics	T	3-0-0	3	3	PEC

VERTICAL 4: PRODUCT AND PROCESS DEVELOPMENT							
S.NO	COURSE CODE	COURSE NAME	COURSE TYPE #	PERIODS/ WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1	IE23016	Process Measurement Systems	T	3-0-0	3	3	PEC
2	IE23C04	Product Life Cycle Management	T	3-0-0	3	3	PEC
3	IE23017	Additive Manufacturing	T	3-0-0	3	3	PEC
4	IE23018	Product Design and Development	T	3-0-0	3	3	PEC
5	IE23019	Creativity, innovation and Value Engineering	T	3-0-0	3	3	PEC
6	IE23020	Accounting and Finance For Management	T	3-0-0	3	3	PEC

VERTICAL 5: HUMAN FACTORS							
S.NO	COURSE CODE	COURSE NAME	COURSE TYPE #	PERIODS/ WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1	IE23021	Safety and Risk Analytics	T	3-0-0	3	3	PEC
2	IE23C09	Safety Engineering and Management	T	3-0-0	3	3	PEC
3	IE23022	Human Machine Interaction System	T	3-0-0	3	3	PEC
4	IE23023	Cognitive Ergonomics	T	3-0-0	3	3	PEC
5	IE23024	Occupational Health and safety	T	3-0-0	3	3	PEC
6	IE23025	Principles of Management	T	3-0-0	3	3	PEC

VERTICAL 6: SUSTAINABLE SYSTEMS							
S.NO	COURSE CODE	COURSE NAME	COURSE TYPE #	PERIODS/ WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1	IE23026	Environmental Impact Assessment	T	3-0-0	3	3	PEC
2	IE23027	Circular Economy	T	3-0-0	3	3	PEC
3	IE23028	Life Cycle Assessment	T	3-0-0	3	3	PEC
4	IE23029	Environmental Management Systems and Auditing	T	3-0-0	3	3	PEC
5	IE23030	Systems Engineering and Management	T	3-0-0	3	3	PEC
6	IE23031	Waste Management	T	3-0-0	3	3	PEC

COURSES FOR HONOURS DEGREE							
S.NO	COURSE CODE	COURSE NAME	COURSE TYPE #	PERIODS/ WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1	IE23032	Advanced Optimization Techniques	T	3-0-0	3	3	SDC
2	IE23033	Computational Methods and Algorithms	T	3-0-0	3	3	SDC
3	IE23034	Modelling of Manufacturing System	T	3-0-0	3	3	SDC
4	IE23035	System Dynamics	T	3-0-0	3	3	SDC
5	IE23036	Bio Mechanics	T	3-0-0	3	3	SDC
6	IE23037	Supply Chain Risk And Resilience	T	3-0-0	3	3	SDC
7	IE23038	Stochastic Optimization	T	3-0-0	3	3	SDC
8	IE23039	Financial Engineering	T	3-0-0	3	3	SDC

COURSES FOR MINOR DEGREE (OPERATIONS AND SUPPLY CHAIN MANAGEMENT)							
S.NO	COURSE CODE	COURSE NAME	COURSE TYPE #	PERIODS/ WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1	IE23040	Operations Management	T	3-0-0	3	3	SDC
2	IE23041	Quantitative Methods for Decision Making	T	3-0-0	3	3	SDC
3	IE23042	Supply Chain Management Decisions	T	3-0-0	3	3	SDC
4	IE23043	Warehousing	T	3-0-0	3	3	SDC
5	IE23044	Logistics Management	T	3-0-0	3	3	SDC
6	IE23045	Enterprises Resource Planning	T	3-0-0	3	3	SDC

EMERGING TECHNOLOGY COURSE (ETC)							
S.NO	COURSE CODE	COURSE NAME	COURSE TYPE #	PERIODS/ WEEK		CREDITS	CATEGORY
				L-T-P	TCP*		
1	IE23E01	Artificial Intelligence and Machine Learning	T	3-0-0	3	3	ETC
2	IE23E02	Industry 4.0	T	3-0-0	3	3	ETC
3	IE23E03	Design for X	T	3-0-0	3	3	ETC
4	IE23E04	Blockchain Technology	T	3-0-0	3	3	ETC

OPEN ELECTIVE COURSE (OEC)							
S.NO	**COURSE CODE**	**COURSE NAME**	**COURSE TYPE #**	**PERIODS/ WEEK**		**CREDITS**	**CATEGORY**
				L-T-P	**TCP***		
1	IE23901	Introduction to Industrial Engineering	T	3-0-0	3	3	OEC
2	IE23902	Design of Experiments for Parameter optimization	T	3-0-0	3	3	OEC
3	IE23903	Quality control and Assurance	T	3-0-0	3	3	OEC
4	IE23904	Reliability Assessment and Maintainability Models	T	3-0-0	3	3	OEC

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

2 0 2 3

COURSE OBJECTIVES:

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

UNIT I BASICS OF COMMUNICATION **6**

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

LAB ACTIVITY: **6**

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

UNIT II NARRATION **6**

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

LAB ACTIVITY: **6**

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

UNIT III DESCRIPTION **6**

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

LAB ACTIVITY: **6**

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

UNIT IV COMPARE AND CONTRAST **6**

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

LAB ACTIVITY: **6**

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

UNIT V EXPRESSION OF VIEWS 6

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

LAB ACTIVITY: 6

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

TOTAL: 60 PERIODS

TEACHING METHODOLOGY

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

EVALUATION PATTERN

Internal Assessment
- Written assessments
- Assignment

Lab assessment
- Listening
- Speaking

External Assessment
- End Semester Examination

LEARNING OUTCOMES

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

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

TEXT BOOKS:

1. “English for Engineers and Technologists” Volume I by Orient Blackswan, 2022
2. “English for Science & Technology - I” by Cambridge University Press, 2023

REFERENCES

1. “Interchange” by Jack C.Richards, Fifth Edition, Cambridge University Press, 2017.
2. “English for Academic Correspondence and Socializing” by Adrian Wallwork, Springer, 2011.
3. “The Study Skills Handbook” by Stella Cortrell, Red Globe Press, 2019
4. www.uefap.com

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

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

OBJECTIVES:

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

UNIT I MATRICES 9+3

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

UNIT II FUNCTIONS OF SEVERAL VARIABLES 9+3

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

UNIT III INTEGRAL CALCULUS 9+3

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

UNIT IV MULTIPLE INTEGRALS 9+3

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

UNIT V VECTOR CALCULUS 9+3

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

TOTAL: 60 PERIODS

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

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

Suggested Laboratory based exercises / assignments / assessments :

Matrices

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

Functions of Several Variables

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

Integral Calculus

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

Multiple Integrals

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

Vector Calculus

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

OUTCOMES:

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

TEXT BOOKS:

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

REFERENCES:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt Ltd., New Delhi, 2018.
2. Greenberg M.D., "Advanced Engineering Mathematics", Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.
3. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics",Narosa Publications, 5th Edition, New Delhi, 2017.
4. Narayanan S. and Manicavachagom Pillai T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi , 2012.

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

CO – PO Mapping:

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

PH23C01 **ENGINEERING PHYSICS** **L T P C**

(Common to all branches of B.E/B.Tech Programmes) **3 0 2 4**

COURSE OBJECTIVES

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

UNIT I CRYSTAL PHYSICS **9+6**

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

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

UNIT II MECHANICS OF MATERIALS **9+6**

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

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

UNIT III OSCILLATIONS, SOUND AND THERMAL PHYSICS **9+6**

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

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

UNIT IV OPTICS AND LASERS 9+6

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

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

    Laser Parameters
    Determination of the wavelength of the laser using grating
11. Air wedge -Determination of the thickness of a thin sheet/wire
12. Optical fibre - Determination of Numerical Aperture and acceptance angle

    -Determination of bending loss of fibre.
13. Michelson Interferometer (Demonstration)

UNIT V QUANTUM MECHANICS 9+6

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

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

TOTAL: 75 PERIODS

COURSE OUTCOMES:

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

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

TEXT BOOKS:

1. Raymond A. Serway, John W. Jewett, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2013.
2. D. Halliday, R. Resnick and J. Walker, Principles of Physics. John Wiley & Sons, 10th

Edition, 2015.

3. N. Garcia, A. Damask and S. Schwarz, Physics for Computer Science Students, Springer-Verlag, 2012.
4. Alan Giambattista, Betty McCarthy Richardson and Robert C. Richardson, College Physics, McGraw-Hill Higher Education, 2012.

REFERENCES:

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

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

ME23C01	ENGINEERING DRAWING AND 3D 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 1: ENGINEERING CURVES, PROJECTION OF POINTS AND LINES

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

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

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

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

(6+12 = 18 Hours)

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

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

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

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

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

(6+12 = 18 Hours)

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

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

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

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

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

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

(6+12 = 18 Hours)

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

UNIT 4: SECTION OF SOLIDS AND SECTIONED DRAFTING OF ASSEMBLED COMPONENTS

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

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

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

(6+12 = 18 Hours)

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

UNIT 5: LATERAL SURFACE DEVELOPMENT AND SHEET METAL DESIGN

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

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

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

(6+12 = 18 Hours)

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

Total: 90 Hours

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

COURSE OUTCOMES

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

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

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

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

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

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

Text book

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

References

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

8. "Computer Aided Engineering Drawing" by S Trymbaka Murthy, Scitech Publications, 3rd edition, 2020.
9. "CAED: Computer Aided Engineering Drawing for I/II Semester BE/Btech Courses" by Reddy K B, CBS Publishers & Distributors, 2nd, 2019.
10. "Computer-Aided Engineering Drawing" by Subrata Pal, Oxford University Press, 2nd, 2020.

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

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

UNIT-I BASIC ELECTRICAL CIRCUITS **6**

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

UNIT II AC AND DC MACHINES **6**

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

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

UNIT III ANALOG AND DIGITAL ELECTRONICS **6**

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

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

UNIT IV SENSORS AND TRANSDUCERS **6**

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

UNIT V MEASUREMENTS AND INSTRUMENTATION 6

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

TOTAL 30

LAB COMPONENET:

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

COURSE OUTCOMES:

- **CO1** Compute the electric circuit parameters for simple circuits.
- **CO2** Understand the working principles and characteristics of electrical machines.
- **CO3** Understand the basic electronic devices.
- **CO4** Understand the basic operating principles of sensors and transducer.
- **CO5** Understand the operating principles measuring devices

TEXT BOOKS:

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

REFERENCES:

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

Mapping COs and POs:

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

ME23C04	MAKERSPACE	L	T	P	C
		1	0	4	3

COURSE OBJECTIVES:

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

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

(A). Dis-assembly & Assembly Practices

i. Tools and its handling techniques.

ii. Dis-assembly and assembly of home appliances – Grinder Mixer Grinder, Ceiling Fan, Table Fan & Washing Machine.

iii. Dis-assembly and assembly of Air-Conditioners & Refrigerators.

iv. Dis-assembly and assembly of a Bicycle.

(B). Welding Practices

i. Welding Procedure, Selection & Safety Measures.

ii. Power source of Arc Welding – Gas Metal Arc Welding & Gas Tungsten Arc Welding processes.

iii. Hands-on session of preparing base material & Joint groove for welding.

iv. Hands-on session of MAW, GMAW, GTAW, on Carbon Steel & Stainless Stell plates / pipes, for fabrication of a simple part.

(C). Electrical Wiring Practices

i. Electrical Installation tools, equipment & safety measures.

ii. Hands-on session of basic electrical connections for Fuses, Miniature Circuit Breakers and Distribution Box,

iii. Hands-on session of electrical connections for Lightings, Fans, Calling Bells.

iv. Hands-on session of electrical connections for Motors & Uninterruptible Power Supply.

(D). Electronics Components / Equipment Practices

i. Electronic components, equipment & safety measures.

ii. Dis-assembly and assembly of Computers.

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

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

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

vi. Demonstration of Programmable Logic Control Circuit.

(E). Contemporary Systems

i. Demonstration of Solid Modelling of components.

ii. Demonstration of Assembly Modelling of components.

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

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

TOTAL: 75 Periods (15 Lecture + 60 Practical)

COURSE OUTCOMES:

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

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

REFERENCES:

1. Stephen Christena, Learn to Weld: Beginning MIG Welding and Metal Fabrication Basics, Crestline Books, 2014.
2. H. Lipson, Fabricated - The New World of 3D Printing, Wiley, 1st edition, 2013.

3. Code of Practice for Electrical Wiring Installations (IS 732:2019)
4. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Oxford University Press, 7th ed. (Indian edition), 2017.
5. Mazidi, Naimi, Naimi, AVR Microcontroller and Embedded Systems: Using Assembly and C, Pearson India, 1st edition 2013.
6. Visualization, Modeling, and Graphics for Engineering Design, D.K. Lieu, S.A. Sorby, Cengage Learning; 2nd edition.

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

அலகு I **மொழி மற்றும் இலக்கியம்**: **3**

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

அலகு II **மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை**: **3**

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

அலகு III **நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்**: **3**

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு IV **தமிழர்களின் திணைக் கோட்பாடுகள்**: **3**

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

அலகு V **இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு**: **3**

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

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

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

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

UNIT I LANGUAGE AND LITERATURE 3

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

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

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

UNIT III FOLK AND MARTIAL ARTS 3

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

UNIT IV THINAI CONCEPT OF TAMILS 3

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

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

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

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

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

NCC Credit Course Level 1*

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

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

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

UC23P02	**(NAVAL WING) NCC Credit Course Level – I**	**L T P C** **2 0 0 2**
NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

UC23P03	**(AIR FORCE WING) NCC Credit Course Level – I**	**L T P C** **2 0 0 2**
NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

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.

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

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

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

PH23C03	MATERIALS SCIENCE (Industrial Engineering)	L T P C 3 0 0 3

COURSE OBJECTIVES

- To make the students understand the basics of phase diagrams and their applications
- To impart knowledge about diffusion and Phase transformations
- To introduce various mechanical properties and their measurement.
- To learn about iron-carbon systems, and about various ferrous and non-ferrous alloys.
- To introduce the preparation, properties and applications of ceramics, composites and nanomaterials.

UNIT I PHASE DIAGRAMS 9

Basic concepts - Gibbs phase rule - Unary phase diagram (iron) - Solid solution - Hume Rothery's rules - Binary phase diagrams: isomorphous systems (Cu-Ni) – determination of phase composition and fraction – tie line and lever rule - binary eutectic diagram (Pb-Sn) – eutectoid and peritectic reactions - other invariant reactions – microstructural changes during the slow cooling: eutectic, hyper eutectic and hypoeutectic compositions- applications of phase diagrams.

UNIT II DIFFUSION AND PHASE TRANSFORMATIONS 9

Fick's laws of Diffusion - Diffusion mechanisms - atomic model of Diffusion - Steady state diffusion and non-steady state diffusion- Factors influencing diffusion - other diffusion paths- Applications. Phase changes - Time scale for phase changes - nucleation and growth –nucleation kinetics- homogeneous and heterogeneous nucleation - growth and overall transformation kinetics- Applications of phase transformation - Glass transition.

UNIT III MECHANICAL PROPERTIES 9

Tensile test - plastic deformation by slip – slip systems – mechanisms of strengthening in metals: strain hardening, grain size reduction, solid solution strengthening, precipitation hardening –Creep: creep curves, stress and temperature effects, mechanisms of creep, creep-resistant materials – Fracture: ductile and brittle fractures - the Griffith criterion – fracture toughness -Fatigue failure: the S-N curve – factors that affect fatigue life – Hardness: Rockwell and Brinell hardness tests, Knoop and Vickers microhardness tests.

UNIT IV FERROUS AND NON-FERROUS ALLOYS 9

The Fe-Fe_3C phase diagram: phases, invariant reactions, development of microstructure in eutectoid, hypo eutectoid and hypereutectoid alloys- influence of other alloying elements in the Fe-C systems - isothermal transformation diagram for eutectoid iron-carbon alloy - microstructures: Pearlite, bainite, spheroidite and martensite - steels, stainless steels and cast irons - Copper alloys - aluminium alloys - titanium alloys and their applications.

UNIT V CERAMICS, COMPOSITES AND NANOMATERIALS 9

Ceramics - types and applications - Composites: classification, the role of matrix and reinforcement - Fiber reinforced composites – Carbon-carbon composites -Nanomaterials: types, physical, chemical and mechanical properties - carbon nanotubes - Synthesis of nanomaterials - milling, sonochemical, Physical vapour deposition (PVD), Chemical vapour deposition (CVD) - Characterization: Transmission electron microscopy - Atomic force microscopy - X-ray powder diffraction - Nanoparticle size calculation **-** applications of nanomaterials.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will

CO1: Gain knowledge of binary phase diagrams, and also will be able to determine the phase composition and fraction of phase

CO2: Understand the significance of diffusion and various phase transformations

CO3: Have learned about the various mechanical properties like strengthening mechanisms, and tensile, creep, fatigue and hardness.

CO4: Understand the Fe - C system and various microstructures in it, and also about various ferrous and non-ferrous alloys.

CO5: Get an adequate understanding of the preparation, properties and applications of ceramics, composites and nanomaterials

REFERENCES:

1. W.D.Callitser and D.G.Rethwish. Materials Science and Engineering. John Wiley & Sons, 2020.
2. V.Raghavan. Materials Science and Engineering: A First Course. PHI Learning, 2015.
3. M.F.Ashby, P.J.Ferreira and D.L.Schodek. Nanomaterials, Nanotechnologies and Design: An Introduction for Engineers, 2011.
4. J.F.Shackelford. Introduction to Materials Science for Engineers. Pearson, 2015.
5. D.R. Askeland and W.J.Wright. Essentials of Materials Science and Engineering, Cengage Learning, 2013.
6. W.F.Smith, J.Hashemi and R.Prakash. Materials Science and Engineering. McGraw Hill Education, 2017.
7. J.C.Anderson, K.D.Leaver, P.Leevers and R.D.Rawlings, Materials Science for Engineers, CRC Press, 2019

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

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

3 0 2 4

UNIT I WATER TECHNOLOGY

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

PRACTICAL:

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

UNIT II NANOCHEMISTRY

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

PRACTICAL:

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

UNIT III CORROSION SCIENCE

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

PRACTICAL:

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

UNIT IV ENERGY SOURCES

Electrochemical cell, redox reaction, electrode potential – oxidation and reduction potential. Batteries – Characteristics; types of batteries; primary battery (dry cell), secondary battery (lead acid, lithium-ion battery) and their applications. Emerging energy sources – metal hydride battery, hydrogen energy, Fuel cells – H_2-O_2 fuel cell. Supercapacitors –Types and Applications, Renewable Energy: solar heating and solar cells. Recycling and disposal of batteries.

PRACTICAL:

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

UNIT V POLYMER CHEMISTRY

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

PRACTICAL:

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

TOTAL: 75 PERIODS

COURSE OUTCOMES:

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

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

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

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

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

TEXT BOOKS:

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

REFERENCES:

1. Schdeva M.V., “Basics of Nano Chemistry”, Anmol Publications Pvt Ltd, 2011.
2. Friedrich Emich, “Engineering Chemistry”, Medtech, 2014.

3. Gowariker V.R., Viswanathan N.V. and Jayadev Sreedhar, “Polymer Science” New AGE International Publishers, 2009.
4. Vogel’s Textbook of Quantitative Chemical Analysis (8th edition, 2014).

CO - PO Mapping

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

1’ = Low; ‘2’ = Medium; ‘3’ = High

CS23C02 COMPUTER PROGRAMMING IN PYTHON L T P C
3 0 2 4

COURSE OBJECTIVES:

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

UNIT I – STRUCTURED PROGRAMMING 9+6

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

PRACTICALS:

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

UNIT II – MODULARITY AND DECOMPOSITION 9+6

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

PRACTICALS:

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

UNIT III – 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/

ME23C03	ENGINEERING MECHANICS	L T P C
		3 1 0 4

COURSE OBJECTIVES:

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

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

UNIT I STATICS OF PARTICLES 9+3

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

UNIT II EQUILIBRIUM OF RIGID BODIES AND TRUSSES 9+3

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

UNIT III DISTRIBUTED FORCES 9+3

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

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

UNIT IV FRICTION AND WORK PRINCIPLES 9+3

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

UNIT V DYNAMICS OF PARTICLES AND RIGID BODIES 9+3

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

TOTAL : 60 Periods

COURSE OUTCOMES:

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

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

TEXT BOOKS:

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

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

UC23H02 **தமிழரும் தொழில்நுட்பமும்** **L T P C**
1 0 0 1

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

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

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

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

அலகு III உற்பத்தித் தொழில் நுட்பம்: **3**

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

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

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

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

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

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும்
   கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils – The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi – 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of

Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

UC23H02 **TAMILS AND TECHNOLOGY** **L T P C**
1 0 0 1

UNIT I WEAVING AND CERAMIC TECHNOLOGY 3

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

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY 3

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

UNIT III MANUFACTURING TECHNOLOGY 3

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

UNIT IV AGRICULTURE ANDIRRIGATION TECHNOLOGY 3

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

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3

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

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCEBOOKS

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

MA23C05	PROBABILITY AND STATISTICS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To understand the basics of random variables with emphasis on the standard discrete and continuous distributions.
- To understand the basic probability concepts with respect to two dimensional random variables along with the relationship between the random variables and the significance of the Central Limit theorem.
- To understand the basic concepts of sampling distributions and statistical properties of point and interval estimators.
- To apply the small/ large sample tests through Tests of hypothesis.
- To understand the concept of analysis of variance and use it to investigate factorial dependence.

UNIT I ONE-DIMENSIONAL RANDOM VARIABLES 9+3

Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Functions of a random variable.

UNIT II TWO-DIMENSIONAL RANDOM VARIABLES 9+3

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and Linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III ESTIMATION THEORY 9+3

Sampling distributions – Characteristics of good estimators – Method of Moments – Maximum Likelihood Estimation – Interval estimates for mean, variance and proportions.

UNIT IV TESTS OF SIGNIFICANCE 9+3

Type I and Type II errors – Tests for single mean, proportion, Difference of means (large and small samples) – Tests for single variance and equality of variances –χ^2 test for goodness of fit – Independence of attributes.

UNIT V DESIGN OF EXPERIMENTS 9+3

Completely Randomized Design – Randomized Block Design – Latin Square Design – 2^2 factorial design.

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 LAB EXERCISES

1. Data exploration using R
2. Visualizing Probability distributions graphically
3. Evaluation of correlation coefficient
4. Creating a Linear regression model in R
5. Maximum Likelihood Estimation in R
6. Hypothesis testing in R programming
7. Chi square goodness of fit test in R
8. Design and Analysis of experiments with R

OUTCOMES:

CO1: Can analyze the performance in terms of probabilities and distributions achieved by the determined solutions.

CO2: Will be familiar with some of the commonly encountered two dimensional random variables and be equipped for a possible extension to multivariate analysis.

CO3: Provides an estimate or a range of values for the population parameter from random samples of population.

CO4: Helps to evaluate the strength of the claim/assumption on a sample data using hypothesis testing.

CO5: Equips to study the influence of several input variables on the key output variable.

TEXT BOOKS:

1. Irwin Miller and Marylees Miller, "John E. Freund's Mathematical Statistics with applications", Pearson India Education, Asia, 8th Edition, 2014.
2. Walpole, R.E., Myers R.H., Myres S.L., and Ye, K. "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 9th Edition, 2024.

REFERENCES:

1. Richard A. Johnson, Irwin Miller, John Freund "Miller & Freund's Probability and Statistics for Engineers", Person Education, 8th Edition, 2015.
2. Ross, S.M. "Introduction to Probability and Statistics for Engineers and Scientists", Elsevier,
   New Delhi, 5th Edition, 2014.
3. Spiegel, M.R., Schiller, J., Srinivasan, R.A. and Goswami, D. "Schaum's Outline of Theory and Problems for Probability and Statistics", McGraw Hill Education, 3rd Edition, Reprint, 2017.
4. Devore, J.L. "Probability and Statistics for Engineering and the Sciences", Cengage Learning, 9th Edition, 2016.

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

IE23301	WORK SYSTEM DESIGN	L T P C 3 0 2 4

COURSE OBJECTIVES:

1. To understand the concepts of work study productivity and productivity measurement approaches.
2. To record and analyse selected tasks using flowcharts.
3. To apply method study to improve a task. Apply principles of motion economy to improve performance.
4. To conduct a time study to improve the efficiency of the system.
5. To estimate the standard times to assess the office work condition.

UNIT I PRODUCTIVITY 9

Productivity concepts and definitions - 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.

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.

UNIT III WORK MEASUREMENT - I 9

Purpose of work measurement – Techniques of work measurement- Time study- Equipment - selecting and timing the job - performance rating – allowances – Standard time – setting time standard for work with machines - learning effect.

UNIT IV WORK MEASUREMENT - II 9

Worksampling and Standard Time Determination- Group Timing Technique– Development of Standard data- Synthetic Data- predeterminedtimestandards (PTS),types- use of time standard - Methods Time Measurement (MTM) - Introduction to MOST technique - Wage incentive plans.

UNIT V METHOD STUDY 9

Method Study in office- Organization and methods (O & M) - Work measurement of office work - techniques of Work Measurement in office- Standardization and method of setting standards- Form design and control.

TOTAL : 45 PERIODS

LIST OF EXPERIMENTS 15 PERIODS

1. Application of outline process chart for method study

2. Application of Flow process chart for method study.
3. Application of Two handed process chart for method study
4. Determine the performance rating of the operator and rating capacity of the analyst using card dealing
5. Determine the performance rating of the operator and rating capacity of the analyst using walking
6. Determine the standard time using Peg board experiment.
7. Determine the utilization of working operator by Work sampling using Monte Carlo simulation techniques.
8. Determine the standard time using MTM practice

TOTAL: 60 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Measure productivity using productivity measurement approaches.

CO2. Conduct comprehensive methods study, including the recording and analysis of workflows and the application of motion economy principles to enhance efficiency.

CO3. Conduct time studies, accurately rate operator performance, and determine standard times for tasks

CO4. Apply advanced work measurement techniques to determine standard time and improve work processes

CO5. Implement methods study and work measurement techniques in office work condition.

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. BenjaminW.Niebel,AndrisFreivalds,“Methods,standardsandWorkDesign”,McGraw hill, Eleventh edition, 2002.

2. Maynard H.B, “Industrial Engineering Hand book”, McGraw-Hill, 2008.

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

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

ME23C02 **MANUFACTURING PROCESSES** **L T P C**

3 0 2 4

COURSE OBJECTIVES:

To impart knowledge on metal casting, joining, and forming processes

UNIT I METAL CASTING PROCESSES **9**

Sand Casting – Sand Mould – Type of patterns - Pattern Materials – Pattern allowances – Types of sand- sand properties and testing – Cores –Types and applications Basics of gating system – Molding machines – Melting furnaces – Principle of special casting processes- Shell, investment – Ceramic mould–Pressure die casting–Centrifugal Casting-CO_2 casting process Defects in Sand casting process Stir casting– Squeeze casting –Full Moulding –magnetic Moulding- Micro casting -Casting techniques for single crystal components -Casting defects

UNIT II METAL JOINING PROCESSES **9**

Fusion welding processes–Type of Gas welding–Flame characteristics–Filler and Flux materials Arc welding,Electrodes,Coating and specifications–Principles and types of Resistance welding– Gas Tungsten arc welding- Gas metal arc welding –Cold metal Transfer-Wire arc additive Manufacturing–Thermal spraying- Submerged arc welding – Electro slag welding – Plasma arc welding – ThermitWelding –Electron beam welding -Laser beam welding-Ultrasonic Welding –Friction welding–Friction stir welding–Diffusion bonding Weld defects - Brazing and soldering –– Adhesive bonding.

UNIT III BULK DEFORMATION PROCESSES **9**

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging–Characteristics of the processes–Typical forging operations–rolling of metals– Types of Rolling – Flat strip rolling –contour roll forming- shape rolling operations – Defects in rolled parts – Principle of rod and wire drawing–Tube drawing–Principles of Extrusion– Types–Hot and Cold extrusion.

UNIT IV SHEET METAL PROCESSES **9**

Sheet metal characteristics–Typical shearing bending and drawing operations–Stretch forming operations – Formability of sheet metal – Test methods –special forming processes – Working principle and applications–Hydro forming–Rubber pad forming– Multi-point Die Forming– Warm/Hot Forming – Solid Granular Medium Forming –Metals pinning-Introduction of Explosive forming magnetic pulse forming, peen-forming, Super plastic-forming –Micro-forming–Incremental forming.

UNIT V MANUFACTURE OF PLASTIC COMPONENTS **9**

Types and characteristics of plastics – Molding of thermoplastics – working principles and typical applications – injection molding – Plunger and screw machines – Compression molding transfer molding –Typical industrial applications–introduction to blow-molding– Rotational-molding–Film-blowing– Extrusion–Vacuum bag Forming- Thermo-forming– Bonding of Thermo-plastics

Laboratory Experiments

1. Green sand mould preparation with single piece and split patterns.
2.Estimation of green sand properties.
3.Casting of aluminum components through green sand ,full mould process.
4.Microstructural examination of weldments.
5.Estimation of formability of sheet metals.
6.Fabrication of simple sheet metal components.

TOTAL: (45+ 15) 60PERIODS

COURSE OUTCOMES:

The students will be able to

CO1 Explain the working principles of various metal casting processes

CO2 Categorize and select the appropriate metal joining process.

CO3 Compare the working principles of bulk deformation of metals.

CO4 Suggest suitable sheet metal forming processes for production of Engineering Components.

CO5 Explain the manufacturing of plastic components.

TEXT BOOKS:

1. Kalpakjian.S,"Manufacturing Engineering and Technology",Pearson Education India Edition,8th edition 2020.
2. Rao.P.N., Manufacturing Technology Foundry, Forming and Welding,5thEdition.Tata McGraw Hill, 2018.

REFERENCES:

1. Gowri.S,P.Hariharan,A.SureshBabu,Manufacturing Technology, Pearson Education,2008.
2. R.K.Jain Production Technology Manufacturing Systems Vol –I K.hanna Publishers.
3. PaulDegarmaE.,BlackJ.T.and Ronald A.Kosher, Materials and Processes, in Manufacturing, Eight Edition, Prentice Hall of India,1997.
4. Sharma,P.C.,A Textbook of Production Technology, S.ChandandCo.Ltd.,2006.
5. Roy.A.Lindberg, Processes and materials of manufacture, PHI / Pearson Education,2006.

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

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

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

UNIT I FLUID PROPERTIES AND FLOW CHARACTERISTICS 10

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

PRACTICALS

- Calibration of Venturimeter

UNIT II FLOW THROUGH PIPES AND BOUNDARY LAYER 9

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

PRACTICALS

- Determination of friction factor for flow through pipes

UNIT III DIMENSIONAL ANALYSIS AND MODEL STUDIES 7

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

UNIT IV TURBINES 10

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

PRACTICALS

- Characteristics of Pelton wheel turbine

UNIT V PUMPS 9

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

PRACTICALS

- Characteristics of centrifugal pumps
- Characteristics of reciprocating pump

TOTAL: 45 L + 30 P = 75 PERIODS

COURSE OUTCOMES:

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

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

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

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

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

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

TEXT BOOKS:

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

REFERENCES:

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

MAPPING OF CO'S WITH PO'S

PO/PSO		COURSE OUTCOME					OVERALL CORRELATION OF COS TO POS
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	3	3	3	3	3	3
PO2	Problem analysis	2	3	3	3	3	3
PO3	Design / development of solutions	1	3	3	3	3	3
PO4	Investigation	1	1	2	2	2	2
PO5	Modern Tool Usage	1	1	1	1	1	1
PO6	Individual and Team work	1	1	1	1	1	1
PO7	Communication	1	1	1	1	1	1
PO8	Engineer and Society	2	2	2	3	3	2
PO9	Ethics	1	1	1	1	1	1
PO10	Environment and Sustainability	1	1	1	1	1	1
PO11	Project Management and Finance	1	1	1	1	1	1
PO12	Life Long Learning	2	2	2	3	3	2
PSO1	Knowledge of Civil Engineering discipline	3	3	3	3	3	3
PSO2	Critical analysis of Civil Engineering problems and innovation	2	3	3	3	3	3
PSO3	Conceptualization and evaluation of engineering solutions to Civil Engineering Issues	2	3	2	3	3	3

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

COURSE OBJECTIVES:

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

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS 9

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

PRACTICALS

- Tension test on mild steel rod

UNIT II TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM 9

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

PRACTICALS

- Deflection test on carriage spring

UNIT III TORSION 9

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

PRACTICALS

- Torsion test on mild steel rod

UNIT IV DEFLECTION OF BEAMS 9

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

PRACTICALS

- Compression test on helical spring

UNIT V THIN &THICK SHELLS, THEORIES OF FAILURE 9

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

PRACTICALS

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

TOTAL: 45L+30P =75 PERIODS

COURSE OUTCOMES:

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

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

CO2 Understand the bending and shear stress distribution in beams.

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

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

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

TEXT BOOKS:

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

REFERENCES:

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

CO-PO-PSO MAPPING: MECHANICS OF MATERIALS

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

IE23U01 INDUSTRIAL STANDARDS FOR INDUSTRIAL ENGINEERING L T P C

1 0 0 1

COURSE OBJECTIVES:

1. To provide students with a thorough understanding of workplace design, ergonomics, and safety standards, including relevant laws and regulations
2. To enable students to comprehend the principles and requirements of quality management systems.
3. To equip students with the knowledge to analyze and apply environmental and energy management systems.
4. To develop students' ability to understand and implement project management guidelines.
5. To prepare students to integrate various industrial standards into real-world practices, ensuring compliance and continuous improvement.

MODULE I OVERVIEW OF STANDARDS 6

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

MODULE II 9

WORKPLACE DESIGN, ERGONOMICSAND SAFETY STANDARDS

THE FACTORIES ACT, 1948 - Time Standards: Standard Data, MTM, MOST - ISO 7250-1:2017- ISO7250-2:2024 Basic human body measurements – Anthropometry - ISO 6385:2016 - ISO 45001:2018- OHSAS 18001- NIOSH.

QUALITY STANDARDS

ISO 9001:2015 Quality Management Systems- IATF 16949:2016 Automotive Quality Management System.

SUSTAINABILITY ENVIRONMENTAL AND PROJECT MANAGEMENT STANDARDS

ISO 14001:2015 - Environmental Management Systems - ISO 50001:2018 - Energy Management Systems - ISO 21500:2012 - Guidance on project management.

TOTAL: 15 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Recall and describe the key provisions of The Factories Act, 1948, and the principles of ISO 6385:2016 and ISO 7250-1:2017.

CO2. Explain and interpret the requirements of ISO 45001:2018 and OHSAS 18001, and their impact on workplace safety and health

CO3. Apply the principles of Methods-Time Measurement (MTM) and Maynard Operation Sequence Technique (MOST) in workplace design and time standards

CO4. Examine and differentiate between the quality management systems of ISO 9001:2015 and IATF 16949:2016, identifying their unique applications in different industries

CO5. Explain comprehensive management systems that combine the standards of ISO 14001:2015, ISO 50001:2018, and ISO 21500:2012 for sustainable and efficient industrial operations.

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

CE23C01	MECHANICS OF MACHINES	L T P C
		3 0 2 3

COURSE OBJECTIVES:

1. Understand the basic concepts and terminologies related to mechanisms and machines.
2. Analyze the kinematic and dynamic behavior of various mechanical systems.
3. Design and analyse gears, and gear trains.
4. Apply principles of static and dynamic balancing to rotating and reciprocating masses.
5. Utilize analytical and graphical methods to solve real-world engineering problems related to machinery.

UNIT I FUNDAMENTALS OF MECHANISMS AND MACHINES 9

Introduction to mechanisms and machines-Kinematic links, pairs, and chains -Types of constrained motion - Degrees of freedom (mobility)-Grashof's law and types of four-bar linkages -Velocity and acceleration analysis of simple mechanisms using Relative velocity method.

UNIT II LINKAGES AND MECHANISMS DESIGN 9

Design and Analysis of Linkages, Four-bar linkages, Slider-crank mechanisms and Quick-return mechanisms- Types of cams and followers- Cam profile design Displacement, velocity, and acceleration analysis of cam mechanisms

UNIT III TOOTHED GEAR AND GEAR TRAINS 9

Gear tooth profiles, Involute and cycloidal gears, Interference and undercutting, Gear materials and manufacturing processes-Types of gears and gear trains- Gear nomenclature- Analysis of simple and compound gear trains, Epicyclic (planetary) gear trains-

Relevant Laboratory exercises :

Study of gear parameters

Experimental study of velocity ratios of simple, compound, epicyclic and differential gear trains.

Apparatus required are non-powered gear models and gear trains models.

UNIT IV BALANCING AND VIBRATIONS 9

Balancing of rotating masses- Balancing of reciprocating masses-Balancing of multi-cylinder engines-Types of vibrations, Natural frequency and damping, Forced vibrations, Vibration isolation and control

Relevant Laboratory exercises :

To study the free vibration behavior of SDOF both damped and undamped systems and to determine the frequency or period of vibration. (oscillation) theoretically and actually by experiment. Apparatus required are spring mass vibration setup, torsional vibration setup.

To determine the critical speed of shaft of various sizes and to compare it with the theoretical values. Apparatus required is a setup specially developed for the study of Whirling Phenomenon

UNIT V GYROSCOPIC EFFECTS AND INTRODUCTION TO ROBOTICS 9

Gyroscopic forces and moments, Gyroscopic stabilization, Applications of gyroscopic principles - Types of robots and their applications, Kinematics of robots, Degrees of freedom in robotic systems, Kinematic and dynamic analysis using simulation tools

Practical applications and hands-on sessions.

Relevant Laboratory exercises : To determine the gyroscopic couple of rotating masses and to verify the gyroscope rules of a plane rotating disc. Apparatus required is motorised gyroscope

TOTAL: (45+15 = 60 PERIODS)

COURSE OUTCOMES:

The students will be able to

CO1. Demonstrate a thorough understanding of basic concepts and terminologies related to mechanisms and machines, such as kinematic links, pairs, chains, and degrees of freedom.

CO2. Perform detailed kinematic and dynamic analysis of various mechanical systems, including linkages, cams, and gears, using both graphical and analytical methods.

CO3. Design and analyze mechanical components such as linkages, cams, gears, and gear trains, ensuring they meet specified performance criteria and constraints.

CO4. Apply principles of static and dynamic balancing to rotating and reciprocating masses in machinery, reducing vibrations and enhancing the stability and performance of mechanical systems.

CO5. Utilize analytical and graphical methods to develop solutions for real-world engineering problems related to machinery, integrating knowledge of mechanical behavior, material properties, and design constraints.

TEXT BOOKS:

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

REFERENCES:

1. Cleghorn. W. L., Nikolai Dechev, “Mechanisms of Machines”, Oxford University Press, 2015.
2. Rao.J.S. and Dukkipati.R.V. “Mechanism and Machine Theory”, New Age International Pvt. Ltd., 2006.
3. Rattan, S.S, “Theory of Machines”, McGraw-Hill Education Pvt. Ltd., 2017.
4. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill, 2009.
5. Thomas Bevan, “The Theory of Machines”, Pearson Education Ltd., 2010

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

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

THERMODYNAMICS **L T P C**

ME23C14 **3 0 0 3**

COURSE OBJECTIVES:

To impart knowledge on various forms of energy, energy transfer and energy interactions

UNIT I FIRST LAW OF THERMODYNAMICS 9

Thermodynamic systems, Properties and processes Thermodynamic Equilibrium - Displacement work - P-V diagram. Thermal equilibrium - Zeroth law – Concept of temperature and Temperature Scales. First law – application to closed and open systems – steady and unsteady flow processes.

UNIT II SECOND LAW AND CONCEPT OF ENTROPY 9

Heat Engine – Refrigerator - Heat pump. Statements of second law and their equivalence & corollaries. Carnot cycle - Reversed Carnot cycle - Performance - Clausius inequality. Concept of entropy - T-s diagram - Tds Equations - Entropy change for a pure substance, Principle of increase in entropy.

UNIT III EXERGY ANALYSIS 9

High and low grade energy, Exergy and Anergy, Availability and Irreversibility for open and closed system processes - I and II law Efficiency, Applications of II Law.

UNIT IV PROPERIES OF PURE SUBSTANCES, IDEAL AND REAL GASES 9

Steam - formation and its thermodynamic properties - p-v, p-T, T-v, T-s, h-s diagrams. PVT surface. Determination of dryness fraction of wet and very wet steam. Calculation of work done and heat transfer in non-flow and flow processes using Steam Table and Mollier Chart.

Properties of Ideal gas, real gas - comparison. Equations of state for ideal gas.Real Gas, Vander Waal's relation - Reduced properties - Compressibility factor - Principle of Corresponding states - Generalized Compressibility Chart.

UNIT V GAS MIXTURES AND THERMODYNAMIC RELATIONS 9

Gas mixtures, Maxwell relations - Tds Equations - heat capacities relations - Energy equation, Joule-Thomson experiment - Clausius- Clapeyron equation.

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Understand and carry out various thermodynamic system analysis

CO2. Apply the second law of thermodynamics to various thermal systems

CO3. Determine the availability and perform the exergy analysis of thermal systems

CO4. Evaluate the properties of pure substance and real gases

CO5. Explain the thermodynamic relations and compute properties of gas mixtures

TEXT BOOKS:

1. Nag.P.K., "Engineering Thermodynamics", 6th Edition, Tata McGraw Hill (2017), New Delhi
2. Cengel, Y and M. Boles, Thermodynamics - An Engineering Approach, Tata McGraw Hill,8th Edition, 2015

REFERENCES:

1. Rathakrishnan, E., "Fundamentals of Engineering Thermodynamics", 2nd Edition, Prentice Hall of India Pvt. Ltd, 2006.
2. E. Natarajan, Engineering Thermodynamics-Fundamentals and Applications, First Edition 2019, ISBN: 93-1568-61-3, Anuragam Publication.
3. Chattopadhyay, P, "Engineering Thermodynamics", 2nd Edition Oxford University Press, 2016
4. Claus Borgnakke and Richard E. Sonntag, "Fundamentals of Thermodynamics", 7th Edition, Wiley Eastern, 2009.
5. Venkatesh. A, "Basic Engineering Thermodynamics", Universities Press (India) Limited, 2007
6. Moran & Shapiro, "Principles of Engineering Thermodynamics", 8th Edition, Wiley Eastern,

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

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

IE23401	APPLIED ERGONOMICS	L T P C
		3 0 2 4

COURSE OBJECTIVES:

1. To explain the Interdisciplinary nature and basic knowledge on human factor engineering.
2. To describe the anthropomorphic measures and Work posture measurement for workers
3. To define the Physiological factors affecting work and Psychological effect on work.
4. To design the workplaces under various environmental conditions to improve the work.
5. To analyse the proper assessment tool for the ergonomic evaluation in an industry

UNIT I INTRODUCTION 9

Human factors Engineering/Ergonomics – Interdisciplinary nature- Human–machine systems - Ergonomics and its areas of application in the work system - Bio-static and Bio-dynamic Mechanics -Human Information receiving and processing – Information theory and its application – Cognitive systems - Mental Work Load -Signal detection theory

UNIT II WORK PLACE DESIGN 9

Problems of body size- Anthropometry measures- Work posture– Design for standing and seated workers - Design of repetitive tasks - Design of manual handling tasks- VDT work stations – Hand tool design -Design of Displays and controls

UNIT III PHYSIOLOGICAL ASPECTS OF HUMAN AT WORK 9

Stress and fatigue -Physical work capacity - Physiological factors affecting work capacity –Fitness for work –Working hours and shift work- Quantitative work load analysis – Psychological work Demands.

UNIT IV DESIGN OF ENVIRONMENT 9

Design and Assessment in Hot, cold workplaces and the design of the physical environment– Noise and vibration- Vision –Illumination- Human errors and Accidents – OSHA: Ergonomics Safety and Health Management rules – Personal Protective Equipment, AQI.

UNIT V ERGONOMIC ASSESSMENT TOOLS 9

Common tools used by ergonomist in work posture- Rapid Upper Limb Assessment (RULA), Rapid Entire Body Assessment (REBA), Ovako Working Posture Analysis System (OWAS), Strain Index, Rapid Office Strain Assessment (ROSA), Risk Assessment of Pushing and Pulling (RAPP), Manual Handling Assessment Chart (MAC), Role of an ergonomist.

TOTAL : 45PERIODS

List of Experiments: 15 PERIODS

1. Development of anthropometric data for male and female and design the desk for students.
2. Effect of workload on heart rate and energy expenditure using Ergo cycle.
3. Evaluation of physical fitness using step test
4. Effect of work-rest schedule on physical performance (Ergo cycle / tread mill)
5. Analysis of noise level in different environment

6. Analysis of Illumination of work places.
7. Estimation of metabolic rate using metabolic Analyzer.
8. Experiment using Vibrometer

COURSE OUTCOMES:

The students will be able to

CO1. Illustrate the knowledge on basic of human factor engineering and Engineering science.

CO2. Apply the skills associated with ergonomic measurement methods and analytical techniques to workplace ergonomic problems.

CO3. Conduct an ergonomic analysis and ergonomic recommendations for modern work environment problems.

CO4. Implement the occupational health and safety rules to improve the work place.

CO5. Analyse the proper assessment tools in ergonomics evaluation in an Industry

TEXT BOOKS:

1. Bridger, R. S." Introduction to Ergonomics", 3rd ed. CRC Press, New York and London,2008
2. Martin Helander, "A guide to Ergonomics of Manufacturing", TMH, 2006
3. Hedge, Alan**, "**Ergonomic workplace design for health, wellness, and productivity" CRC Press 2016

REFERENCES:

1. Philips, Chandler A, "Human Factors Engineering", John Wiley and Sons, Inc. 2000
2. Sanders, M.M. & McCormick, E.J. "Human Factors in Engineering & Design "7th ed., McGraw-Hill, NY,1993
3. Patrick Neumann "Inventory of Tools for Ergonomic Evaluation" SMARTA theme of the Swedish National Institute for Working Life.

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

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

IE23C06

OPERATIONS RESEARCH

L T P C

3 0 2 4

COURSE OBJECTIVES:

1. Provide knowledge of optimization techniques and approaches.
2. Formulate a real-world problem as a mathematical programming model.
3. Enable the students apply mathematical, computational and communication skills needed for the practical utility of Operations Research.
4. Knowledge to solve networking problems.
5. Knowledge about Project Management.
6. Gain knowledge on solving decision making and game theory models.

UNIT I LINEAR PROGRAMMING 9

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method. Solutions to LPP using simplexalgorithm – Two phase method – Big M method

UNIT II ADVANCES IN LINEAR PROGRAMMING 9

Revised simplex method - primal dual relationships – Dual simplex algorithm – Sensitivity analysis– changes in RHS value – changes in Coefficient of constraint – Adding new constraint – Addingnew variable.

UNIT III NETWORK ANALYSIS I 9

Transportation problems: Northwest corner rule, least cost method, Vogel's approximation method- stepping stone method - MODI method – Unbalanced transportation – Assignment problem – Hungarian algorithm. TSP- Solving using Hungarian Algorithm- Applications of TSP to other engineering problems

UNIT IV NETWORK ANALYSIS II 9

Project Management CPM & PERT. Minimum spanning tree problem, shortest path problem,Maximal flow problem-Maximal-flow minimum cut theorem - Maximal flow algorithm

UNIT V DECISION THEORY AND GAME THEORY 9

Decision Theory- Decision under certainty-Decision under Risk-Decision under uncertainty – Decision Tree- Game theory – Two person zero sum games – Graphical solution Algebraic solution – Linear Programming solution.

LIST OF EXPERIMENTS 15 PERIODS

1. Formulation of Linear Programming Problem
2. Solving LPP using optimization software
3. Sensitivity Analysis of Linear Programming Problem
4. Solving Transportation and Assignment Problems
5. Identifying critical activities in a project using software
6. Decision making using various floats in a project

7. Solving Minimal Spanning Tree problems and Shortest route problems using optimization software
8. Solving decision making problems and game theory problems using Software.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1. Convert anabstract real-world problem to an optimization model.

CO2. To perform sensitivity analysis for an optimization problem

CO3. To build and solve Transportation Models, Assignment Models and TSP models

CO4. To handle issues in Project Management and other network problems.

CO5. To make decision under risk and uncertainty

TEXT BOOKS:

1. Panneerselvam R, “Operations Research”, PHI, 2009.
2. Srinivasan G., “Operations Research Principles and Applications”, PHI, 2017.

REFERENCES:

1. Hamdy A Taha, “Operations Research – An Introduction”, Pearson, 2017.
2. Philips, Ravindran and Solberg, “Operations Research principle and practise”, John Wiley, 2007.
3. Ronald L Rardin, “Optimisation in Operations Research”, Pearson, 2018.

CO’s - PO’s & PSO’s MAPPING

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

IE23402	MANUFACTURING AUTOMATION	L T P C
		3 0 2 4

COURSE OBJECTIVES:

1. Define automation and justification in manufacturing.
2. Explain the control technologies in automation.
3. Explain the concept of fixed automation using transfer lines.
4. Describe the programmable automation such as CNC and industrial robotics.
5. Use of automated material handling, storage and data capture.

UNIT I MANUFACTURING OPERATIONS 9

Automation in production systems, principles and strategies, Product/production relationships, Production concepts and mathematical models, manufacturing economics.

UNIT II CONTROL TECHNOLOGIES 9

Automated systems – elements, functions, levels, Continuous Vs discrete control, Computer

Process control, Sensors, Actuators, ADC, DAC, Programmable Logic Controllers(PLC) – ladder logic diagrams.

UNIT III TRANSFER LINES 9

Automated production lines – applications, Analysis – with and without buffers, automated

Assembly systems, line unbalancing concept.

UNIT IV NUMERICAL CONTROL AND ROBOTICS 9

NC - CNC – Part programming – DNC – Adaptive control – Robot anatomy – Specifications – End effectors – Industrial applications.

UNIT V AUTOMATED HANDLING AND STORAGE 9

Automated Guided Vehicle systems, AS/RS, Carousel storage, Automatic data capture - Bar code technology-RFID

45 PERIODS

LIST OF EXPERIMENTS 15 PERIODS

1. Exercises in CNC Turning Machine
2. Exercises in CNC Milling Machine
3. Exercises using Sensors
4. PLC Ladder Logic Programming and Execution
5. Pick and Place Programming for Robots

TOTAL: 60 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Select of automated equipment with cost justification.

CO2. Understand control technologies

CO3. Select buffer size and location in transfer lines

CO4. Prepare a simple CNC program, select a robot configuration for given application.

CO5. Recommend an appropriate automated material handling, storage and data capture method.

TEXT BOOKS:

1. Mikell P.Groover, Automation, "Production Systems and Computer Integrated Manufacturing" 5th Edition,PHI, 2019.

REFERENCES:

1. Mikell P.Groover, Emory W. Zimmers, Jr., "CAD/CAM: Computer - Aided Design and Manufacturing", PHI, 2017.

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

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

ME23C06 **DESIGN THINKING** **L T P C**

2 0 2 3

OBJECTIVES:

The main learning objective of this course is to prepare the students to understand, apply and analyze the various design thinking concepts and tools for better innovative ideas.

THEORY

UNIT I INTRODUCTION TO DESIGN THINKING 6

An insight into Design, Design Methodology, the origin of Design thinking, Design thinking Vs Engineering thinking, the importance of Design Thinking, Design Vs Design thinking, understanding Design thinking and its various process models or frameworks, Stanford process models and its five stages, features of design thinking, application of Design thinking

UNIT II EMPATHIZE IN DESIGN THINKING 6

Human-Centered Design (HCD) process, explanation of HCD design thinking with examples, Role of Empathy in design thinking, persona creation and its importance, tools of empathy: Empathy maps, advantages and disadvantages of empathy maps, Customer journey map and its advantages & disadvantages, Mind Maps, and its uses, understanding empathy tools.

UNIT III DEFINE PHASE AND IDEATION PHASE 6

Explore define phase in Design Thinking, Methods of Define phase. Introduction to ideation Methods, convention methods for ideation, intuitive methods: Brainstorming, storyboard telling, select ideas from ideation Methods: Bingo Selection, Six Thinking Hats.

UNIT IV PROTOTYPING PHASE AND TESTING PHASE 6

Prototyping and methods of prototyping, Difference between low fidelity and high-fidelity prototypes, paper prototyping, techniques for implementing paper prototyping, Digital prototyping, user testing methods, Advantages, and disadvantages of user Testing/ Validation.

UNIT V DESIGN THINKING FOR INNOVATION 6

Innovation in Design Thinking, Definition of innovation, the art of innovation, types of innovations, product innovation, process innovation, and organizational innovation, characteristics of innovation, levels of innovation, Innovation towards design, Case studies

TOTAL: 30 PERIODS

Introduction to Design Thinking

Exercise 1: Load Reduction Instruction (LRI) activity

Exercise 2: Reflection - The Marshmallow Challenge

Exercise 3: Round-Robin Brainstorming - Mind Tools

Ideation Tools & Exercises

Exercise 4: The Wallet Challenge -Team Activity

Exercise 5: Thirty circle - Story Telling

Exercise 6: Framing the Design Challenge with mind mapping

Analysis & Drawing Inferences - User research

Exercise 7: Persona Creation & User Research

Exercise 8: Creating Empathy maps

Exercise 9: Creating Customer Journey maps

The art of the pitch

Exercise 10: Make a paper prototype for user testing (mock-up model)

Exercise 11: Develop & Present a 3-Minute Pitch (Sample Pitches)

Exercise 12: The Design Challenge – Testing Documentation and Pitching

TOTAL: 30 PERIODS

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

1. Understand the principles of design thinking and it approaches.
2. Apply empathy and its tools in ideation techniques in human-centered design problems.
3. Apply the design thinking techniques for Define and Ideation Phase of the design thinking context.
4. Build the prototype, analyze and test it in a design thinking context.

Apply design thinking tools toward innovative ideas.

TEXT BOOK:

1. Tim Brown, "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation", Harper Collins Publishers Ltd., 2009.

Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand – Improve– Apply", Springer, 2011.

REFERENCES:

1. Roger Martin, "The Design of Business: Why Design Thinking is the Next Competitive Advantage", Harvard Business Press, 2009.
2. Idris Mootee, "Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School", John Wiley & Sons, 2013.
3. Jeanne Liedtka, Andrew King, Kevin Bennett, “Book - Solving Problems with Design Thinking - Ten Stories of What Works” (Columbia Business School Publishing), 2013.
4. Maurício Vianna, Ysmar Vianna, Isabel K. Adler, Brenda Lucena, Beatriz Russo, “Design thinking: Business Innovation”, MJV Press, 2011.
5. Burgelman, Christensen, and Wheelwright, “Strategic Management of Technology and Innovation”, 5th Edition, McGraw Hill Publications, 2017.
6. Brenda Laurel, "Design Research methods and perspectives", MIT press, 2003.

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

IE23501 **PRODUCTION AND OPERATIONS MANGEMENT** **L T P C**

3 0 2 4

COURSE OBJECTIVES:

1. Recognize and appreciate the concept of Production and Operations Management in creating and enhancing a firm's competitive advantages.
2. Describe the concept and contribution of various constituents of Production and Operations Management (both manufacturing and service).
3. Relate the interdependence of the operations function with the other key functional areas of a firm.
4. Teach analytical skills and problem-solving tools to the analysis of the operations problems
5. Apply scheduling and Lean Concepts for improving System Performance.

UNIT I INTRODUCTION 9

Objectives of Operations Management, Scope of Operations Management, Relationship of Operations with other Functional areas, Manufacturing Vs Service sector, Operations Decision making, Phases in Product Design and Development, Product Life Cycle, Process Selection. Measures of capacity, Factors affecting capacity, Capacity Planning, Systematic approach to capacity planning, Long-term and short-term capacity decisions, Tools for capacity planning-Decision trees.

UNIT II FORECASTING 9

Need, Determinants of Demand, Demand Patterns, and Qualitative Forecasting Methods-Delphi techniques. Market Research, Nominal Group Technique. Quantitative Forecasting methods – Moving Average Methods, Exponential Smoothing Methods, Regression methods, Monitoring and Control of Forecasts, Multi-Item Forecasting, Requirements and Selection of Good forecasting methods.

UNIT III INVENTORY MODELS 9

Inventory Costs- Purchase model– Manufacturing model –Models with Shortages-Model with pricebreaks - Reorder point model - Probabilistic inventory model

UNIT IV AGGREGATE PLANNING AND MATERIAL REQUIREMENT PLANNING 9

Role of aggregate Product planning, Managerial inputs to Aggregate planning, Pure and Mixed strategies, Mathematical Models for Aggregate planning – Transportation Method, Linear programming Formulation, Linear Decision Rues, Master Production Schedule(MPS), Procedure for developing MPS, MRP -Lot sizing methods – Implementation issues, MRP – II, Introduction to ERP.

UNIT V PRODUCTION ACTIVITY CONTROL AND LEAN MANUFACTURING 9

Objectives and Activities of Production Activity Control -JIT- KANBAN- Introduction to Scheduling in different types of Production Systems. Lean Manufacturing - Principles – Activities - Tools and techniques - Case studies.

LIST OF EXPERIEMENTS **TOTAL : 15 PERIODS**

HANDS-ON TRAINING ON FOLLOWING:

1. Make or Buy Decision making
2. Break Even Point analysis
3. Decision Tree analysis to make capacity decisions
4. Time Series analysis
5. Regression methods
6. Measures of forecasting accuracy
7. EOQ /EBQ Calculations
8. Price Break Models
9. Finding Re-order Point
10. Find the best strategy for aggregate planning
11. Solving MRP Problems
12. Lot Sizing in MRP
13. Waste Identification in process

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1. Understand the various functions function in different areas of Industry

CO2. Evaluate the forecasting for Product or Services with various methods

CO3. Develop an inventory models for different scenarios

CO4. Develop aggregate plan, material requirement plan for an industry

CO5. Able to control the production and identify the waste by using various tools

TEXT BOOK:

1. Panneerselvam. R, Production and operations Management, PHI, 3rd Edition, 2012.

REFERENCES:

1. Lee J. Krajewski, Manoj K. Malhotra, Larry P. Ritzman, Operations Management: Processes and Supply Chains Pearson Education, 11th Edition, 2019
2. Norman Gaither, Greg Frazier, Operations Management, Thomson Learning, 9th Edition, 2002. 3. William J Stevenson, Operations Management, McGraw Hill, 13th Edition, 2018.

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

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

IE23C01 **ENGINEERING QUALITY CONTROL** **L T P C**

3 0 2 4

COURSEOBJECTIVES:

1. To develop a clear knowledge in the basics of various quality concepts.
2. To understand the student's application of control charts and their techniques.
3. To develop the special control procedures for service and process-oriented industries.
4. To analyse and understand the process capability study.
5. To illustrate the acceptance sampling procedures for incoming raw material.

UNIT I QUALITY FUNDAMENTALS 9

Importance of quality- evolution of quality- definitions of quality- dimensions of quality- quality control quality assurance- areas of quality- quality planning- quality objectives and policies- quality costs economics of quality- quality loss function-three cases and problems- quality Vs productivity- Quality Vs reliability- Quality Standards.

UNIT II CONTROL CHARTS FOR VARIABLES 9

Process variation- preliminary decisions- control limits and their computation- construction and application of X bar, R and S charts- warning and modified control limits- process adjustment for trend - Comparison of process variation with specification limits- O.C. curve for X bar chart- individual measurement charts- X-chart, moving average and moving range chart, multi-vari chart.

UNIT III CONTROL CHARTS FOR ATRRIBUTES 9

Limitations of variable control charts- Control charts for fraction non-conforming- p and np charts, variable sample size, operating characteristic function, run length- Control chart for nonconformities(defects)- c, u, ku charts, demerits control chart- applications.

UNIT IV STATISTICAL PROCESS CONTROL 9

Process stability- process capability study using control charts- capability evaluation- Cp, Cpk and Cpm – capability analysis using histogram and normal probability plot- machine capability study gauge capability study- setting statistical tolerances for components and assemblies.

UNIT V ACCEPTANCE SAMPLING 9

Need- economics of sampling- sampling procedure- single and double sampling- O.C. Curves- Average outgoing quality- Average sample number- Average total inspection- Multiple and sequential sampling- Standard sampling plans-Variable sampling plans- Military, Dodge-Roming, IS 2500.

TOTAL : 45 PERIODS

LABORATORY EXPERIMENTS 15 PERIODS

Students will perform analysis of data in the following topics using Data Analysis package

1. **Control chart for Variables**

   (i) To find out the control limits for $\bar{X}$, R and S chart
   (ii) To find out the process standard deviation for $\bar{X}$, R and S chart

2. **Control chart for Attributes**

   (i) To find out the control limits for constant and varying sample size for the following NP ,P, C , U and Ku charts.

3. **Process Capability Analysis**

   (i) To find the Cpk, Cp, UCL , LCL and other indices in process capability study.

4. **Acceptance Sampling**

   (i) To design single, double, sequential and multiple sampling.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Control the quality of processes using control charts for variables in manufacturing industries.
CO2. Control the occurrence of defective product and the defects in manufacturing companies.
CO3. Control the occurrence of defects in services.
CO4. Analyzing and understanding the process capability study.
CO5. Developing the acceptance sampling procedures for incoming raw material.

TEXT BOOKS:

1. Douglus C. Montgomery, “Introduction to Statistical Quality Control”, Wiley-India, Eighth Edition, 2019.
2. Krishnaiah K.,” Applied Statistical Quality Control and Improvement”, PHI, 2014.

REFERENCES:

1. AmitavaMitra, “Fundamentals of Quality Control and Improvement”, Wiley, Fourth Edition, 2015.
2. Dale H. Besterfield, Quality Control, Pearson Education Asia, 10th Edition, 2018.
3. Eugene L. Grant and Richard S. Leaven Worth, “Statistical Quality Control”, McGraw-Hill Education, Seventh Edition, 2000.

CO’s - PO’s & PSO’s MAPPING

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

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

3 0 0 3

COURSE OBJECTIVES:

1. Teach the needfor quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM
2. ExplaintheTQMPrinciplesforapplication
3. Define the basics of Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA
4. Describe Taguchi's Quality Loss Function, Performance Measures and apply Techniques likeQFD, TPM, COQ and BPR
5. IllustrateandapplyQMS andEMSinanyorganization

UNIT I INTRODUCTION **9**

Introduction-Needforquality-Evolutionofquality-Definitionofquality-Dimensionsofproductand service quality –Definition of TQM-- Basic concepts of TQM - Gurus of TQM(Briefintroduction)– Quality Information System -TQMFramework-BarrierstoTQM–BenefitsofTQM

UNIT II TQM PRINCIPLES **9**

Leadership - Deming Philosophy, Quality Council, Quality statements and Strategic planning-CustomerSatisfaction–CustomerPerceptionofQuality,Feedback,Customercomplaints,Service Quality, Kano Model and Customer retention – Employee involvement –Motivation,Empowerment, Team and Teamwork, Recognition & Reward and Performance Appraisal--Continuousprocessimprovement–JuranTrilogy,PDSAcycle,5SandKaizen - Bench Marking-Supplierpartnership–Partnering,Supplierselection,SupplierRatingandRelationshipdevelopment.

UNIT III TQMTOOLS&TECHNIQUESI **9**

The seven traditional tools of quality - New management tools - Six-sigma Process Capability-Benchmarking-Reasonstobenchmark,Benchmarkingprocess,WhattoBenchMark,Understanding Current Performance, Planning, Studying Others, Learning from the data, Usingthe findings, Pitfalls and Criticisms of Benchmarking - FMEA - Intent, Documentation, Stages:DesignFMEA andProcessFMEA.

UNIT IV TQMTOOLS&TECHNIQUESII **9**

Quality circles – Quality Function Deployment (QFD) - Taguchi quality loss function – TPM – Concepts,improvementneeds–Performancemeasures-CostofQuality- The role of information Technology in Quality Improvement–BPR

UNIT V QUALITYMANAGEMENTSYSTEM **9**

Introduction-BenefitsofISORegistration-ISO9000SeriesofStandards-Sector-SpecificStandards-AS9100,TS16949andTL9000--ISO9001Requirements-Implementation-Documentation-InternalAudits-Registration--Environment Management Systems:Introduction—ISO 14000 Series Standards (ISO 14001, 14004, 14031, 19011) —IATF 16949 Automotive Quality Management

System - A-BenefitsofEMS

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. ApplyTQMconceptsinaselectedenterprise

CO2. ApplyTQMprinciplesinaselectedenterprise

CO3. Understand Six Sigma and apply Traditional tools, New tools, Benchmarking andFMEA.

CO4. UnderstandTaguchi'sQualityLossFunction,PerformanceMeasuresandapply QFD, TPM, COQ and BPR

CO5. ApplyQMSandEMSinanyorganization.

TEXT BOOKS:

1. DaleH.Besterfiled, Carol B.Michna,Glen H. Bester field,MaryB.Sacre, HemantUrdhwaresheand RashmiUrdhwareshe, “Total Quality Management”, Pearson Education Asia, RevisedThird Edition, Indian Reprint, Sixth Impression,2013.

REFERENCES:

1. Joel.E.Ross,“TotalQualityManagement– TextandCases”,Routledge.,2017

2. Kiran.D.R,“TotalQualityManagement:Keyconceptsandcasestudies,Butterworth—Heinemann Ltd, 2016.

3. Dinesh kumar Khamari, Quality Management System Manual IATF 16949 : 2016., 2020

CO’s-PO’s & PSO’s MAPPING

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

ME23C17	MACHINE DESIGN	L T P C
		3 0 2 4

COURSE OBJECTIVES:

1. Designing machine members subjected to static loads.
2. Designing and modeling shafts, couplings, welded joints, riveted joints and bearings for various applications.
3. Designing and modeling helical springs, flywheels, connecting rods and crankshafts for various applications.
4. Designingflexible elements like belt, ropes and chain drives for engineering applications.
5. Designing spur, helical gear drives and multi speed gear box for power transmission.

UNIT I STEADY STRESSES IN MACHINE MEMBERS 9

Introduction to the design process - factor influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principle stresses for various load combinations, eccentric loading -Factor of safety - theories of failure – Design based on strength and stiffness.

UNIT II SHAFTS, COUPLINGS, JOINTS AND BEARINGS 9

Design of solid and hollow shafts based on strength and rigidity– Keys, key ways and splines –Rigid and flexible couplings. Threaded fasteners, Welded joints and riveted joints for structures, Sliding contact and rolling contact bearings (Simple problems)

UNIT III ENERGY STORING ELEMENTS AND ENGINE COMPONENTS 9

Various types of springs, optimization of helical springs - Flywheels considering stresses in rims and arms for engines and punching machines- Connecting Rods and crank shafts.

UNIT IV DESIGN FOR FLEXIBLE ELEMENTS 9

Design of Flat belts and pulleys - Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys – Design of Transmission chains and Sprockets.

UNIT V SPUR GEARS, HELICAL GEARS AND GEAR BOXES 9

Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects - Fatigue strength - Factor of safety - Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations. Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box -Constant mesh gear box. – Design of multi speed gear box for machine tool applications – Variable speed gear box.

LIST OF EXPERIMENTS

3D GEOMETRIC MODELLING 30

Modeling, Assembly and drafting of following Mechanical Components using Parametric and Feature based Packages

Bearings – Sliding contact and rolling contact bearings

Couplings - Rigid and flexible couplings

Joints – Welded joints and riveted joints

Engine parts –Connecting Rod, Crank shaft

TOTAL: 75 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Design machine members subjected to static loads.

CO2. Design and model shafts, couplings, welded joints, riveted joints and bearings for various applications

CO3. Design and model helical springs, flywheels, connecting rods and crankshafts for various applications.

CO4. Design flexible elements like belt, ropes and chain drives for engineering applications

CO5. Design spur ,helical gear drives and multi speed gear box for power transmission

Note: (Use of P S G Design Data Book is permitted in the University examination)

TEXT BOOKS:

1. Bhandari V B, “Design of Machine Elements”, 5th Edition , Tata McGraw-Hill Book Co, 2020.

REFERENCES:

1. Design Data Hand Book”, PSG College of Technology, Coimbatore, 2023.
2. Ansel C Ugural, “Mechanical Design – An Integral Approach”, 1st Edition, Tata McGraw-Hill Book Co, 2009
3. Merhyle Franklin Spotts, Terry E. Shoup, and Lee EmreyHornberger, “Design of Machine Elements” Revised 8th Edition, Printice Hall, 2019.
4. Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine component Design”,7th Edition, Wiley, 2019.
5. Sundararajamoorthy T. V. and Shanmugam .N, “Machine Design”, Anuradha Publications, 2018.
6. R.S.Khurmi and J.K.Gupta, “Machine Design”, S.Chand Publications, 2020.

CO’s-PO’s & PSO’s MAPPING

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

IE23502	DESIGN OF EXPERIMENTS	L T P C
		3 0 2 4

COURSEOBJECTIVES:

1. To familiarize the concepts of Single Factor Experiment and Post hoc tests
2. To illustrate understanding of Factorial experiments
3. To enable students with the extensions of Factorial experiments and Response Surface Methods
4. To provide students with an understanding of Taguchi method for parameter Optimization
5. To provide students with understanding of Shainin DOE

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 SPECIAL FACTORIAL DESIGNS & RESPONSE SURFACE METHODS 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 - Introduction to Response Surface Methods- Designs for fitting First –order Model -Central Composite Design – Box- Behnken Designs.

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 SHAININ DESIGN OF EXPERIMENTS 9

Basics of Shainin DOE - Comparison between Taguchi DOE Vs Shainin DOE methods - Problem Solving Algorithm - Problem Identification Tools- Shainin Design of Experiments Tools - Case studies

TOTAL: 45 PERIODS

List of Experiments:

Create the design and analyze the data using statistical packages for the following:

1. Hypothesis testing
2. Completely Randomize Design
3. Randomized Block Design
4. Latin Square Design
5. Factorial Experiment
6. 2^k Factorial Design
7. Confounding and Partial Confounding Design
8. Fractional Factorial Experiment
9. Response Surface Methodology
10. Taguchi's Orthogonal experiments

TOTAL: 15 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Understand the fundamental principles of Classical Design of Experiments

CO2. Apply single factor experiment for process parameter understanding and optimization.

CO3. Apply Factorial Design principles for understanding of process parameters and its optimization

CO4. Gain knowledge on Taguchi's approach to experimental design for attaining robustness.

CO5. Apply Response Surface Method and Shainin DOE to evaluate quality

TEXT BOOK:

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

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

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

IE23503	RELIABILITY ENGINEERING	L T P C
		3 0 0 3

COURSEOBJECTIVES:

1. To gain conceptual understanding on Reliability studies
2. To impart knowledge on the life data analysis
3. To gain understanding of reliability prediction methods of various configurations
4. To impart knowledge on reliability testing and monitoring methods
5. To provide understanding of maintainability/availability/replacement models

UNIT I RELIABILITY CONCEPT 9

Reliability definitions – Quality vs. Reliability - Reliability measures – f(t), F(t) , R(t) functions – Central tendency of failure time distributions – Design life - Mortality graph - A priori and A posteriori probabilities of failure – Component Mortality – Exponential reliability function – Useful life.

UNIT II FAILURE DATA ANALYSIS 9

Failure data taxonomy – Empirical methods for Ungrouped, Grouped, Complete, Censored data – Failure time distributions - Survival graphs – Bartlett's Test – Kolmogorov Smirnov Test – Chi square goodness of fit Test – Hazard Plotting: Exponential, Weibull distributions: Smith's improved estimate.

UNIT III SYSTEM RELIABILITY PREDICTION 9

Series and Parallel structures – Parallel Redundancy – m/n System – Standby System – Composite configurations: Baye's decomposition method: Single/double cross linked structure - Cut and Ties sets Method – Fault Tree Analysis – Human Reliability.

UNIT IV RELIABILITY MANAGEMENT 9

Life Testing: Failure terminated test – Time terminated test – Determination of Upper and Lower MTBFs – Sequential Reliability Testing – Reliability Allocation – Reliability Growth Monitoring: Duane Model – Warranty Models -Replacement decisions: Deterministic and Stochastic models – Economic life.

UNIT V MAINTAINABILITY AND AVAILABILITY 9

Analysis of Downtime – Repair time distributions: Exponential, Lognormal – Maintainability measures – Maintainability prediction – Design for optimum maintainability – Spare parts control - Availability measures: Inherent, Achieved, Operational, Point and Interval Availabilities – System Availability – Optimal Inspection models.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Understand the fundamental theory in Reliability Engineering

CO2. Analyse the failure time data and determine the fitness of the data into theoretical distributions

CO3. Estimate system reliability of standard/complex configurations

CO4. Apply reliability allocation, growth monitoring and life testing models

CO5. Demonstrate Maintainability and Availability of system

TEXT BOOK:

1. Charles Ebeling, “An Introduction to Reliability and Maintainability Engineering”, Tata McGraw Hill, 2007.

REFERENCES:

1. Patrick D.T. O’Connor and Andre Kleyner, “Practical Reliability Engineering”, Fifth Edition, John Wiley & Sons, New York, 2012.
2. Andrew K.S.Jardine and Albert H.C.Tsang, “Maintenance, Replacement and Reliability: Theory and Applications”, Taylor & Francis, 2013.

CO’s - PO’s & PSO’s MAPPING

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

UC23E01 ENGINEERING ENTREPRENEURSHIP DEVELOPMENT

L	T	P	C
2	0	2	3

COURSE OBJECTIVES:

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

MODULE – I: ENTREPRENEURIAL MINDSET **4L,8P**

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

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

MODULE – II: OPPORTUNITIES **4L,8P**

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

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

MODULE – III: PROTOTYPING & ITERATION **4L,8P**

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

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

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

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

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

MODULE – V: ENTREPRENEURIAL ECOSYSTEM **4L,8P**

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

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

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

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

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

CO3: Generate and develop creative ideas through ideation techniques

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

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

REFERENCES:

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

IE23701	APPLIED MULTIVARIATE ANALYSIS	L T P C
		3 0 2 4

COURSE OBJECTIVES:

1. To extract the knowledge on the applications of multivariate statistical analysis.
2. To understand the simple regression, multiple regression and correlation procedures.
3. To apply the factor analysis in real life applications and principal component analysis effectively for data exploration and data dimension reduction.
4. To classify and implement the discriminant analysis to various cases.
5. To find groupings and associations using cluster analysis.

UNIT I MULTIVARIATE METHODS 9

Review of basic matrix operations and random vectors, Eigen values and Eigen vectors. An overview of multivariate methods - Basic Multivariate Statistics - Mean, Variance, Covariance and Correlation, Multivariate normal distribution.

UNIT II REGRESSIONANALYSIS 9

Inferences about population parameters - Simple Regression, and Correlation – Estimation using the regression line, correlation analysis, Multiple Regression– Logistic Regression - Canonical Correlation Analysis - Multivariate analysis of variance (MANOVA) – Conjoint Analysis – Choice based conjoint (CBC), Adaptive CBC.

UNIT III FACTOR ANALYSIS 9

Principal components analysis – Objectives, estimation of principal components, testing for independence of variables, Factor analysis model – Method of estimation – Factor rotation – Factor Scores - EFA - CFA - Path analysis and Path Diagrams, Software tools for development – SEM and ISM.

UNIT IV DISCRIMINANT ANALYSIS 9

Discriminant analysis – Classification with two multi-Variate normal populations- Evaluating classification function – Classification with several populations – Fishers Method for Discriminating among several Populations.

UNIT V CLUSTER ANALYSIS 9

Cluster analysis – Clustering methods, Hierarchical clustering methods – Single Linkage, Complete Linkage, Average Linkage, Ward's Hierarchical Clustering Method, Non-Hierarchical Clustering methods - K-means Method, Validation and profiling of clusters – Multi-Dimensional Scaling – Introduction to Model Building Process.

TOTAL : 45 PERIODS

LABORATORY EXPERIMENTS 15 PERIODS

Students will perform analysis of data in the following topics using Python and Data Analysis package

1. Correlation Analysis

2. Simple Regression
3. Multiple Regression
4. Factor Analysis
5. Discriminant Analysis
6. Cluster Analysis

TOTAL: 60 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Predict the values of one or more variables on the basis of observations on the other variables.

CO2. Synthesize the specific statistical hypotheses, in terms of the parameters of multivariate populations.

CO3. Construct data reduction or structural simplification as simply as possible without sacrificing valuable information and will make interpretation easier.

CO4. Apply to sort and group the "similar" objects or variables are created, based upon measured characteristics.

CO5. Prepare to understand appropriate use of clustering methods.

TEXT BOOKS:

1. Dallas E Johnson, Applied Multivariate methods for data analysis, Duxbury Press(1998).
2. Brian S. Everitt and Graham Dunn, Applied Multivariate Analysis, Second edition, Arnold press, (2001).
3. Joseph F. Hair, Jr. William C. Black Barry J. Babin, Rolph E. Anderson, Multivariate Data Analysis, Pearson Edition, (2010).

REFERENCE:

1. Richard I Levin, Statistics for Management, PHI (2000)

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

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

IE23702	SIMULATION MODELING AND ANALYSIS	L T P C
		3 0 2 4

COURSE OBJECTIVES:

1. To gain knowledge on solving different waiting line models.
2. To gain knowledge about generation of the random numbers using different algorithms and Enable to generate random variates.
3. To learn how to test the random number and random variates.
4. To enable to design of Monte Carlo simulation experiment.
5. To solve different simulation problems using various simulation software

UNIT I QUEUING THEORY 9

Queuing theory terminology – Single server, multi-server- limited and unlimited queue capacity limited and unlimited population –limited and infinite queue length.

UNIT II GENERATION OF RANDOM NUMBERS and RANDOM VARIATES 9

Systems – Modelling – Types – Systems components – Simulation basics- Random numbers – Methods of generation : Manual, table, algorithms – mid square, multiplier, constant multiplier, additive and multiplicative congruential algorithms- Random variates for standard distributions like uniform, exponential, Poisson, binomial, normal etc

UNIT III TESTING OF RANDOM NUMBERS AND RANDOM VARIATES 9

Testing of Random numbers and Random variates – Chi square test - KS test - Run test - Poker test - Gap test - Autocorrelation test Input Data Modelling.

UNIT IV MONTE CARLO SIMULATION and DESIGN OF SIMULATION EXPERIMENTS 9

Monte Carlo Simulation method - Random walk problem - Inventory problem - Queuing problem - Production problem - Replacement problem - Steps on Design of Simulation Experiments

UNIT V SIMULATION LANGUAGES & CASE STUDIES 9

Development of simulation models using of simulation language for systems like Queuing, Inventory, Replacement, and Production etc

45 PERIODS

LIST OF EXPERIMENTS

The following experiments using C++/Python/ Optimization package **15 PERIODS**

1. Single Server Queuing Model
2. Multi Server Queuing Model
3. Random Number Generation Mid Square, Constant Multiplier, Congruential
4. Random variates Generation Exponential, Poisson, Normal, Binomial

5. Testing of Random variates Chi-Square, KS, Run, Poker
6. Monte Carlo Simulation: Random Walk Problem
7. Monte Carlo Simulation: Paper vendor problem

By using any simulation language

8. Production problem
9. Warehouse problem
10. Health care problem

TOTAL: 60 PERIODS

SOFTWARE REQUIRED

Dev- C++, Simulation Packages

COURSE OUTCOMES:

The students will be able to

CO1. The students acquire capability in applying and using of queuing models for day today problem.

CO2. Learned to generate random numbers and variates.

CO3. Learned to test the statistical stability of random number and random variates.

CO4. Learned to solve real time problem using Monte Carlo simulation.

CO5. Learned to use simulation language to simulate and analyze systems.

TEXT BOOKS:

1. Jerry Banks, John S Corson, Barry.L. Nelson, David M.Nicol and P.Shahabudeen, Discrete Event Systems Simulation, Pearson education, Fifth edition, 2009.
2. Thomas J Schriber, “Simulation Using GPSS”, John Wiley, 2002.

REFERENCES:

1. David Kelton, Rondall P Sadowski and David T Sturrock, “Simulation with Arena”, McGraw Hill, 2004.
2. Law A M and Kelton W D, Simulation Modelling and analysis, Tata McGraw Hill, 2003.

CO’s-PO’s & PSO’s MAPPING

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

IE23703 **SUPPLY CHAIN MANAGEMENT** **L T P C**

3 0 2 4

COURSE OBJECTIVES:

1. To describe the role and drivers of and 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 application of Information Technology and Emerging 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 INVENTORY **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 Sourcing 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

LIST OF EXPERIMENTS **15 PERIODS**

1. Find the performance of supply chain drivers related to facilities in calculating the design capacity, utilization and efficiency
2. Find the performance of Supply chain drivers related to inventory management for finding the inventory turnover ratio for different scenarios
3. Solve the mathematical model for network design optimization of facility location and capacity allocation using spread sheet
4. Evaluate the safety inventory for different inventory policies using spreadsheet
5. Optimize the logistics network design in Linear Programing model using python codes
6. Solve the Vehicle Routing optimization problem by using different clustering algorithms
7. Selection of supplier by Linear Programming model using python codes.
8. Demonstration of beer game and understanding the Bull Whip Effect which causes increased in order as one moves up the supply chain.
9. Demonstration of Digital visualization of physical supply chain and its elements (firms, flows and product) using supply chain simulation and optimization software
10. Solve the facility location problem using supply chain software

TOTAL: 60 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Understand the scope of Supply Chain Management (SCM) and the Drivers of Supply Chain Performance.

CO2. Design suitable Supply Chain network and Inventory for a given situation in any organization

CO3. Solve the issues related to Logistics in SCM.

CO4. Understand Sourcing, Coordination and current issues in SCM.

CO5. Appraise about the applications of IT in SCM and apply SCM concepts in selected enterprise.

TEXT BOOK:

1. Sunil Chopra, Peter Meindl and D.V. Kalra, “Supply Chain Management: Strategy, Planning, and Operation", Pearson Education, 2016.
2. Kurt Y. Liu, “Supply Chain Analytics”, palgrave macmillan,2022
3. Ivanov D. (2017, 2018, 2019, 2020) Supply Chain Simulation and Optimization with anyLogistix.

REFERENCES:

1. Ravi Ravindran A, Donald P. Warsing, Jr, “Supply Chain Engineering: Models and Applications”, “CRC Press, 2012.
2. Srinivasan G.S, “Quantitative models in Operations and Supply Chain Management”, PHI, 2010.
3. V.V.Sople, “Supply Chain Management – Text and cases”, Pearsons, 2012
4. https://www.anylogistix.com/

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

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

IE23U02 PERSPECTIVE OF SUSTAINABLE DEVELOPMENT L T P C

3 0 0 3

MODULE I INTRODUCTION 6

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

MODULE II ENVIRONMENTAL SUSTAINTABILITY 6

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

MODULE II SOCIAL & ECONOMIC SUSTAINABILITY 9

Equity and justice, Community development, Smart cities and sustainable infrastructure, Cultural heritage and sustainability, Ethical considerations in sustainable development.
Triple bottom line approach, Sustainable economic growth, Corporate social responsibility (CSR), Green marketing and sustainable product design, Circular economy and waste minimization, Green accounting and sustainability reporting.

MODULE IV SUSTAINABLE INDUSTRIAL PROCESSES, ASSESSMENT AND REPORTING 9

Sustainable Process Design Techniques, Lean Manufacturing and Sustainability, Energy Efficiency in Industrial Systems, Sustainable Material Selection, Green Manufacturing Technologies, Industrial Symbiosis.

Life Cycle Assessment (LCA), Sustainability Metrics and Indicators, Key performance indicators (KPIs), Environmental Impact Assessment (EIA) Process and tools, Sustainability Frameworks and standards

MODULE V SUSTAINABILITY PRACTICES 30

- Map local or regional projects to the United Nations Sustainability Development Goals (SDGs), identify gaps and opportunities for improvement.
- Perform a biodiversity audit in a local area, documenting species, assessing the health of the ecosystem and present a conservation plan based on the audit results.
- Calculate the ecological footprint of individuals or organizations and propose actionable steps to reduce the footprint.
- Develop a corporate social responsibility (CSR) initiative for a hypothetical company.
- Develop a business model for a product or service that minimizes waste and promotes sustainability.
- Conduct an energy efficiency audit of a facility.
- Perform a Life Cycle Assessment on a product, from raw material extraction to disposal.
- Develop Key Performance Indicators (KPIs), create a monitoring and reporting plan to track progress.
- Conduct a mock environmental impact assessment and write a comprehensive Environmental Impact Assessment (EIA) report.

TOTAL: 60 PERIODS

REFERENCES:

1. Allen, D., & Shonnard, D. R. (2011). Sustainable engineering: Concepts, design and case studies. Prentice Hall.

2. Munier, N. (2005). Introduction to sustainability (pp. 3558-6). Amsterdam, The Netherlands: Springer.

3. Blackburn, W. R. (2012). The sustainability handbook: The complete management guide to achieving social, economic and environmental responsibility. Routledge.

4. Clini, C., Musu, I., & Gullino, M. L. (2008). Sustainable development and environmental management. Published by Springer, PO Box, 17, 3300.

5. Bennett, M., James, P., & Klinkers, L. (Eds.). (2017). Sustainable measures: Evaluation and reporting of environmental and social performance. Routledge.

6. Seliger, G. (2012). Sustainable manufacturing for global value creation (pp. 3-8). Springer Berlin Heidelberg.

7. Stark, R., Seliger, G., & Bonvoisin, J. (2017). Sustainable manufacturing: Challenges, solutions and implementation perspectives. Springer Nature.

8. Davim, J. P. (Ed.). (2013). Sustainable manufacturing. John Wiley & Sons.

IE23801 PROJECT WORK/ INTENSHIP WITH PROJECT WORK L T P C

0 0 20 8

COURSE OBJECTIVES

1. To apply the principle/techniques that they have learnt to a new problem situation which may be the design and manufacture of a device, a rearch, a computer or management project or a design problem.
2. A project topic must be selected either from published list or students themselves can propose suitable topics in consulation with the guides. It can be a theortical research projector industry oriented. Generally it is a group project.
3. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Department based on oral presentation and the project report.

COURSE OUTCOMES:

The students will able to

CO1. Discover potential research areas in the field of Industrial Engineering

CO2. Compare and contrast the several existing solutions for the problems identified

CO3. Formulate and propose a plan for creating a solution for the research plan identified.

CO4. Conduct the experiment as a team and interpret the results

CO5. Report and present the findings of the work conducted.

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

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

IE23001	DECISION MAKING MODELS	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To give exposure fuzzy concepts and fuzzy logic
2. To create awareness on metaheuristic applications to solve complex problem
3. To provide insights in to solution approaches for solving multi objective optimization problems
4. To apply neural network concepts for solving intricate problems
5. To provide acquaintance towards Multi-Criteria Decision-Making Methods

UNIT I FUZZY SYSTEMS 9

Introduction to Fuzzy logic-Fuzzy sets and membership functions-Operations on Fuzzy sets-Fuzzy relations, rules, propositions, implications and inferences-Defuzzification techniques-Fuzzy logic controller design -Applications of Fuzzy logic

UNIT II METAHEURISTICS 9

Introduction: Decision making and structured decision making, Necessity of structured Decision making Single Objective Decision Making: Traditional techniques - linear, non-linear and dynamic; nontraditional techniques - Genetic algorithms, Simulated Annealing ‘Ant colony optimization, Particle swarm optimization.

UNIT III MULTI OBJECTIVE OPTIMIZATION 9

Plan generation - weightage method, constraint method, muti objective genetic algorithms, muti objective differential evolution; Plan generation and selection - Fuzzy programming, Goal Programming, compromise programming- Data Envelopment Analysis

UNIT IV NEURAL NETWORKS 9

Learning rules and various activation functions, Single layer Perceptions, Back Propagation networks, Architecture of Back propagation(BP) Networks, Back propagation Learning, Variation of Standard Back propagation Neural Network, Introduction to Associative Memory, Adaptive Resonance theory and Self Organizing Map, Recent Applications.

UNIT V MULTI-CRITERIA DECISION MAKING METHODS 9

Description of Some MCDM Methods- WSM Method- WPM Method- AHP Method- Fuzzy AHP-ELECTRE Method - TOPSIS Method- ISM

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Apply the fuzzy concepts and fuzzy logic

CO2. Understand the application of metaheuristic to solve complex problem

CO3. find solution for multi objective optimization problems

CO4. Recommended best solutions by using neural network approach

CO5. Investigate Multi-Criteria Decision-Making problems

TEXT BOOKS:

1. Fuzzy Logic with Engineering Applications (3rd Edn.), Timothy J. Ross, Willey, 2010.
2. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, S.Rajasekaran, G. A. Vijayalakshami, PHI, 2007
3. Multi-Criteria Decision Making Methods: A Comparative Study ,EvangelosTriantaphyllou, Kluwer Academic Publishers ISBN 0-7923-6607-7

REFERENCES:

1. Foundations of Neural Networks, Fuzzy Systems, and Knowldge Engineering, Nikola K. Kasabov, MIT Press, 1998.
2. Genetic Algorithms in Search, Optimization And Machine Learning, David E. Goldberg, Pearson Education, 2002.

CO's-PO's&PSO'sMAPPING

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

IE23C05 ENGINEERING ECONOMICS AND COSTING L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To understand the concept of Engineering Economics and gaining knowledge to implement various micro economics concept in real life.
2. To gain knowledge in the field of macro-economics to enable the students to have better understanding of various components of macro-economics.
3. To understand the different procedures of pricing.
4. To gain knowledge in the field of costing.
5. To analyze the various methods of costing in detail.

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, Demand Analysis – Defining demand, Types of demand and Determinants of demand, Elasticity of Demand and Supply.

UNIT II PRODUCTION AND COST ANALYSIS 9

Production Analysis – Production function, Returns to a factor, Returns to scale, ISO quants and least cost combination of inputs. Cost Analysis – Cost concepts, Determinants of cost, Short-run cost-output Relationship, Long-run cost output relationship, Economies and Diseconomies of scale and 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 COSTING 9

Objectives, Functions, Importance of Costing – Cost Accounting – Classification of costs – Elements of cost – Estimation in Material cost, Labour cost and overheads – Allocation of overheads.

UNIT V COSTING METHODS AND CONTROL 9

Job costing – Operating costing – Process costing, Budgetary control.

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Summarize principles of micro economics and demand forecasting.

CO2. Recognize the concepts in production and detailed cost analysis.

CO3. Infer the principles of pricing methodologies.

CO4. Examine the basics of costing for all type of industry.

CO5. Distinguish cost analysis using different methods of costing.

TEXT BOOKS:

1. Yogesh Maheshwari, “Managerial Economics”, Third edition, PHI 2012.
2. Jawaharlal, Cost Accounting, Tata McGraw Hill, 2013

REFERENCES:

1. Mote V L, Samuel Paul and G.S.Gupta, “Managerial Economics – concepts and cases”,McGraw Hill Education (India), 2011.
2. Paneerselvam R, “Engineering Economics”, PHI, 2013.
3. Ramachandra Aryasri A and Ramana Murthy V V, “Engineering Economics and Financial Accounting”, McGraw Hill Education (India), New Delhi, 2004.
4. Nag A, “Macro Economics for Management Students” MacMillan India Ltd., New Delhi, 2005.

CO’s-PO’s&PSO’sMAPPING

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

IE23C10	SUPPLY CHAIN ANALYTICS	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To expose about the role of analytics in supply chain network design
2. To apply the analytical tools in supplier selection, transportation and warehousing
3. To demonstrate the application of analytics in inventory
4. To evaluate the performance improvement strategies in supply chain
5. To understand the application of analytics in coordination and risk assessment in supply chain

UNIT I INTRODUCTION TO ANALYTICS IN SUPPLY NETWORKS 9

Introduction to Supply Network, Performance Measures for Efficiency and Effectiveness, SCOR model, Strategic Fit and Scope, Types of Distribution Networks, Analytics in Management, Design of Distribution Networks.

UNIT II SUPPLIER SELECTION, TRANSPORTATION AND WAREHOUSE ANALYTICS 9

Linear Programming, Rating method, Ranking method, Borda Count, Clustering, Goal Programming and related multi-criterion decision making (MCDM) techniques. Transportation models, Route planning, Transshipment, Shipment schedule, Flow path optimization, Warehouse location problem, MILP formulation, Location with foreign exchange risks, space calculation for warehouse, Non-linear optimization for warehouse space allocation.

UNIT III INVENTORY ANALYTICS 9

Elementary Concepts related to Inventory Management, Economic Order Quantity (Instantaneous Replenishment), Inventory Management under Uncertainty – Concept of Safety Stock, Continuous Review System, Periodic Review System. Newsvendor Model, Performance Measures: Expected Lost Sales, Expected Sales, Expected Leftover Inventory, Expected Profit, Fill Rate, In-Stock Probability, and Stock-Out Probability Choosing an Order-up-to Level to Meet a Target Service Level, In-Stock Probability, and Desired Fill-Rate. Assemble-to-Order, Make-to-Order and Quick Response with Reactive Capacity, Reducing Mismatch Costs with Make-To-Order

UNIT IV STRATEGIC PERFORMANCE IMPROVEMENT IN SUPPLY CHAIN 9

Data Envelopment Analysis for competitive comparisons among multiple warehouses and service units and formulation of strategic action plans for improving the efficiencies of non-performing DMUs, Stochastic Frontier Analysis.

UNIT V MODELLING COORDINATION AND RISK ANALYTICS IN SUPPLY CHAIN NETWORK 9

Information Distortion in Supply Network and Bull-Whip Effect, Coordination and collaboration modelling in supply networks. Mapping the riskiness profile of a country, taxation, Mapping the riskiness profile of possible international routes and designing the route plan based on riskiness profile. Design and optimization of global supply chain networks, Multi-period supply chain network design

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Apprise about the role of analytics in supply chain network design

CO2. Investigate the supplier selection, transportation and warehousing issues using analytical tools

CO3. Perform the analytics in the inventory system

CO4. Examine the strategies for performance improvement in supply chain

CO5. Support to the decision making in coordination and risk in supply chain by using analytics

TEXT BOOK:

1. Liu, Kurt Y. 2022. Supply Chain Analytics: Concepts, Techniques and Applications. 1st ed. Cham, Switzerland: Springer Nature.
2. Peter W. Robertson, 2020, Supply Chain Analytics (Mastering Business Analytics) 1st Edition, Routledge

REFERENCES:

1. Supply Chain Management: Strategy & Analysis, Chopra, Meindl& Kalra, Pearson Education, Asia.
2. Supply Chain Management, Janat Shah, Pearson education, Asia
3. Designing & Managing the Supply Chain, Simchi-Levi, & Kaminsky, McGraw-Hill Publication.

CO's-PO's&PSO'sMAPPING

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

IE23002	SUSTAINABLE SUPPLY CHAIN MANAGEMENT	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To understand about the sustainable development and Sustainable Development Goals
2. To give an exposure on concepts, principles and frame work of sustainability engineering
3. To apply the Life Cycle Assessment for case scenarios
4. To perform the environmental life cycle costing, social life cycle assessment, and life cycle sustainability assessment
5. To give insights about circular economy

UNIT I PRINCIPLES OF SUSTAINABLE DEVELOPMENT AND SUSTAINABLE DEVELOPMENT GOALS **9**

Sustainable Development: History, Definitions, Environmental issues and crisis, Resource degradation, greenhouse gases, desertification, social insecurity, Industrialization, Globalization and Environment. Sustainable Development and International Contribution: Components of sustainability, Complexity of growth and equity, International Summits, Conventions, Agreements, Transboundary issues, Action plan for implementing sustainable development, Moral obligations and Operational guidelines- Sustainable Development Goals

UNIT II SUSTAINABLE ENGINEERING AND CONCEPTS, PRINCIPLES AND FRAME WORK **9**

Green Economy and Low Carbon Economy, Eco Efficiency, Triple bottom Line, Guiding principles of sustainable engineering, Frameworks for sustainable Engineering. Tools for sustainability Assessment: Environmental Management System, Environmental Auditing, Cleaner Production Assessment, Environmental Impact Assessment, Strategic Environmental

UNIT III FUNDAMENTALS OF LIFE CYCLE ASSESSMENT **9**

Why and What is LCA, LCA Goal and Scope, Life cycle inventory, Life Cycle Impact Assessment, Interpretation and presentation of Results, Iterative Nature of LCA, Methodological Choices, LCI Databases and LCA Software, Strength and Limitations of LCA.

UNIT IV ENVIRONMENTAL LIFE CYCLE COSTING, SOCIAL LIFE CYCLE ASSESSMENT, AND LIFE CYCLE SUSTAINABILITY ASSESSMENT **9**

Introduction, Environmental Life Cycle Costing, Social Life Cycle Assessment, Life Cycle Sustainability, LCA Applications in Engineering: Environmental Product Declarations and Product Category Rules, Carbon and Water Foot Printing, Energy systems, Buildings and the Built Environment, Chemical and Chemical Production Food and Agriculture Introduction to Environmental Economics: Introduction – What Is Environmental Economics?, Valuing the Environment, Market-based Incentives (or Economic Instruments) for Sustainability, Command-and-Control versus Economic Instruments, A Simple Model of Pollution Control

UNIT V CIRCULAR ECONOMY **9**

Linear Economy and its emergence, Economic and Ecological disadvantages of linear economy, Replacing Linear economy by Circular Economy, Development of Concept of Circular Economy, A differential - Linear Vs Circular Economy - Characteristics of Circular Economy - Material recovery, Waste Reduction, reducing negative externalities, Explaining Butterfly diagram, Concept of Loops - Circular design, innovation and Assessment - Zero waste: Waste Management in context of Circular Economy, Circular design, Research and innovation, LCA, Circular Business Models

TOTAL:45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Explain the sustainable development and Sustainable Development Goals

CO2. Apprise on concepts, principles and frame work of sustainability engineering

CO3. Investigate the Life Cycle Assessment for given environment.

CO4. Evaluate the environmental life cycle costing, social life cycle assessment, and life cycle sustainability assessment

CO5. Gain knowledge on circular economy

TEXT BOOKS:

1. Jay Heizer , Barry Render and Chuck Munson ,Principles of Operations Management: Sustainability and Supply Chain Management, Pearson, 11th Edition,2014.
2. W. Benton, Supply Chain Focused Manufacturing Planning and Control, Supply Chain Focused Manufacturing Planning and Control,Cengage Learning,2014

REFERENCES:

1. Morana, Joelle. 2013. Sustainable Supply Chain Management: Morana/Sustainable Supply Chain Management. London, England: ISTE Ltd and John Wiley & Sons.
2. Cetinkaya, Balkan, Richard Cuthbertson, Graham Ewer, Thorsten Klaas-Wissing, Wojciech Piotrowicz, and Christoph Tyssen. 2010. Sustainable Supply Chain Management: Practical Ideas for Moving towards Best Practice. 2011th ed. Berlin, Germany: Springer.

CO's-PO's&PSO'sMAPPING

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

IE23C08	PROJECT MANAGEMENT	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To understand the complete structure of project management and select the most desirable projects.
2. To identify the resources needed for each stage, including involved stakeholders, tools and supplementary material.
3. To describe the time needed to successfully complete a project, considering factors such as task dependencies and task lengths.
4. To analyse the project and provide internal stakeholders with information regarding project and project control.
5. To develop a project scope while considering factors such as customer requirements and internal/external goals

UNIT I INTRODUCTION TO PROJECT MANAGEMENT 9

Objectives of Project Management- Importance of Project Management- Types of Projects Project Management Life Cycle- Project Selection – Feasibility study: Types of feasibility- Steps in feasibility study. Analytical skills - Benefit analysis techniques - Elements of a project charter - Estimation tools and techniques -Strategic management.

UNIT II PROJECT PLANNING 9

Change management planning - Cost management planning - Project budgeting tools and techniques - Communications planning - Contract types and selection criteria - Estimation tools and techniques - Human resource planning - Lean and efficiency principles - Procurement planning - Requirements gathering planning - Scope deconstruction tools and techniques (WBS, Scope backlog) - Scope management planning - Stakeholder management planning -Time management planning, including scheduling tools and techniques - Workflow diagramming techniques.

UNIT III PROJECT IMPLEMENTATION 9

Continuous improvement processes -Contract management techniques - Elements of a statement of work - Interdependencies with project elements - Project budgeting tools and techniques - Quality standard tools - Vendor management techniques - Basic Scheduling Concepts - Resource Levelling – Resource Allocation.

UNIT IV PROJECT MONITORING AND CONTROL 9

Performance management and tracking techniques (EV, PERT, CPM, Trend Analysis) - Process analysis techniques (Lean, Kanban, Six Sigma) - Project control thresholds and tolerance - Project finance principles - Project monitoring tools and techniques - Project quality best practices and standards (BS, CMMI, IEEE, ISO) - Risk identification and analysis techniques -Quality validation and verification techniques.

UNIT V PROJECT CLOSURE **9**

Archiving practices and statutes – Compliance - Contract closure requirements - Closeout procedures - Feedback techniques - Performance measurement techniques (KPI, key success factors) - Project review techniques - Transition planning technique. Scrum and Agile Management – Critical success factors for IT Projects – Case Studies.

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Evaluate and select the most desirable projects.

CO2. Create appropriate approaches to plan a new project.

CO3. Develop appropriate methodologies to develop a project schedule.

CO4. Practice new techniques to monitor and control the project.

CO5. Identify important risks facing a new project.

TEXT BOOKS:

1. Project Management Institute, “PMBOK Guide”, Seventh Edition.
2. Arun Kanda, “Project Management A Life Cycle Approach”, Prentice Hall of India, 2011.

REFERENCES:

1. Panneerselvam R and Senthilkumar P, “Project Management”, Prentice Hall of India, 2009.
2. Khanna R B, “Project Management”, Prentice Hall of India, 2011
3. Harald Kezner, “Project Management Case Studies” 5th Edition, Wiley, 2017.

CO’s - PO’s & PSO’s MAPPING

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

IE23003 LOGISTICS, WAREHOUSE AND EXIM MANAGEMENT L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To develop an understanding of the role and importance of logistics to achieve competitiveness.
2. To impart knowledge on Packaging and Containerization
3. To familiarise about the warehouse functions, types and Principles
4. To impart knowledge on Warehousing operations and material handling equipment's
5. To give exposure on Export and Import Procedures

UNIT I LOGISTICS MANAGEMENT 9

Definition, Evolution, Importance. The concepts of logistics. Logistics relationships. Functional applications – Logistics Organization - Logistics in different industries -Logistics Activities: – functions, objectives, solution. Third party and fourth party logistics - Reverse Logistics - Global Logistics. Legal types - Modes of transportation –Transport mode selection –methods -Transportation Functionality and Principles; Multimodal Transport: Modal Characteristics; Modal Comparisons; Legal Classifications; International Air Transport; Drone/Air Cargo Tariff Structure; Freight: Definition, Rate; Freight Structure and Practice , Transport costs – rate profiles–transport regulations– intra and interstate transport of goods. Transport Industry in India- International Transport – Rail ways, Road transport, Ports – Transport Security - Trends in Modern Transport

UNIT II PACKAGING AND CONTAINERIZATION 9

Transportation and Packaging. Packaging and Packing: Labels, Functions of Packaging, Designs, Kinds of Packaging; Packing for Transportation and Marking: Types of Boxes, Container, Procedure, Cost, Types of Marking, Features of Marking. Containerization: Genesis, Concept, Classification, Benefits and Constraints; Inland Container Depot (ICD): Roles and Functions, CFS, Export Clearance at ICD; CONCOR; ICDs under CONCOR; Chartering: Kinds of Charter, Charter Party, and Arbitration

UNIT III WAREHOUSE FUNCTIONS AND TYPES 9

Warehouse – objectives- Functions Activities-Types- Own Warehouses- Hired Warehouses- Private Warehouses- Public Warehouses- Government Warehouses- Bonded Warehouses- Co-operative Warehouses- Distribution Warehouses- Fulfilment/ Consolidation Warehouses Warehouses Providing Value Added Services- Cross Docking and Trans-loading Warehouses- Break Bulk Warehouses- Storage Warehouses- Refrigerated Warehouses Characteristics of ideal warehouses- Warehouse Layout- Principles and Facilities Types

UNIT IV WAREHOUSE OPERATIONS 9

Internal Operations: Measures and metrics of warehouse operations- Logistics in the warehouse- Localization of materials in a warehouse- Identification and classification of Materials and products in the warehouse- Managing the material/products turns in warehouse (FIFO/LIFO) – Problems and issues in shipment processes. Warehousing Equipment: Material Handling equipment and Systems Safety Matting, Industrial Safety Equipment- Storage types and storage unit management- Material Storage Systems - benefits – methods- Industrial Shelving, Industrial Storage Bins - Industrial

Storage Cabinets - Spill Containment Systems-Industrial Waste Disposal

UNIT V EXPORT & IMPORT PROCEDURES 9

Export & Import – Introduction, Definitions. Evolution of Export & Import. Foreign Trade-Institutional Framework and Basics-Documentation and Steps, Export–Import Strategies and Practice, Export Marketing, Business Risk Management and Coverage, Export Incentive Schemes Export Procedures and Documents, Customs Clearance of Import and Export Cargo, Methods and Instruments of Payment and Pricing Inco terms, Methods of Financing Exporters

TOTAL:45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. To understand about the principles and practices of logistics management in global trade.

CO2. To demonstrate the role of packaging and containerization in world economy

CO3. To examine about warehouse and its functions.

CO4. To develop effective warehouse operations strategies

CO5. To appraise about export and import procedures in logistics

TEXT BOOK:

1. Kapoor Satish K & Kansal Purva.(2003) Basics of Distribution Management: A Logistical Approach :Prentice Hall of India

REFERENCES:

1. Agrawal D K. (2007). Distribution and Logistics Management: A Strategic Marketing Approach :Macmillan publishers India.
2. Alan Ruston, Phil Crouches & Peter Baker. (2014)The Handbook of Logistics and Distribution Management. New Delhi: kogan page India.
3. Bowersox. (2000). Logistical Management: Mc-Graw Hill.

CO's-PO's&PSO'sMAPPING

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

IE23005 **QUALITY SYSTEMS AND AUDITING** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

1. To understand the objectives and Importance of Quality Management.
2. To analyze the phases of audit and audit plan.
3. To learn about the role of Information Technology in Quality improvement.
4. To study the Corrective action response and adequacy of the response
5. To prepare the formal report.

UNIT I INTRODUCTION TO QUALITY **9**

History of Quality – objectives and Importance of Quality Management – Contributions of Quality Gurus - Quality Information System – Strategy Development and Deployment – Need for a Quality approach to strategy – Definition of Quality and its types – Distinction between product quality and service quality.

UNIT II QUALITY IMPROVEMENT TECHNIQUES **9**

Continuous process improvement - The Juran Trilogy - Improvement strategies - The PDSA Cycle - Kaizen - Six- Sigma - Bench Marking – Cost of Quality – Quality function Deployment- The role of Information Technology in Quality improvement

UNIT III METHODS IN AUDITING **9**

Brief history of auditing – General model of auditing – The compliance audit – Performance audit – Product audits – Process audits – System audits – Audit defined – Management principles.

UNIT IV AUDIT PROGRAM MANAGER AND PREPARATION **9**

Accountability – Resources for audit program – Phases of audit – The audit team – Second rule of auditing – Authority – Requirements – Understand the process – Audit Plan – Evaluate documents.

UNIT V PERFORMANCE AND REPORTING **9**

Opening meeting – Gather the facts – Tracing – Interviews – Interview Techniques – Perceptions – Team meetings – Daily briefings – Onward – Report Characteristics – Pain and pleasure – Findings – Preparing the finding sheets – Recommendations – Exit meeting – Formal report – Report distribution - Closure phase – Remedial action – Corrective action – Corrective action response – Adequacy of the response – Records – An Example Procedure- the process approach – Auditing process-based Quality Management System – Audit program management – The process of Auditing – Audit reporting phase – Audit closure phase.

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Distinguish between the product quality and service quality.

CO2. Analyze the model of auditing.

CO3. Evaluate the documents for audit plan

CO4. Analyze the Corrective action response and adequacy of the response

CO5. Apply the process of auditing

REFERENCES:

1. Daniel Galin, Software Quality Assurance – from Theory to Implementation, Pearson Education, 2009.
2. Yogesh Singh, "Software Testing", Cambridge University Press, 2012.
3. AdityaMathur, Foundations of Software Testing, Pearson Education, 2008.
4. Ron Patton, Software Testing, Second Edition, Pearson Education, 2007.
5. Srinivasan Desikan, Gopalaswamy, Ramesh, SoftwareTesting Principles and Practices, Pearson Education, 2006.

CO's-PO's&PSO'sMAPPING

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

IE23006	METROLOGY AND MEASUREMENTS	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To learn basic concepts of the metrology and importance of measurements.
2. To teach measurement of linear and angular dimensions assembly and transmission elements.
3. To study the tolerance analysis in manufacturing.
4. To develop the fundamentals of GD & T and surface metrology.
5. To provide the knowledge of the advanced measurements for quality control in manufacturing industries.

UNIT I BASICS OF METROLOGY 9

Measurement – Need, Process, Role in quality control; Factors affecting measurement - SWIPE; Errors in Measurements – Types – Control – Measurement uncertainty – Types, Estimation, , Statistical analysis of measurement data, Measurement system analysis, Calibration of measuring instruments, Principle of air gauging- ISO standards.

UNIT II MEASUREMENT OF LINEAR, ANGULAR DIMENSIONS, ASSEMBLY AND TRANSMISSION ELEMENTS 9

Linear Measuring Instruments – Vernier caliper, Micrometer, Vernier height gauge, Depth Micrometer, Bore gauge, Telescoping gauge; Gauge blocks – Use and precautions, Comparators – Working and advantages; Opto-mechanical measurements using measuring microscope and Profile projector – Angular measuring instruments – Bevel protractor, Clinometer, Angle gauges, Precision level, Sine bar, Autocollimator, Angle dekkor, Alignment telescope. Measurements on Screw threads - Measurements on Gears-Analytical measurement- Functional test on gears **–**

UNIT III TOLERANCE ANALYSIS 9

Tolerancing– Interchangeability, Selective assembly, Tolerance representation, Terminology, Limits and Fits, (using tables IS919); Design of Limit gauges,- Tolerance analysis in manufacturing, Process capability, tolerance stackup, tolerance charting.

UNIT IV METROLOGY OF SURFACES 9

Fundamentals of Geometric Dimensioning and Tolerancing (GD & T)- Conventional vs Geometric tolerance, Datums, Inspection of geometric deviations– Measurement of Surface finish –Parameters, Comparative, Stylus based and Optical Measurement techniques, Filters, Introduction to 3D surface metrology- Parameters.

UNIT V ADVANCES IN METROLOGY 9

Lasers in metrology - Advantages of lasers – Laser scan micrometers; Laser interferometers – Applications—Computer Aided Metrology - Basic concept of CMM – Types of CMM – Constructional Features- -Machine Vision - Basic concepts of Machine Vision System – Elements – Applications -

On-line and in-process monitoring in production

TOTAL:45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Discuss the concepts of measurements to apply in various metrological instruments.

CO2. Apply the principle and applications of linear and angular measuring instruments, assembly and transmission elements.

CO3. Apply the tolerance symbols and tolerance analysis for industrial applications.

CO4. Apply the principles and methods of form and surface metrology.

CO5. Apply the advances in measurements for quality control in manufacturing Industries.

TEXT BOOKS:

1. Dotson Connie, “Dimensional Metrology”, Cengage Learning, First edition, 2012.
2. Mark Curtis, Francis T. Farago, “Handbook of Dimensional Measurement”, Industrial Press, Fifth edition, 2013.

REFERENCES:

1. AmmarGrous, J “Applied Metrology for Manufacturing Engineering”, Wiley-ISTE, 2011.
2. Galyer, J.F.W. Charles Reginald Shotbolt, “Metrology for Engineers”, Cengage Learning EMEA; 5th revised edition, 1990.
3. National Physical Laboratory Guide No. 40, No. 41, No. 42, No. 43, No. 80, No. 118, No. 130, No. 131. http://www.npl.co.uk.
4. Raghavendra N.V. and Krishnamurthy. L., Engineering Metrology and Measurements, Oxford University Press, 2013.
5. Venkateshan, S. P., “Mechanical Measurements”, Second edition, John Wiley &Sons, 2015.

CO’s-PO’s&PSO’sMAPPING

CO’s	PO’s												PSO’s	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	-	2	-	-	-	2	2	1	2	-	-	1
2	2	-	2	2	-	-	-	2	2	2	-	-	2	1
3	3	2	2	2	-	-	-	-	-	2	-	-	2	1
4	2	-	-	3	2	-	-	-	-	-	-	-	-	1
5	2	-	-	2	2	-	-	-	-	-	-	-	-	1
Avg.	2	2	2	2	2.	0	0	2	2	2	2	0	2	1

IE23C03 LEAN MANUFACTURING AND SIX SIGMA L T P C

3 0 0 3

COURSEOBJECTIVES:

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:

The students will be able to

CO1. understand what is Lean and Six sigma and their importance in the globalised competitive world.

CO2. Understand the importance of integrating Lean and Six sigma and also the process of their integration.

CO3. Plan the Resources required to undertake the LSS projects and also acquire how to select the suitable projects and the teams.

CO4. Apply DMAIC methodology to execute LSS projects and in this regard they will be acquainted with various LSS tools

CO5. Understand the process of institutionalizing the LSS effort and also understand the Design for LSS.

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

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

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

IE23007 MAINTENANCE ENGINEERING AND MANAGEMENT L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To explain maintenance concepts and maximize profit and minimize downtime in maintenance.
2. To summarize and take optimum maintenance decisions.
3. To plan analyse the root cause for maintenance problems.
4. To plan manage the spare parts for maintenance activity.
5. To define and describe the losses and improve the Overall Equipment Effectiveness

UNIT I MAINTENANCE CONCEPT AND TRENDS 9

Maintenance definition – Maintenance objectives – Maintenance challenges – Tero Technology Maintenance costs – Scope of maintenance department. Latest Trends –Role of Digital Twins in maintenance- Augmented reality in training for maintenance- IOT for maintenance data collection.

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:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Understand the equipment availability and downtime and latest trends

CO2. Implement maintenance policies for maximizing the profit.

CO3. Make a diagnosis of maintenance problems.

CO4. Improve uptime of machines by effective spare parts management.

CO5. Improve the overall Equipment Effectiveness.

TEXT BOOKS:

1. Andrew K.S.Jardine & Albert H.C. Tsang, “Maintenance, Replacement and Reliability-Theory and Applications” Taylor and Francis, 2021.
2. Mishra R C and Pathak K., “Maintenance Engineering and Management”, PHI,2012

REFERENCES:

1. Bikas Badhury & S.K.Basu, “Tero Technology: Reliability Engineering and Maintenance Management”, Asian Books, 2008.
2. Seichi Nakajima, “Total Productive Maintenance”, Productivity Press, 1993.
3. Matthew P. Stephens, “Productivity and Reliability-Based Maintenance Management”, Purdue University Press, 2010

CO’s-PO’s&PSO’sMAPPING

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

IE23008 SOFTWARE ENGINEERING AND METHODOLOGIES L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To study the basics of software development.
2. To study the customer needs and apply in software development.
3. To design the code and do the testing analysis.
4. To develop quality tools and techniques used in software industry.
5. To develop and implement the software standards.

UNIT I SOFTWARE ENGINEERING AND MODELS 9

Software Development – Phases, Process Models (ISO & CMM) – Product Life Cycle – Software Life Cycle Models.

UNIT II REQUIREMENTS ANALYSIS 9

Software requirements specifications – Structured tools for Software development– Structured analysis.

UNIT III SOFTWARE COST ESTIMATION 9

Planning a Software project – Cost Estimation and models – Software configuration management plans– Project monitoring plans.

UNIT IV SOFTWARE DESIGN 9

System Design and Principles – Module level concepts – Structured design – Design methodology – Object oriented approach – Detailed design – Coding.

UNIT V SOFTWARE TESTING 9

Software testing– Functional testing – Structural testing – Testing Process – Software Quality Metrics– Software Quality Management – Software Productivity.

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. To practice the various software modeling tools and techniques.

CO2. To study the various performance measurement tools and techniques.

CO3. Able to estimate time and cost of projects.

CO4. Able to select appropriate monitoring plan.

CO5. To study the importance of software design and software testing.

TEXT BOOKS:

1. Pressman R S , Software Engineering, McGraw Hill, seventh edition , 2010.
2. Mayrhausen A V, Software Engineering and Management, Academic press, 1990.

REFERENCES:

1. PankajJalote, An integrated approach to Software Engineering, Naross Publishing, 2018.
2. Somavile , Software Engineering, Addison – Wesley, 2011.
3. Stephen H. Khan, Metrics and Models and Software Quality Engineering, Addison Wesley,2002.

CO's-PO's&PSO'sMAPPING

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

IE23009 **SOFTWARE QUALITY MANAGEMENT** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

1. To study the basic principles and concepts of software quality
2. To effective designing, analyzing and developing the software engineering activities
3. To gain knowledge on software quality assurance and risk management
4. To analyze the principles and applications of software quality management tools
5. To gain knowledge about software quality standards

UNIT I INTRODUCTION **9**

Software Projects- Projects Planning- Process models,-Waterfall-RAD-V, Spiral, Incremental-Prototyping- Agile- Project Tracking

UNIT II SOFTWARE METRICS **9**

Goal Question Metric (GQM) model- Product Quality metrics-process Quality metrics- Metrics for software maintenance and testing-Complexity Metrics.

UNIT III SOFTWARE PROJECT ESTIMATION **9**

Effort and Cost Estimation - Expert Judgment- LOC-Function Points- Extended Function Points-Feature Points- Object Points-COCOMO-81, COCOMO-II- Risk Management.

UNIT IV SOFTWARE QUALITY **9**

Quality Management Systems-Software Quality Models- FURP- McCalls Models- Applying seven basic quality tools in software development-Measuring Quality- Gilb - CoQUAMO- Lean software development.

UNIT V SOFTWARE QUALITY ASSURANCE **9**

Software Reliability Models-Rayleigh model- Weibull model-Defect Removal Effectiveness-Quality standards- ISO 9000 models and standards for process improvement- ISO/IEC 9126- 1 to 9126-4-SQuaRE, ISO/IEC 25000-ISO/IEC 25010- CMM-PCMM-CMMI-SPICE

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Understand the basic principles and concepts in software quality

CO2. Effectively design, analyze and develop software engineering activities

CO3. Gain knowledge on software quality assurance and risk management

CO4. Understand the principles and applications of software quality management tools

CO5. Gain knowledge about software quality standards

TEXT BOOKS:

1. Roger S. Pressman, Software Engineering a Practioners Approach, McGraw Hill International Edition, New Delhi, 7th Edition, 2010.
2. Stephen Kan, Metrics and Models in Software Quality Engineering, Pearson Education Asia, 8th Impression 2009.

REFERENCES:

1. Walker Royce, Software Project Management – A unified framework, Pearson Education Asia, New Delhi, 2000.
2. Alan Gillies, Software Quality – Theory and Management, Thomson Learning, 2011.

CO's-PO's&PSO'sMAPPING

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

IE23010	FACILITIES PLANNING AND DESIGN	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To understand the basic principles in facilities planning and site location.
2. To gain knowledge on the basic principles in facility layout design decisions through proper analysis.
3. To analyze various modern trends while designing a layout using computerized algorithms.
4. To understand the basic principles of product layout and develop knowledge in line balancing concepts to implement improved system.
5. To understand basic principles in designing, measuring and analyzing material flow to improve the efficiency of the system.

UNIT I SITE LOCATION PLANNING 9

Introduction - Significance of location decision- Factors affecting location decisions- Multi Criteria layout problems - Qualitative models & Quantitative models, Break-Even analysis- Brown & Gibbs model- Single facility location models- Gravity location models- Mini-Sum model- Mini-Max model- Multi facility location models- Covering model- P median model- Types of layout problem- Developing facilities planning strategies- Examples of inadequate planning

UNIT II LAYOUT DESIGN 9

Facility Layout : Need, Objectives and Classification - Product, Process, Fixed-position, Cellular and Hybrid layouts, Layout design procedure – Nadler's ideal system approach – Immer's basic steps – Apple's layout procedure – Reed's layout procedure, Factors affecting plant layout- P-Q chart, Layout planning – Systematic layout planning(SLP) – Information gathering, Flow & Activity analysis, Relationship diagram, Space Constraint – OSHA, ADA regulations in facility design

UNIT III COMPUTERIZED LAYOUT PLANNING 9

Computerized layout planning – CRAFT, ALDEP, CORELAP – Trends in computerized layout planning- Layout software - Group technology models – Production flow analysis (PFA) – Rank order clustering (ROC)

UNIT IV ASSEMBLY LINE BALANCING 9

Basic features of mass manufacturing, Product oriented layout- assumptions and types, Assembly line balancing – Objectives, Line balancing techniques – Largest Candidate Rule (LCR) – Kilbridge & Wester Method (KWM) – Rank Positional Weight Method (RPW) – COMSOAL, Introduction to Multi-model assembly line - Mixed model assembly line balancing.

UNIT V MATERIALS HANDLING AND PACKAGING 9

Concept of material handling, Scope and definitions of material handling – Objectives, Principles of material handling, Material handling system design, Classification of material handling equipments, AGV – types, Conveyors – types of conveyors, Equipment selection & specification, JIT impact on

facilities design, Packaging – Types & Functions.

TOTAL:45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Interpret appropriate location models for various facility types.

CO2. Examine different type of design and analyze various facility layouts.

CO3. Analyze and apply various computerized techniques while designing a layout.

CO4. Predict a strategy to level the workload across all the workstations.

CO5. Estimate smooth and cost effective system in the material handling process.

TEXT BOOKS:

1. Tompkins, J.A. and White J A et al., “Facilities planning”, Fourth edition, John Wiley & Sons, 2010.
2. Sunderesh S.Heragu, “Facilities Design”, Fourth edition, CRC Press, 2016.

REFERENCES:

1. Krajewski. J and Ritzman, “Operations management – Strategy and Analysis”, Addison – Wesley publishing company, 5th edition, 1999.
2. Pannerselvam.R, “Production and Operations Management”, PHI, 2017.
3. James, Apple, “Material Handling System Design”, Ronald Press, 1980.
4. Richard Francis. L. and John A. White, “Facilities Layout and location - an analytical approach”, Second edition, PHI., 2002

CO’s-PO’s&PSO’sMAPPING

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

IE23011 OPERATIONS SCHEDULING ALGORITHMS L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To gain conceptual and basic understanding of Sequencing and Scheduling algorithms in industries
2. To impart knowledge on the Applications of Single Machine Sequencing Algorithms
3. To gain understanding of Parallel Processor Scheduling Algorithms
4. To impart knowledge on Flow Shop Scheduling and its algorithms
5. To provide understanding about Job Shop Scheduling and its algorithms

UNIT I SCHEDULING CONCEPTS 9

Scheduling objectives – Scheduling Theory/Function – Sequencing – Performance measures – Priority rules - Scheduling Theorems – Scheduling constraints – Pure Sequencing model: Assumptions.

UNIT II SINGLE MACHINE MODEL 9

Characteristics - Smith's rule – Hogdson's algorithm – Wilkerson Irwin algorithm – Neighbourhood Search method – Branch and Bound algorithm – Dynamic Programming method – Non simultaneous arrivals – Dependent jobs sequencing – Sequence dependent setup times.

UNIT III PARALLEL PROCESSOR MODEL 9

Characteristics - Preemptive jobs: McNaughton's algorithm – Non preemptive jobs: Heuristic approaches – Minimizing weighted mean flow time: H_1 and H_m heuristics – Dependent jobs: Hu's heuristic – Muntz Coffman heuristic.

UNIT IV FLOW SHOP MODEL 9

Characteristics – Johnson's Algorithm – Extension to 3 machine problem – nxm FSP: Campbell Dudek Smith algorithm – Palmer's algorithm – Gupta's algorithm – Start/Stop lags – Mitten's algorithm – Ignall Schrage algorithm – Dispatch Index heuristic.

UNIT V JOB SHOP MODEL 9

Characteristics – Graphical representation – Feasible schedule identification (Network diagram) – Semi active schedule - Active schedule – Single pass approach – Non delay schedule – Heuristic schedule generation – Dynamic job shop scheduling – Open shop – Meta heuristics applications.

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Understand the fundamental theory in Sequencing and Scheduling.

CO2. Determine the sequence that minimizes a performance measure in single machine problems

CO3. Design a Parallel Machine schedule to minimize performance measures

CO4. Apply heuristics/algorithms to design a Flow shop

CO5. Demonstrate the use of heuristics for Job shop scheduling

TEXT BOOK:

1. Kenneth R.Baker, “Introduction to Sequencing and Scheduling”, John Wiley & Sons, New York, 2000.

REFERENCES:

1. Kenneth R.Baker, Dan Trietsch, “ Principles of Sequencing and Scheduling”, John Wiley & Sons, New York, 2019.

2. Richard W.Conway, William L.Maxwell and Louis W.Miller, “Theory of Scheduling”, Dover Publications, 2003.

CO’s-PO’s&PSO’sMAPPING

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

IE23012 COMPUTER INTEGRATED MANUFACTURING SYSTEMS L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To understand the Group technology and Flexible Manufacturing Systems.
2. To analyze the transfer lines of a manufacturing systems.
3. To understand the manufacturing support systems.
4. To analyze the quality of the manufacturing systems.
5. To gain knowledge in Industry 4.0.

UNIT I GROUP TECHNOLOGY AND FMS 9

Part Families, Production Flow Analysis, Cellular Manufacturing, Rank Order Clustering, Flexible Manufacturing Systems- components, FMS applications, FMS analysis – Bottleneck model.

UNIT II MANUFACTURING SYSTEMS 9

Manufacturing systems - components, types of a manufacturing system, Single station manufacturing cells; Manual Assembly lines, line balancing Algorithms, Mixed model Assembly lines, Alternative Assembly systems. Automated production lines, Applications, Analysis of transfer lines.

UNIT III MANUFACTURING SUPPORT SYSTEMS 9

Product design and CAD, CAD/CAM and CIM, Computer aided process planning- Variant and generative approaches, Concurrent Engineering and design for manufacture, Aggregate Production Planning, Master Production Schedule, Materials Requirement Planning, Manufacturing Resource Planning (MRP-II), Enterprise Resource Planning, Lean production, Agile manufacturing.

UNIT IV QUALITY CONTROL SYSTEMS 9

Quality in Design and Manufacturing – Traditional and Modern Quality Control - Process Variability and Process Capability – Inspection Fundamentals – Sampling versus 100% Inspection – Automated Inspection – Inspection Metrology - Coordinate Measuring Machine – surface Measurement – Machine Vision - Optical Inspection Methods.

UNIT V INDUSTRY 4.0 9

Introduction - Industry 4.0 – Smart manufacturing: Smart design, smart machining, smart monitoring, smart control, smart scheduling - Internet of Things - Industrial Internet of Things - Framework: Connectivity devices and services - Intelligent networks of manufacturing - Cloud computing - Data analytics -Cyber physical systems -Machine to Machine communication- case studies.

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1 Interpret Group technology and Flexible Manufacturing Systems

CO2 Analyze the transfer lines of a manufacturing systems

CO3 Extend the manufacturing support systems

CO4 Analyze the quality control and automated inspection systems

CO5 Understanding the fundamentals of Industry 4.0

TEXT BOOKS:

1. Mikell P.Groover, “Automation production systems and computer integrated manufacturing”, PHI, fifth edition,2019.
2. Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, A press, 2016.

REFERENCE:

1. Kant Vajpayee S,“Principles of Computer-Integrated Manufacturing”,PHI,2005

CO’s-PO’s&PSO’sMAPPING

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

IE23013 PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To understand the concept of productivity and significance of productivity.
2. To evaluate, appraise, and measure productivity.
3. To gain knowledge on various productivity techniques.
4. To apply the process for improving the productivity & applications of Re-Engineering concepts required for various organizations.
5. To analyze and implement BPR tools for improving the productivity.

UNIT I INTRODUCTION TO PRODUCTIVITY CONCEPTS 9

Basic concept and meaning of Productivity – Misconceptions about Productivity, Production vs Productivity, Significance of Productivity – Factors affecting Productivity – Productivity cycle, Scope of Productivity Engineering and Management, Problems with the Partial Productivity Perspective, Importance of management's role in increasing Productivity

UNIT II PRODUCTIVITY MEASUREMENT AND EVALUATION 9

Productivity measurement in International, National and Industrial level – Total Productivity Model – Relationship between Total productivity and other management goals, Productivity measurement in Manufacturing and Service sectors –Seven keys to high Productivity, – Need for Productivity Evaluation – Evaluation Methodology.

UNIT III PRODUCTIVITY PLANNING AND IMPLEMENTATION 9

Need for Productivity Planning – Short term and long term productivity planning – Productivity improvement approaches, Principles - Productivity Improvement techniques – Technology based, Material based, Employee based, Product based techniques, Dimensions of Productivity Improvement – Managerial aspects of Productivity Implementation schedule, Productivity audit and control.

UNIT IV REENGINEERING PROCESS 9

Foundation elements for organizational transformation and Fundamentals of process reengineering – Principles, Methodology and guidelines for Organization Transformation, DSMCQ and PMP organization Transformation models – Process Improvement Models like PMI, Edosomwan, LMICIP and NPRDC Models.

UNIT V BPR TOOLS AND IMPLEMENTATION 9

Analytical and Process Tools and Techniques - Role of Information and Communication Technology in BPR – Requirements and steps in BPR Implementation – Case studies.

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Summarize the concept of productivity and Management's role in productivity improvement

CO2. Measure and evaluate productivity.

CO3. Discover the planning techniques and to implement various productivity techniques.

CO4. Illustrate the Reengineering process for improving the productivity.

CO5. Infer and implement BPR tools for improving the productivity.

TEXT BOOKS:

1. Sumanth, D.J, "Productivity Engineering and Management", TMH, New Delhi, 1990.
2. Edosomwan, J.A, "Organizational Transformation and Process re- Engineering", British Cataloging in publications, 1996.

REFERENCES:

1. David J. Sumanth, "Total Productivity Management", St. Lucie Press, 2000.
2. Premvrat, Sardana, G.D. and Sahay, B.S, "Productivity Management - A systems approach", Narosa Publications, New Delhi, 1998.
3. Robert Schaffer, "Managing Productivity", Jaico Publishing House, Mumbai, 2003.

CO's-PO's&PSO'sMAPPING

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

IE23014 DECISION SUPPORT AND INTELLIGENT SYSTEMS L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To understand the fundamental terms, concepts and theories associated with the phases of Decision Support Systems.
2. To evaluate the various mathematical models, data warehousing and data mining.
3. To discuss and develop skills in the analysis, design and implementation of group support systems and knowledge management systems.
4. To analyze the expert system as a subsystem of DSS
5. To create the knowledge representation methods.

UNIT I DECISION MAKING FOUNDATION AND DEVELOPMENT 9

Management Support System - Managerial decision making, System modeling and support - preview of the modeling process - phases of decision-making process - DSS Architecture, Analysis, Design, Requirements, and Validation

UNIT II MODELING AND ANALYSIS 9

DSS components - Modelling and Analysis - Database Organization and Structures, Data Warehousing, Data Marts, Business Intelligence/Business Analytics, Online Analytical Processing (OLAP), Data Mining - DSS development - Software tools for Development - AHP.

UNIT III KNOWLEDGE MANAGEMENT 9

Group support systems- Enterprise DSS- supply chain and DSS - Knowledge management methods - Organizational Learning and Transformation, technologies and tools.

UNIT IV KNOWLEDGE REPRESENTATION 9

Artificial intelligence and expert systems - Concepts, structure, types - Knowledge Engineering - Principle and Methods - Difficulties, methods, selection, verification and validation - Advanced Intelligent Systems.

UNIT V SEMANTIC NETWORKS 9

Representation in logic and schemas, semantic networks, production rules and frames, inference techniques, intelligent system development, implementation and integration of management support systems.

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Make decisions in the semi structured and unstructured problem situations.

CO2. Illustrate the data warehousing and data mining principles in basic applications.

CO3. Develop a knowledge management system with simple tools and techniques.

CO4. Construct intelligent based DSS.

CO5. Express logical and analytical thinking in making decisions.

TEXT BOOK:

1. Efraim Turban and Jay E Aronson, “Decision Support and Business Intelligent Systems”, PHI, Eighth edition, 2010.

REFERENCES:

1. Gupta, J.N.D., Forgionne, G.A., and Manuel, M.T., Intelligent Decision-making Support Systems: Foundations, Applications and Challenges, Springer, 2006
2. Iantovics, B., and Kountchev, R., Advanced Intelligent Computational Technologies and Decision Support Systems, Springer, 2014
3. Kumer. K., Zindani, D. and Davim, J.P., Digital Manufacturing and Assembly Systems in Industry 4.0, CRC Press, 2019
4. Tweedale, J.W., Neves-Silva, R., Jain, L.C., Phillips-Wren, G., Watada, J., and Howlett, R.J., Intelligent Decision Technology Support in Practice, Springer, 2016
5. Valencia-Garcia, R, Paredes-Valverde, M.A., Salas-Zarate, M.P. and Alor-Hernandez, Giner., Exploring Intelligent Decision Support Systems, Springer, 2018

CO’s-PO’s&PSO’sMAPPING

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

IE23015	SMART MANUFACTURING AND ROBOTICS	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To suggest smart manufacturing technological needs in a manufacturing industry.
2. To interpret IoT to support the digital manufacturing.
3. To specify the sensors for particular application.
4. To control various robot links using kinematic equations.
5. To elaborate on significance of digital twins

UNIT I SMART FACTORY **9**

Smart Factory – Levels of Smart Factories – Benefits – Technologies – IoT, Additive Manufacturing- Computer Vision- AR/VR- COBOTS- Sustainable and Digital Manufacturing-Key Principles– Creating a Smart Factory – Smart Factories and Cyber security.

UNIT II INDUSTRY 4.0 **9**

Introduction - Industry 4.0 –Internet of Things - Industrial Internet of Things - Framework: Connectivity devices and services - Intelligent networks of manufacturing - Cloud computing - Data analytics – Cyber physical systems -Machine to Machine communication - Case Studies.

UNIT III SENSORS AND MACHINE VISION **9**

Sensory Devices - Non optical - Position sensors - Optical position sensors - Velocity sensors Proximity sensors - Contact and noncontact type - Tactile and slip sensors - Force and torque sensors- Introduction to Image Processing

UNIT IV DIGITAL TWINS **9**

Basic Concepts – Features and Implementation - Digital Twin: Digital Thread and Digital Shadow- Building Blocks – Types – Characteristics of a Good Digital Twin Platform – Benefits, Impact & Challenges – Future of Digital Twins.

UNIT V ROBOT KINEMATICS AND ROBOT PROGRAMMING **9**

Forward Kinematics and Reverse Kinematics of Manipulators with Two, Three Degrees of Freedom (In 2 Dimensional) - Homogeneous Transformation- D-H Representation of forward kinematics. Teach Pendant Programming, Lead through programming, Robot programming Languages – VAL Programming – Motion Commands, Sensor Commands, End effecter commands, and Simple programs.

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Identify the technological need for smart manufacturing.

CO2. Use IoT based Machine to Machine connectivity for information sharing and collection

CO3. Perform selection of sensor for a particular task.

CO4. Able to analyze need for digital twins in practical manufacturing.

CO5. Program a robot to perform a task.

TEXT BOOKS:

1. Fu.K.S. Gonzalz.R.C., and Lee C.S.G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw-Hill Book Co., 1987.
2. Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited, 2012.
3. Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, A press, 2016.

REFERENCES:

1. Janakiraman.P.A., “Robotics and Image Processing”, Tata McGraw-Hill, 1995.
2. Richard D. Klafter., Thomas A. Chmielewski, Michael Negin, “Robotic Engineering: An Integrated Approach”, PHI.,1989.
3. Saeed B.Niku., “Introduction to Robotics: Analysis, Control, Applications”, Wiley, 2011.
4. John. J. Craig, Introduction to Robotics: Mechanics and Control, Pearson, 2022

CO’s-PO’s&PSO’sMAPPING

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

IE23016	PROCESS MEASUREMENT SYSTEMS	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To describe the principles of mechanical testing methods.
2. To discuss the principles of ultrasonication and its effects.
3. To explore tribological behaviour and wear reduction techniques.
4. To contrast the surface characteristics and video measurement technologies
5. To define the various types of corrosion and test procedures.

UNIT I MECHANICAL TESTING PROCESS 9

Introduction to mechanical behaviour, standards, and procedure for the measurement of mechanical properties. Measurement of Hardness, tensile properties, fatigue properties. Effect of heat treatment on mechanical properties.

UNIT II MEASUREMENT OF ULTRASONICATION PROCESS 9

Introduction to ultrasonication process, principles, process parameters. Effect on the hardness, effect on the tensile behaviour and microstructure. Effect on the wear behaviour of ultrasonicated casted materials

UNIT III WEAR MEASUREMENT PROCESS 9

Introduction to tribology: friction, wear and lubrication. Measurement of friction and wear: methods, standards, equipment, parameters, thermal wear imaging, data and image acquisition. Wear reduction methods: Surface modification and property enhancement methods.

UNIT IV SURFACE FINISH AND VIDEO MEASUREMENT PROCESS 9

Ideal surface, surface structure and 2D and 3D surface roughness parameters. Roughness measurement equipment. Video measurement systems: Introduction and principles, measurement of wear depth, scratch dimensions, kerf taper angle.

UNIT V CORROSION MEASUREMENT TECHNIQUES 9

Definition, types, standards and principles. Corrosion test procedures and equipment: Salt spray test, immersion test, electrochemical test and tribo corrosion test. Corrosion rate measurements

TOTAL:45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Experiment the mechanical testing methods and their measurement.

CO2. Relate the ultrasonication principles and determine the effects of ultrasonication methods.

CO3. Outline the material's friction and wear behaviour, and discuss methods for reducing wear.

CO4. Describe the various surface characteristics and the video measurement methods.

CO5. Asses the corrosion characteristics and the corrosion measurement techniques.

TEXT BOOKS:

1. Davis, H.E., Hauck G. & Troxell G.E., The Testing of engineering Materials, (4th Edition), McGraw Hill, College Divn., 1982.
2. Ernest Rabinowicz, Friction and Wear of Materials, 2nd Edition, ISBN: 978-0-471-83084-9, Wiley Publisher, 2013.
3. E. McCafferty, Introduction to Corrosion Science, Springer Science & Business Media, 04-Jan-2010.

REFERENCES:

1. Hein eloper & Rosenthal, Principles of Metal Casting, Tata McGraw Hill, 2000.
2. Friction, Wear, Lubrication A Textbook in Tribology, 2nd edition by Kenneth C Ludema, Layo Ajayi, 2019.
3. Emanuele Trucco, Alessandro Verri, "Introductory Techniques for 3D Computer Vision", 1st Edition, 2009.
4. "Techniques for Corrosion Monitoring", 2nd edition - December 1, 2020.

CO's-PO's&PSO'sMAPPING

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

IE23C04	PRODUCT LIFE CYCLE MANAGEMENT	L T P C
		3 0 0 3

COURSE OBJECTIVES:

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), Core functions (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:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Explain basic concepts of product life cycle management.

CO2. Demonstrate product development approaches.

CO3. Explain elements of product modelling.

CO4. Discuss in detail the concept of product data management.

CO5. Discuss about integration of PLM with other applications.

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.

CO's-PO's&PSO'sMAPPING

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

IE23017	ADDITIVE MANUFACTURING	L T P C
		3 0 0 3

COURSE OBJECTIVES:

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-Lightweight 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 Delivery - Process Parameters -Materials -Benefits -Applications.

UNIT V OTHER ADDITIVE MANUFACTURING PROCESSES 9

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

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities.

CO2. Acquire knowledge on process of transforming a concept into the final product in AM technology.

CO3. Elaborate the vat polymerization and material extrusion processes and its applications.

CO4. Acquire knowledge on process and applications of powder bed fusion and direct energy deposition.

CO5. Evaluate the advantages, limitations, applications of binder jetting, material jetting and laminated object manufacturing processes.

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 Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
3. 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.

CO's-PO's&PSO'Smapping

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

IE23018	PRODUCT DESIGN AND DEVELOPMENT	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To understand the principles of generic development process; product planning; customer need analysis for new product design and development.
2. To enhance the understanding of setting product specifications and generate, select, screen, and test concepts for new product design and development
3. To apply the principles of product architecture
4. To expose the different Prototyping techniques and develope a robust design
5. To understand the concepts of economics principles; project management practices in development of new product.

UNIT I INTRODUCTION TO PRODUCT DESIGN 9

Characteristics of Successful Product Development –Duration and Cost of Product Development – Challenges of Product Development - Product Development Processes and Organizations – Product Planning Process - Process of Identifying Customer Needs

UNIT II PRODUCT SPECIFICATIONS, CONCEPT GENERATION, SELECTION AND TESTING 9

Establish Target and Final product specifications – Activities of Concept Generation - Concept Screening and Scoring - Concept Testing Methodologies.

UNIT III PRODUCT ARCHITECTURE 9

Types of modularity – Implications of architecture – Product change – Variety – Component standardization – Product performance – Manufacturability – Product development management – Establishing the architecture – Developing function structures – Development of working structures – Selection and combination of working structures to concepts.

UNIT IV DESIGN FOR MANUFACTURE, PROTOTYPING AND ROBUST DESIGN 9

DFM Definition - Estimation of Manufacturing cost- Reducing the component costs, costs of supporting function and assembly costs – Impact of DFM decision on other factors - Prototype basics - Principles of prototyping – Prototyping technologies - Planning for prototypes - Robust design – Robust Design Process

UNIT V PRODUCT DEVELOPMENT ECONOMICS AND MANAGING PROJECTS 9

Elements of Economics Analysis- Build a Base –Case Financial Model-Performance Sensitivity Analysis – Influence of Qualitative factors- Baseline Project Planning - Accelerating the project - Project execution – Postmortem project evaluation.

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Apply the principles of generic development process; product planning; customer need analysis for new product design and development.

CO2. Set product specifications and generate, select, screen, test concepts for new product design and development.

CO3. Understand the importance of Product Architecture

CO4. Apply to adopt Prototyping techniques and develop a robust design.

CO5. Understand and represent the managing the projects with cost elements

TEXT BOOKS:

1. Karal, T.Ulrich Steven D.Eppinger, “Product Design and Development”, McGraw Hill, International Editions, 2003.
2. Kenneth Crow, "Concurrent Engineering/Integrated Product Development". DRM Associates, 6/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book

REFERENCES:

1. Kevin N Otto, Kristin L Wood, “Product Design – Techniques in Reverse Engineering and New Product Development”, Pearson Education, Inc, 2016
2. Stephen Rosenthal, "Effective Product Design and Development", Business One Orwin Homewood, 1992
3. Stuart Pugh, "Total Design – Integrated Methods for successful Product Engineering", Addison Wesley Publishing, Neyourk, NY, 1991.

CO’s-PO’s&PSO’sMAPPING

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

IE23019 CREATIVITY, INNOVATION AND VALUE ENGINEERING L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To study principles and essential theory of creativity
2. To understand the various methods and tools for creativity
3. To apply the principles of innovation management in a product design and its service
4. To study the concepts of value engineering.
5. To understand the methods and tools in value engineering concepts

UNIT I INTRODUCTION TO ESSENTIAL THEORY OF CREATIVITY 9

Directed creativity: The Need for Creative Thinking in the Pursuit of Quality - Essential Theory for Directed Creativity: Definitions and the Theory of the Mechanics of Mind; Heuristics and Models: Attitudes, Approaches, and Actions That Support Creative Thinking.

UNIT II METHODS AND TOOLS FOR CREATIVITY 9

Three basic principles behind the tools of directed creativity – Tools that prepare the mind for creative thought – Tools that stimulate the imagination for new idea – Development and action: the bridge between mere creativity and the rewards of innovation - ICEDIP: Inspiration, Clarification, Distillation, Perspiration, Evaluation and Incubation – Creativity and Motivation

UNIT III INNOVATIVE MANAGEMENT 9

Achieving Creativity – Introduction to TRIZ methodology of Inventive Problem Solving - the essential factors – Innovator's solution – creating and sustaining successful growth – Disruptive Innovation model – Segmentive Models – New market disruption - Commoditation and DE-commoditation – Managing the Strategy Development Process – The Role of Senior Executive in Leading New Growth – Passing the Baton

UNIT IV 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 V 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

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Apply the principles of essential theory of creativity in new product design and development.

CO2. Understanding the various tools and methods for creativity of product and its service.

CO3. Remember the factors of Innovation Management in a new product development

CO4. Understand the concepts of value Engineering

CO5. Design a product in systematic manner considering the concept of value engineering

TEXT BOOKS:

1. Clayton M. Christensen Michael E. Raynor," The Innovator's Solution", Harvard Business School Press Boston, USA, 2013
2. Donald A. Norman," Emotional Design", Perseus Books Group New York , 2004
3. Geoffrey Petty," How to be better at Creativity", The Industrial Society 1999
4. Mudge, Arthur E. "Value Engineering"- A systematic approach, McGraw Hill, New York, 2000.

REFERENCES:

1. Semyon D. Savransky," Engineering of Creativity – TRIZ", CRC Press New York USA 2003.
2. Rousing Creativity: Think New Now Floyd Hurr, ISBN 1560525479, Crisp Publications Inc. 1999

CO's-PO's&PSO'sMAPPING

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

IE23020 ACCOUNTING AND FINANCE FOR MANAGEMENT L T P C

3 0 0 3

COURSE OBJECTIVES:

1. Understanding the Basics of accounting and recording of transactions
2. Evaluating P&L statements, Balance sheets and other accounting statements.
3. Learn and apply the various cost accounting methods.
4. Study the various cost control procedures.
5. Sketch and prepare a budget and make investment decisions.

UNIT I INTRODUCTION 9

Basics of accounting – Management Accounting – Financial accounting – cost accounting – comparison of financial accounting, cost accounting and management accounting – generally accepted accounting principles – Accounting standards – Accounting cycle-Recording of transactions: journalizing, ledger posting, preparation of Trial Balance.

UNIT II FINANCIAL ACCOUNTING 9

Preparation of Companies Financial Statements - Salient features of Balance Sheet and Profit and Loss statement, cash flow and Fund flow Analysis(Elementary),ratio analysis.

UNIT III COST ACCOUNTING 9

Cost accounting systems: Job Costing, process costing, allocation of overheads, Activity based costing, variance analysis–marginal costing–Break even analysis.

UNIT IV BUDGETING 9

Requirements for a sound budget, fixed budget – preparation of sales and production budget, flexible budgets, zero based budgets and budgetary control.

UNIT V FINANCIAL MANAGEMENT 9

Investment decisions – Investment appraisal techniques – payback period method, accounting rate of return, net present value method, internal rate of return and profitability index method-cost of capital.

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Analyse the financial transaction and prepare the Trail Balance

CO2. Evaluate the financial statements.

CO3. Ability to apply the management and cost accounting techniques for decision making.

CO4. Construct and analyse a various types of budget

CO5. Examine investment decision based on capital budgeting techniques.

TEXT BOOKS:

1. M.Y. Khan & P.K. Jain, Management Accounting, Tata McGraw Hill, 8 thedtion, 2018.
2. Maheshwari SN, Maheshwari SK& Maheshwari SK An Introduction to Accountancy, 12thEd,Vikas Pub. House.2022.
3. Horne, J.C. Van and Wackowich. Fundamentals of Financial Management. Pearson Education, 12th Edition, 2008.

REFERENCES:

1. Narayanaswamy R 2014, Finanacial Accounting – A Managerial Perspective,5th Ed, Prentice Hall of India.
2. Bhattacharyya, Asish K. Principles And Practice Of Cost Accounting, 3rd Edition,2004.
3. I M. Pandey Financial Management, Vikas Publishing House Pvt. Ltd.,11th Edition, 2018.

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

IE23021	SAFETY AND RISK ANALYTICS	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. Know the types, sources and characteristics of safety data.
2. Understand the safety data visualization and exploration.
3. Understands the safety performance and evaluation.
4. Builds the safety predictive models.
5. Discuss the behavioral safety analytics, injury epidemiology, and safety related decision making.

UNIT I INTRODUCTION **9**

Introduction to Safety and Risk Management– Hazard Triangle–Safety Ontology– Qualitative and Quantitative Risk Assessments- Hazard and Risk Data – Incident Investigation Data- Behavioural and Organizational Safety Data.

UNIT II SAFETY DATA ASSESSMENT **9**

Data Dimensions and Information Quality - Missing Data Handling - Data Transformation – Data Reduction- Probability Distribution- Sample and Statistics - Safety Data Visualization Tools - Safety Data Exploration.

UNIT III DESCRIPTIVE ANALYTICS **9**

Leading and Lagging Indicators for Measuring Safety- Control Charts for Safety Performance Evaluation and Monitoring - Safety Capability Analysis – Pre-processing of Text Data - Document Classification using KNN - Topic Modelling - Latent Dirichlet Allocation - Bow-Tie Construction - Consequence Modelling and Risk Distribution.

UNIT IV PREDICTIVE SAFETY ANALYTICS **9**

Introduction to Predictive Safety and Risk Analytics- Logistic Regression - Application of Logistic Regression- Classification and Regression Tree (CART) - Support Vector Machine - Application of Support Vector Machine - Association Rule Mining - Application of Association Rule Mining.

UNIT V BEHAVIORAL SAFETY ANALYTICS **9**

Statistical Measures of Safety Program Effectiveness - Intervention Design - Risk Based Decision Making - Risk Based Maintenance- Introduction to Behavioural Safety- Behavioural Safety Data Collection and Preliminary Analysis - Causal Modelling - Injury Epidemiology - Occupational Safety, Health and Working Conditions Code, 2020 and Role of Safety and Risk Analytics

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Analyse the sources and characteristics of safety data.

CO2. Visualize and Explore the safety data.

CO3. Evaluation of Safety Performance.

CO4. Analyse the Safety data using Predictive analytics.

CO5. Analyse the Behavioural Safety data.

TEXT BOOKS:

1. H Kumamoto and E J Henley, Probabilistic Risk Assessment and Management for Engineers and Scientists, IEEE Press, 2000.
2. Weiss S M, Indurkhya N, Zhang T and Damerau F J, Text mining: predictive methods for analysing unstructured information, Springer, 2005.

REFERENCE:

1. James, G., Witten, D., Hastie, T., and Tibshirani, R , An Introduction to Statistical Learning , Springer,2017
2. Christopher M Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
3. Tan, P. N., Steinbach, M., & Kumar, V. Introduction to data mining Pearson Education India, 2016.

CO's-PO's&PSO'sMAPPING

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

IE23C09	SAFETY ENGINEERING AND MANAGEMENT	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To understand unsafe conditions and recognize unsafe alerts.
2. To interpret the rules and regulations for safety operations.
3. To evaluate the health and hygiene of industries.
4. To apply the safety system analysis to prevent accidents.
5. To understand the regulatory bodies and to collaborate and modify processes / procedures for safety.

UNIT I INTRODUCTION 9

Need for safety - Safety and productivity - Accident, Injury, Unsafe act, Unsafe Condition - Dangerous Occurrence - Reportable accidents. Theories of accident causation. Safety organization- objectives, types, functions. Risk and Hazard - Mechanical hazards – Boilers, Pressure vessels, Electrical Exposure.

UNIT II CHEMICAL HAZARDS AND ENVIRONMENTAL CONTROL 9

Chemical exposure – Toxic materials – Radiation Ionizing and Non-ionizing Radiation - Industrial Hygiene – Industrial Toxicology. Environmental Control – Industrial Noise - Noise measuring instruments, Control of Noise, Vibration, Industrial Lighting, Ventilation and Heat control - Personal Protection.

UNIT III INDUSTRIAL HYGIENE AND OCCUPATIONAL HEALTH 9

Industrial Hygiene - Importance of hygiene in industry, domestic hygiene and industrial hygiene - Air sampling, the concept of threshold limits, personal monitoring - risk management at work places, emergency control measures - Industrial physiology, classification of workload, work capacity and man-job alignment, fatigue and rest allowances, physiological list in occupational health assessment – Occupational Hazard – Occupational Health audit and survey.

UNIT IV HAZARD ANALYSIS 9

System Safety Analysis – Material Safety Data Sheets (MSDS) - Techniques – Fault Tree Analysis (FTA), Failure Modes and Effects Analysis (FMEA), HAZOP analysis, and Risk Assessment – methodology, criticality analysis, corrective action and follow-up.

UNIT V SAFETY REGULATIONS 9

Explosions – Disaster management – catastrophe control, hazard control - Safety Laws and Regulations – Relevant Provisions of Factories Act and Rules, Indian Electricity Act and Rules, Explosive Act and Rules, Gas Cylinders Rules – Safety Regulatory Authorities – Functions and processes of regulatory body of safety - Product safety – case studies.

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Identify and prevent chemical, environmental, mechanical, fire hazard.

CO2. Collect, analyze and interpret the accidents data based on various safety techniques.

CO3. Develop proper safety hygiene's on industries and its employees.

CO4. Construct to perform hazard analysis.

CO5. Express to design the system with environmental consciousness by implementing safety regulation.

TEXT BOOKS:

1. John V.Grimaldi, "Safety Management", AITB S Publishers, 2003.
2. R.K Jain (2000) Industrial Safety, Health and Environment management systems, Khanna Publications.
3. Krishnan, N.V. (1997). Safety management in Industry. Jaico Publishing House, New Delhi.

REFERENCES:

1. David L.Goetsch, "Occupational Safety and Health for Technologists", Engineers and Managers, Pearson Education Ltd. 5th Edition, 2005.
2. Deshmukh L M, "Industrial Safety Management", Tata McGraw-Hill Publishing Company Ltd., 2005.
3. Safety Manual, "EDEL Engineering Consultancy", 2000.

CO's-PO's&PSO'sMAPPING

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

IE23022	HUMAN MACHINE INTERACTION SYSTEM	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To explain Human Machine Interface, Hardware, software and operating environment to use HMI in various fields.
2. To understand the automated using real-time data, communication systems, Artificial Intelligence (AI) techniques
3. To develop human-centered design; fundamental principles of interaction
4. To design characteristics of human-machine cooperation and interaction systems in smart manufacturing.

UNIT I INTRODUCTION 9

Introduction to HMI—current and future, systems, features, and benefits Human–machine interfaces in smart manufacturing, HMI on a growth drive Origins of smart manufacturing , HMIs -, benefits, disadvantages of HMI, Total Global HMI dedicated AR/VR devices 2020–2030.

UNIT II INDUSTRY 4.0 9

Industry4.0—framework, objectives, strategic enabler, readiness assessment Industry 4.0 automation, implementation of Industry 4.0- HMI; Socio- technical approach in HMI-Framework of HMI.

UNIT III ROBOTICS AND AUTONOMOUS SYSTEMS IN SMART MANUFACTURING 9

Development of robots-Future of robotics- Introduction to autonomous systems-Concept of robotics laws-Communication system used in robotics, Advantages and Disadvantages of robots Robotics beyond 2030.

UNIT IV CHALLENGES AND IMPACT OF HMI IN SM& AI 9

Challenges and impact of human–machine interaction systems in smart manufacturing, Smart manufacturing concepts, Artificial intelligence implementations in HMI for smart manufacturing Advantages and disadvantages of AI the components, working principles.

UNIT V AI - TECHNOLOGY 9

AI technology, The ethics of AI, Stage of intelligence, AI in 2030, 5G and beyond environment for smart manufacturing, The current communication system, Features and advantages of 5G technology, Differences between 4G and 5G.

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Understand the Human Machine interaction in current and future of an industry.

CO2. Know the Industry 4.0 frame work and its approach

CO3. Learn the robotics automation and smart manufacturing in modern industry

CO4. Analyze the challenges and impact of HMI in smart manufacturing and AI

CO5. Understand the AI technologies and feature advantages of 5G technology in an Industry.

TEXT BOOKS:

1. Wai Yie Leong “Human Machine Collaboration and Interaction for Smart Manufacturing”, Published by The Institution of Engineering and Technology, London, United Kingdom 2022
2. Sarath Sreedharan, Anagha Kulkarni, Subbarao Kambhampati, “Explainable Human–AI Interaction”, Morgan & Claypool publishers, 2022.

REFERENCES:

1. André Liem, “Prospective Ergonomics”, John Wiley and Sons, Inc. 2017

CO’s-PO’s&PSO’sMAPPING

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

IE23023	COGNITIVE ERGONOMICS	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To learn the mechanisms and constraints of human cognition and their impact on Product design
2. To understand and use important concepts, theories, principles, and research methods in the field of cognitive ergonomics
3. To demonstrate the relevance and importance of cognitive ergonomics in our society and industry
4. To increase students' interest and awareness of cognitive ergonomic issues in their everyday life and future career

UNIT I INTRODUCTION **9**

Inter disciplinary aspects of Human factor Engineering, Cognitive concept of Human Machine Interface, Cognitive and Industrial Psychology.

UNIT II HUMAN COGNITIVE PROCESS **9**

Human cognitive process, human mental process. Attention, sensation, perception, memory encoding/ retrieval, reasoning and cognition affecting the Productivity

UNIT III COGNITIVE ERGONOMICS IN DESIGN **9**

Understanding cognitive status of users in the context of product design, scope of cognitive ergonomics in planning. evaluation, and effectiveness of systems

UNIT IV COGNITIVE ERGONOMICS IN ENVIRONMENTAL **9**

Illumination, Noise and Vibration – Measurement of sound, Hearing protectors, reduction of noise, effects of noise on Human performance ,Interference of noise with spoken communication, Whole body vibration , sources of vibration discomfort

UNIT V COGNITIVE THEORIES **9**

Emotional Design Model, Pleasure Model, Basic Model of Product Appraisal Process, Kansei Engineering, Brief Insights to Hick's Law and Fitts's Law, Hierarchical task analysis (HTA)' and cognitive walk-through method (CWM)

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Articulate the implications and consequences of human factors applications in a system's context

CO2. Understand the human cognitive processes and effectiveness

CO3. Demonstrate an understanding of the role and scope of cognitive ergonomics in the planning, evaluation, and effectiveness of systems

CO4. Describe the environmental factors that affects the productivity and human performance

CO5. Apply cognitive ergonomic theory, concepts, and strategies to understand systems in relevant contexts

TEXT BOOKS:

1. G.C. van der Veer , S. Bagnara , G.A.M Kempen ,Cognitive Ergonomics , North Holland
2. John Long, A.Whitefield, Cognitive Ergonomics and Human-computer Interaction , Cambridge University Press
3. Wickens, C., 1992. Engineering psychology and Human Performance. Harper-Collins: New York
4. Stanton, N. A., and Young, M. S. (2003). A Guide to Methodology in Ergonomics: Designing for human use. Taylor & Francis: New York.

REFERENCES:

1. Lewis, C. and Wharton, C. (1997), Cognitive walkthroughs, in Handbook of Human–Computer Interaction, 2nd ed., Helander, M., Landauer, T.K., and Prabhu, P., Eds., Elsevier, Amsterdam.
2. Stanton, N. A., and Young, M. S. (2003). A Guide to Methodology in Ergonomics: Designing for human use. New York: Taylor & Francis.
3. Annett, J., Duncan, K.D., Stammers, R.B., and Gray, M. (1971), Task Analysis, Her Majesty's Stationery Office, London.
4. Vicente, K.J., 1999, Cognitive Work Analysis: Towards Safe, Productive and Healthy Computer-Based Work. (Mahwah, NJ: Erlbaum).

CO's-PO's&PSO'sMAPPING

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

IE23024	OCCUPATIONAL HEALTH AND SAFETY	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To learn nature and scope of Occupational health and safety and basic laws
2. To understand the health and SMS in various perspective
3. To learn the work place hazards and risk control
4. To monitor, audit, and review health and safety performance to ensure continuous improvement.
5. To identify and control workplace hazards, promote welfare, and ensure safe movement and operations.

UNIT I INTRODUCTION 9

The scope and nature of occupational health and safety, Moral, legal and financial reasons for promoting good standards of health and safety, The legal framework for the regulation of health and safety including sources and types of law, The scope, duties and offences of employers, managers, employees and others under the Health and Safety at Work.

UNIT II HEALTH AND SAFETY MANAGEMENT SYSTEMS (SMS) -PLANNING 9

Importance of planning , Principles and practice of risk assessment , General principles of control and hierarchy of risk reduction measures , Sources of health and safety information , Safe systems of work , Permits to work.

UNIT III HEALTH AND SMS - ORGANIZING 9

Organizational health and safety roles and responsibilities, directors and managers, Concept of health and safety culture and its significance in the management of health and safety in an organization, Human factors which influence behavior at work, improved safety behavior at work, Emergency procedures and arrangement for contacting the emergency services, Requirements for, and effective provision of, first aid in the workplace.

UNIT IV HEALTH AND SMS - MEASURING, AUDIT AND REVIEW 9

Active and reactive monitoring, Health and safety auditing, Check List, Investigating incidents, Recording and reporting incidents, Review of health and safety performance.

UNIT V WORKPLACE HAZARDS AND RISK CONTROL 9

Health, welfare and work environment requirements, Violence at work, Substance misuse at work, Safe movement of people in the workplace, Working at height , Excavations, Safe movement of vehicles in the workplace, Driving at work.

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Understand the fundamentals of scope and nature of occupational health and safety.

CO2. Plan of health and safety management systems in an workplace

CO3. Understand the role and scope of health and safety management systems and health to improve safety

CO4. Measure and audit the health and safety management systems in a workplace

CO5. Understand the workplace hazards and risk control

TEXT BOOKS:

1. Phil Hughes, Ed Ferrett, "Introduction to Health and safety at work", The Handbook for the NEBOSH, National General Certificate, 5th edition , 2011
2. Bernard j , Healey, Kenneth, T. Walker "Introduction to occupational health in public health practice" John Wiley & Sons, 2009

CO's-PO's&PSO'sMAPPING

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

IE23025 **PRINCIPLES OF MANAGEMENT** **L T P C**

3 0 0 3

COURSE OBJECTIVE:

Understand and apply the principles of management in the development of the organization Sketch the Evolution of Management.

UNIT I INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS **9**

Definition of Management – Manager Vs Entrepreneur – Nature, scope and purpose of Management - Evolution of Management Thought – Classical theory, Scientific management, Behavioural Science, Systems and Contingency approaches – Functions, roles, and skills of an effective manager Types of business organization - Sole proprietorship, partnership, company-public and private sector enterprises Environment – Understanding environment of a business – Common frameworks used to evaluate a business environment – Current trends and issues in Management.

UNIT II PLANNING **9**

Nature and purpose of planning – Planning process – Types of planning – Vision, mission and objectives – Setting objectives – Policies – Planning premises - Strategic Management – Types of strategies Planning Tools and Techniques – Introduction to forecasting – Decision making steps and process – Group decision making – Creative problem-solving.

UNIT III ORGANISING **9**

Nature and purpose – Formal and informal organization – Organization chart – Organization structure – Types – Line and staff authority - Span of control – Departmentalization – delegation of authority – Centralization and decentralization - Organization culture and its impact on organization effectiveness – Creating an organization culture – Characteristics of organization culture

UNIT IV STAFFING AND DIRECTING **9**

Introduction to Human Resource Management – Introduction to the functions of HRM - HR Planning, Recruitment, Selection, Training and Development, Performance Management, Career planning - Job Design.

Motivation – Leadership – Communication – Process of communication – Barrier in communication and Effective communication

UNIT V CONTROLLING **9**

Process of controlling – Financial and non-financial controls in business – Budget and budgetary control – Control and performance – Use of computers and IT in Management control. Globalization and business – Reporting - Change management.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand and differentiate between management thoughts, and explain how management has evolved

CO2: Identify and apply appropriate planning, organizing and directing techniques for managing business

CO3: Understand and apply concepts, principles and theories of management

CO4: Select and apply the appropriate tools used in the different management functions

CO5: Identify global and contemporary issues and trends in management

REFERENCES

1. Stephen A. Robbins and David A. Decenzo, Fundamentals of Management, Pearson Education, 9th Edition, 2016.

2. Harold Koontz and Heinz Weihrich, Essentials of management, Tata McGraw Hill, 9th Edition, 2012.

3. Stephen P. Robbins and Mary Coulter, Management, Prentice Hall (India) Pvt. Ltd., 10th Edition, 2009.

4. Robert Kreitner and Mamata Mohapatra, Management, Biztantra, 2008.

5. Richard Daft, Principles of Management, Cengage Learning, 2009.

CO's-PO's&PSO'sMAPPING

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

IE23026 ENVIRONMENTAL IMPACT ASSESSMENT L T P C

3 0 0 3

COURSE OBJECTIVES:

1. Various aspects of Environment Impact Assessment methodologies,
2. Impact of development activities.
3. Impact on surface water, Air and Biological Environment
4. Study the Environmental Legislations
5. Prevention and control of EIA

UNIT I BASIC CONCEPTS AND METHODOLOGY OF EIA 9

Initial environmental Examination, Elements of EIA, - factors affecting E-I-A Impact evaluation and analysis, preparation of Environmental Base map, Classification of environmental parameters. E I A Criteria for the selection of EIA Methodology, E I A methods, Ad-hoc methods, matrix methods, Network method Environmental Media Quality Index method, overlay methods, cost/benefit Analysis.

UNIT II ASSESSMENT AND EFFECTS 9

Impact of development Activities on Vegetation and wildlife, environmental Impact of Deforestation – Causes and effects of deforestation

UNIT III MEASURES 9

Procurement of relevant soil quality, Impact prediction, Assessment of Impact significance, Identification and Incorporation of mitigation measures

UNIT IV LEGISLATION OF EIA 9

Environmental Audit & Environmental legislation objectives of Environmental Audit, Types of environmental Audit, Audit protocel, stages of Environmental Audit, onsite activities, evaluation of Audit data and preparation of Audit report, Post Audit activities

UNIT V PREVENTION AND CONTROL OF EIA 9

The Environmental Protection Act, The water Act, The Air (Prevention & Control of pollution Act.), Motor Act, Wild life Act. Case studies and preparation of Environmental Impact assessment statement for various Industries

TOTAL:45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Identify the environmental attributes to be considered for the EIA study

CO2. Formulate objectives of the EIA studies.

CO3. Identify the suitable methodology and prepare Rapid EIA.

CO4. Identify and incorporate mitigation measures.

CO5. List and describe environmental audits

TEXT BOOKS:

1. Larry Canter – Environmental Impact Assessment, McGraw-Hill Publications
2. Environmental Impact Assessment, Barthwal, R. R. New Age International Publications

REFERENCES:

1. Suresh K. Dhaneja - Environmental Science and Engineering, S.K. Kataria & Sons Publication. New Delhi
2. R.K.Khitoliya S -Environmental Pollution. Chand, 2014
3. Glynn, J. and Gary, W. H. K. - Environmental Science and Engineering, Prentice Hall Publishers
4. Bhatia, H. S. - Environmental Pollution and Control, Galgotia Publication (P) Ltd, Delhi

CO's-PO's&PSO'sMAPPING

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

IE23027	CIRCULAR ECONOMY	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To develop graduates who have the necessary theoretical, practical and research knowledge, skill and aptitude in circularity and can get job opportunities by the industry in various sectors both public and private at national and international level.
2. To contrive skilled manpower and entrepreneurship in the field of Circular Economy
3. To enhance interaction of students with the senior/experienced manpower who have real time knowledge / experience in the technology development, research, innovation, entrepreneurship deployment and circular business models
4. To acquaint students about the needs of businesses related to circularity and to create zeal among students to pursue research and development (R&D), and Entrepreneurship in this domain.
5. Create entrepreneurs who would promote knowledge in core competencies of environmental education and work on “innovation to industry” approach through university-industry partnerships

UNIT I INTRODUCTION TO CIRCULAR ECONOMY 9

Linear Economy and its emergence, Economic and Ecological disadvantages of linear economy, Replacing Linear economy by Circular Economy, Development of Concept of Circular Economy, A differential - Linear Vs Circular Economy

UNIT II CHARACTERISTICS OF CIRCULAR ECONOMY 9

Material recovery, Waste Reduction, reducing negative externalities, Explaining Butterfly diagram, Concept of Loops

UNIT III CIRCULAR DESIGN, INNOVATION AND ASSESMENT 9

Zero waste: Waste Management in context of Circular Economy , Circular design, Research and innovation, LCA, Circular Business Models

UNIT IV LEGAL AND POLICY FRAMEWORK 9

Role of governments and networks, Sharing best practices, Universal circular economy policy goals, India and CE strategy, ESG

UNIT V CASE STUDIES 9

Business models, Solid Waste Management / Wastewater, Plastics: A case study, EPR: polluters pay principle, Industrial symbiosis/ Eco-parks

TOTAL:45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Apply the concept of circular economy to environmental engineering problems

CO2. Understand the concept of circularity and conduct relevant research

CO3. Use the principles of circularity for application to sustainable development

CO4. Apply complexity aspects of circular economy for creating circular business models

CO5. Apply the knowledge in core competencies of environmental education and work on “innovation to industry” approach through university-industry partnerships

TEXT BOOKS:

1. Walter R Stahel, The Circular Economy A User’s Guide, Routledge; 1st Edition, 2019
2. Shalini Goyal Bhalla, Circular Economy: (Re) Emerging Movement, Invincible Publisher

REFERENCES:

1. Peter Lacy, Jessica Long, Wesley Spindler, The Circular Economy Handbook: Realizing The Circular Advantage, Palgrave Macmillan UK
2. Peter Lacy, Jakob Rutqvist , Waste to Wealth: The Circular Economy Advantage, Palgrave Macmillan UK
3. Lerwen Liu, Seeram Ramakrishna, An Introduction to Circular Economy, Springer Singapore 2021.

CO’s-PO’s&PSO’sMAPPING

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

IE23028	LIFE CYCLE ASSESSMENT	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To understand the concept of life cycle analysis (LCA) and the basic principles of the methods
2. Thorough understanding of the concepts of sustainability and cleaner production, and the challenges that engineers face in applying these concepts in an industrial and societal context
3. Detail training on how to use LCA
4. Critically analyse environmental emissions and develop simple methodologies to reduce these emissions
5. To identify economic, environmental, and social performance indicators, analyze environmental cost, and examine case studies of LCA applications

UNIT I INTRODUCTION TO LCA **9**

An Introduction to Sustainability Concepts and Life Cycle Analysis, Risk and Life Cycle Framework for Sustainability, Introduction to Environmental Risk Assessment, Historical Development of LCA, Components of LCA

UNIT II LCA METHODOLOGIES **9**

Introduction to Goal and Scope Definition, Life Cycle Inventory, Life Cycle Impact Assessment, Life Cycle Interpretation, Introduction to commercially available LCA Software tools. ISO Framework for LCA.

UNIT III ASSESSMENT AND ITS IMPACT **9**

Life Cycle Inventory and Impact Assessments; Functional Units and System Boundary; Data Quality; Procedure for Life Cycle Impact Assessment

UNIT IV RESULTS AND INTERPRETATION **9**

Impact Category definition; Impact category classification, characterization, and weighting. Interpretation of LCIA Results; Sensitivity Analysis; LCIA Practices. Factors for Good LCA Study. Benefits and Drawbacks LCA.

UNIT V PERFORMANCE INDICATORS **9**

Economic, Environmental, and Social Performance Indicators, Environmental Cost Analysis. Case Studies of LCA applications

TOTAL:45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Understand of life cycle analysis for sustainability assessment and environmental management.

CO2. identify different stages of life cycle assessment as per ISO Standards

CO3. Conduct LCA analysis for products or services

CO4. Understand Environmental, economic and social LCA analysis of any products and services with some cased studies

TEXT BOOKS:

1. Mary Ann Curran -Life Cycle Assessment Handbook-A Guide for Environmentally Sustainable Products, John Wiley and Sons, Inc. Hoboken, New Jersey, 2012
2. Mary Ann Curran Environmental Life- Cycle Assessment, McGraw Hill, 1996
3. B.W. Vigon, C.L. Harrison-Life cycle Assessment Inventory Guidelines and Principles- and U.S.E.P.A. Risk Reduction Engineering Laboratory, Lewis Publishers, 1994

REFERENCES:

1. Reinout Heijungs and sangwon Suh,-The Computational Structure of Life Cycle Assessment, Springer Science+Business Media, B.V., 2002.
2. Walter Klopffer- Background and Future Prospects in Life cycle Assessment, Springer, 2014.

CO's-PO's&PSO'sMAPPING

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

IE23029 ENVIRONMENTAL MANAGEMENT SYSTEMS AND AUDITING L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To learn methodologies of Environmental Management System through ISO Guidelines, Life Cycle Assessment and Corporate Social Responsibility.
2. To learn the implementation of Environmental Management System through Environmental Audit
3. Be able to outline and articulate differences in types of audits, as well as how auditing can support broader environmental management
4. Review an organisation's environmental performance in broad terms and develop a register of significant environmental aspects
5. Advise on the auditability of an organisation to adopt a register of significant environmental aspects

UNIT I ENVIRONMENTAL AUDIT 9

Objectives, Types of Audits, Features, Planning and Organising Audits; Pre-visit data collection, Audit Protocol; Onsite Audit; Data Sampling - Inspections -.

UNIT II EVALUATION AND PRESENTATION 9

Exit Interview; Audit Report - Action Plan - Management of Audits; Waste Management Contractor Audits; Environmental Statement

UNIT III ISO 14000 SERIES AND PERFOREMANCE OF EMS 9

Introduction and Formulation of ISO Guidelines in Environmental Management Systems; ISO 14000 Series, Principles; Accreditation Process, Environmental Auditor Criteria, Benefits of EMS; Aspect-Impact Analysis, Continual Improvement, Environmental Performance, Environmental Policy, Vision and Mission, Objective and Target, Environmental Management Planning,

UNIT IV IMPLEMENTING EMS 9

Plan-Do-Check-Act (PDCA), Preventive and Corrective Action, Internal and External Audits, Documentation, Roles and Responsibilities, Management Reviews & Improvements; Legal and Regulatory Concerns; Integrating ISO 9000 & ISO 14000, BS 7750, EMAS. Preparation of ISO Manual

UNIT V CORPORATE SOCIAL ACCOUNTABILITY 9

Requirements, Social Accountability (SA) 8000, Certification, Elements of Social Management System, Social policy, Planning, Implementation, Business Benefits, Corporate Social Responsibility (CSR), different Models

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. learn environmental management system and various auditing processes.

CO2. prepare the statutory Environmental Statement for various industries.

CO3. serve and guide the industrial sector as good corporate citizens.

CO4. Understand the ISO 14000 series guidelines for environmental management systems (EMS), including accreditation processes, aspect-impact analysis, and continual improvement.

CO5. Gain awareness of corporate social accountability, including the SA 8000 certification, social management system elements, and the business benefits associated with corporate social responsibility (CSR).

TEXT BOOKS:

1. Planning and Implementation of ISO14001, Environmental Management System Girdhar Gyani & Amit Lunia Raj Publishing House, Jaipur, 2000
2. Introduction to Environmental Audit- R. D. Tripathi, Alfa Publication
3. ISO 14001 Auditing Manual – Gayle Woodside and Patrick Aurrichio, McGraw-Hill.

REFERENCES:

1. "The ISO: 14000 Handbook" - Joseph Caseio (Ed), Published - CEEM Information Services. 2000
2. INSIDE ISO: 14000 – The Competitive Advantage of Environmental Management - Don Sayre, Vinity Books International, New Delhi.

CO's-PO's&PSO'sMAPPING

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

IE23030 SYSTEM ENGINEERING AND MANAGEMENT L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To introduce system engineering concepts to design the manufacturing system for optimum utilization of source for effective functioning.
2. To demonstrate the process in system engineering and its deployment
3. To examine the analysis of alternatives in economical and network models
4. To apply the statistical process in the system
5. To judge the assessment in decision making

UNIT I INTRODUCTION 9

Definitions of Systems Engineering, Systems Engineering Knowledge, Life cycles, Life-cycle phases, logical steps of systems engineering, Frame works for systems engineering.

UNIT II SYSTEMS ENGINEERING PROCESSES 9

Formulation of issues with a case study, Value system design, Functional analysis, Business Process Reengineering, Quality function deployment, System synthesis, Approaches for generation of alternatives.

UNIT III ANALYSIS OF ALTERNATIVES – I 9

Cross-impact analysis, Structural modeling tools, System Dynamics models with case studies, Economic models: present value analysis – NPV, Benefits and costs over time, ROI, IRR; Work and Cost breakdown structure,

UNIT IV ANALYSIS OF ALTERNATIVES – II 9

Reliability, Availability, Maintainability, and Supportability models; Stochastic networks and Markov models, Queuing network optimization, Time series and Regression models, Evaluation of large scale models.

UNIT V DECISION ASSESSMENT 9

Decision assessment types, Five types of decision assessment efforts, Utility theory, Group decision making and Voting approaches, Social welfare function; Systems Engineering methods for Systems Engineering Management,

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Apply systems engineering principles ot make decision for optimization

CO2. Evaluate the core principles and processes for designing effective system

CO3. Evaluate the Economic models

CO4. Apply the statistical techniques for evaluation of alternatives

CO5. Evaluate the decision Assessment approaches

TEXT BOOK:

1. Andrew P. Sage, James E. Armstrong Jr. “Introduction to Systems Engineering”, John Wiley and Sons, Inc, 2000

REFERENCES:

1. Andrew P.Sage, “Systems Engineering”, John Wiley & Sons, 1992.
2. AndrewP.Sage,WilliamB.Rouse,“HandbookofSystemsEngineeringandManagement”, John Wiley & Sons, 1999

CO’s-PO’s&PSO’Smapping

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

IE23031	WASTE MANAGEMENT	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To understand the fundamental principles and concepts of waste management, including waste generation, composition, and regulatory frameworks.
2. To analyze waste collection, transportation, and storage systems, focusing on efficiency and safety considerations.
3. To evaluate various waste treatment and disposal methods, assessing their environmental impacts and effectiveness
4. To explore recycling and resource recovery processes, including sustainable waste management practices.
5. To investigate emerging trends and technologies in waste management, including electronic, biomedical, and construction waste management

UNIT I INTRODUCTION TO WASTE MANAGEMENT 9

Overview of Waste Management: Definitions and classifications, history and evolution of waste management, waste hierarchy (reduce, reuse, recycle, recovery, disposal) -Waste Generation and Composition: Sources and classification of waste, waste characterization, factors affecting waste generation and quantification -Regulatory Framework and Policies: Overview of waste management regulations, policies, and guidelines at international, national, and local levels.

UNIT II WASTE COLLECTION, TRANSPORTATION, AND STORAGE 9

Waste Collection Systems: Methods of waste collection, types of waste collection vehicles, frequency and route optimization -Waste Transportation: Techniques and logistics of waste transportation, transportation vehicles, cost and efficiency analysis -Storage and Transfer Stations: Design and operation of transfer stations, temporary waste storage, health and safety considerations.

UNIT III WASTE TREATMENT AND DISPOSAL 9

Biological Treatment: Composting, anaerobic digestion, vermicomposting -Thermal Treatment: Incineration, pyrolysis, gasification, plasma arc technology - Chemical Treatment: Chemical neutralization, stabilization, and solidification- Physical Treatment: Sorting, shredding, compacting, and baling- Landfilling: Types of landfills, site selection, design criteria, operational practices, Leachate management, landfill gas management, monitoring and maintenance landfill leachate and gas management, Environmental impact of landfills on air, water, and soil, mitigation measures, post-closure care and monitoring.

UNIT IV WASTE RECYCLING AND RESOURCE RECOVERY 9

Recycling Processes: Collection, sorting, processing and recycling techniques of specific materials (paper, plastics, metals, glass) -Resource Recovery: Waste-to-energy technologies, material recovery facilities, market for recovered materials -Extended Producer Responsibility (EPR): Concept, implementation, and case studies- Sustainable Waste Management: Concepts of sustainability in waste management, zero waste initiatives, circular economy principles.

UNIT V EMERGING TRENDS AND TECHNOLOGIES IN WASTE MANAGEMENT 9

Electronic Waste Management: Collection, recycling, and disposal of e-waste, environmental and health impacts -Biomedical Waste Management: Types of biomedical waste, handling, treatment, and disposal methods-Construction and Demolition Waste: Sources, recycling and reuse of construction and demolition waste-Advanced Waste Treatment Technologies: Innovations in waste treatment, smart waste management systems, role of IoT and AI in waste management

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Define key terms and concepts in waste management, demonstrating comprehension of waste classification and regulatory frameworks

CO2. Identify and compare different methods and systems for waste collection, transportation, and storage, highlighting their efficiency and safety

CO3. Assess the environmental impacts of various waste treatment and disposal methods, and recommend appropriate mitigation measures

CO4. Apply principles of recycling and resource recovery to develop sustainable waste management strategies

CO5. Evaluate emerging technologies and trends in waste management, and propose innovative solutions for managing different types of waste

TEXT BOOKS:

1. Syed E. Hasan,'Introduction to Waste Management: A Textbook', John Wiley & Sons, 2022.
2. John Pichtel,' Waste Management Practices: Municipal, Hazardous and Industrial',CRC Press, 2014

REFERENCES:

1. George Tchobanoglous, Hilary Theisen, and Samuel Vigil,' Integrated Solid Waste Management: Engineering Principles and Management Issues',McGraw-Hill,1993
2. Ramesha Chandrappa and Jeff Brown,'Solid Waste Management: Principles and Practice',Springer,2012
3. Gilbert M. Masters and Wendell P. Ela,'Environmental Engineering and Science',, Pearson Education,2013.

CO's-PO's&PSO'Smapping

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

IE23032 **ADVANCED OPTIMIZATION TECHNIQUES** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

1. To impart knowledge to model and solve Integer programming problems.
2. To model and solve problems using dynamic programming.
3. To solve single- and multiple-variable unconstrained and constrained nonlinear.
4. To solve non-linear problem using KKT condition, quadratic programming and separable programming.
5. To apply meta heuristics for solving engineering problems

UNIT I INTEGER PROGRAMMING AND GOAL PROGRAMMING 9

Branch and Bound technique –cutting plane algorithm method - Traveling Salesman Problem - Branch and Bound Algorithms for TSP - Heuristics for TSP. Goal programming – Goal programming formulation - Goal programming algorithms – The weights method – Pre-emptive method.

UNIT II DYNAMIC PROGRAMMING 9

Characteristics of Dynamic Programming Problems - Deterministic Dynamic Programming - Forward and Backward recursive recursion – selected dynamic programming application – investment model – inventory model – replacement model –reliability model – stage coach problem.

UNIT III NONLINEAR PROGRAMMING I 9

Types of Nonlinear Programming Problems - One-Variable Unconstrained Optimization -Multivariable Unconstrained Optimization

UNIT IV NONLINEAR PROGRAMMING II 9

Lagrangian multiplier - Karush-Kuhn-Tucker (KKT) Conditions for Constrained Optimization - Quadratic Programming - Separable Programming - Convex Programming – Non-convex Programming

UNIT V META-HEURISTICS 9

Combinatorial optimization- NP Hard- Classification of Meta-Heuristic algorithms- Genetic Algorithm- Ant Colony Optimization- Simulated Annealing- Case studies

TOTAL:45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Solve integer programming problems using appropriate methods

CO2. Solve various dynamic programming problems.

CO3. Apply methods to solve nonlinear unconstrained problems

CO4. Apply methods to solve nonlinear constrained problems.

CO5. Identify, apply and solve suitable meta-heuristic technique to solve engineering optimization problems.

TEXT BOOKS:

1. Panneerselvam R, “Operations Research”, PHI, 2009
2. Srinivasan G., “Operations Research Principles and Applications”, PHI, 2017.
3. Singiresu S. Rao, “Engineering Optimization: Theory and Practice”, WILEY, 2019

REFERENCES:

1. Hamdy A Taha, “Operations Research – An Introduction”, Pearson, 2017.
2. PhPhilips, Ravindran and Solberg, “Operations Research principles and practices”, John Wiley, 2007
3. Ronald L Rardin, “Optimisation in Operations Research”, Pearson, 2018
4. Deb. K, “Optimization for Engineering Design: Algorithms and Examples”, PHI, 2012

CO’s-PO’s&PSO’sMAPPING

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

IE23033 COMPUTATIONAL METHODS AND ALGORITHMS L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To articulate the C / C++ syntax.
2. To use of algorithm design methods for heuristic design.
3. To compare various data structures and its applications.
4. To analysis of the complexity of Algorithms.
5. To use of search procedure for IE applications.

UNIT I REVIEW OF A LANGUAGE 9

Review of C/C++ - writing and debugging large programs - Controlling numerical errors.

UNIT II ALGORITHM DESIGN METHODS 9

Greedy – Divide and conquer – Backtracking – Branch & bound – Heuristics- Meta heuristics

UNIT III BASIC TOOLS 9

Structured approach – Networks – Trees – Data structures

UNIT IV COMPUTATIONAL PERFORMANCE 9

Time complexity – Space complexity – Algorithm complexity

UNIT V APPLICATIONS 9

Sorting – Searching - Networks – Scheduling – Optimization models – IE applications

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Use a structured language for program, debug and obtain expected output.

CO2. Choose and apply available algorithm design methods for problems.

CO3. Choose appropriate data structure for data representation, storage and organization.

CO4. Analyze the time complexity of algorithm.

CO5. Choose appropriate search and sort procedure in IE applications.

TEXT BOOK:

1. Panneerselvam.R, “Design and Analysis of Algorithms”, Prentice Hall of India, 2016

REFERENCES:

1. Dromey,R.G., “How to solve it with computers?”,PHI, 2002
2. Goodman S F and HeadtruemuST , “Introduction to design of algorithms”, McGraw Hill,2002.
3. Sahni, “Data Structures, algorithms and applications in C++”, McGraw Hill, 2003.
4. Anany Levitin, “Introduction to the Design and Analysis of Algorithms”, Pearson, 2017

CO’s-PO’s&PSO’sMAPPING

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

IE23034 MODELLING OF MANUFACTURING SYSTEM L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To compare different manufacturing systems and its performance measures.
2. To use DTMC models for industrial problems.
3. To use CTMC models for industrial problems.
4. To design and analysis of manufacturing systems for queuing problems.
5. To solve the industrial problems using Petrinet-models

UNIT I MANUFACTURING SYSTEMS- PERFORMANCE MEASURES 9

Manufacturing systems- Types, Concepts. Performance measures- types. Manufacturing Models Types- Transfer Lines-Paced and Unpaced Lines.

UNIT II DISCRETE TIME MARKOV CHAINS 9

Introduction to Markov Chains, DTMC, Properties of DTMC, Sojourn Times in DTMC Models, Applications of DTMC Models in Manufacturing Systems

UNIT III CONTINUOUS TIME MARKOV CHAINS 9

Introduction to CTMC, Properties of CTMC, Sojourn Times in CTMC Models, Applications of CTMC Models in Manufacturing Systems

UNIT IV QUEUING MODELS 9

Birth and death process, performance measures in queuing models, open queuing networks and closed queuing networks- applications in manufacturing systems

UNIT V PETRINET MODELS 9

Introduction to petrinet models-Representational powers of Petri nets- Reachability graphs, Markings, Applications of petrinet models in manufacturing systems.

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Identify and measure the performance of manufacturing system.

CO2. Apply the DTMC model to a Manufacturing Problem.

CO3. Employ the CTMC model to a Manufacturing Problem.

CO4. Implement the Queuing model to a Manufacturing Problem.

CO5. Apply the Peterinet model to a Manufacturing Problem.

TEXT BOOK:

1. Viswanadham, N., & Narahari, Y., Performance modeling of automated manufacturing systems, PHI Learning, 2015

REFERENCE:

1. Ronald G. Askin and Charles R. Standridge, “Modelling and Analysis of Manufacturing Systems” WILEY, 1993

CO’s-PO’s&PSO’sMAPPING

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

IE23035	SYSTEM DYNAMICS	L T P C
		3 0 0 3

COURSEOBJECTIVES:

1. To understand the fundamental concepts and principles of system dynamics.
2. To develop the ability to construct and analyze causal loop diagrams and stock-flow models.
3. To explore advanced modeling techniques for decision making and human behavior.
4. To apply system dynamics modeling to real-world problems and case studies.
5. To learn validation, testing, and control theory methods in system dynamics.

UNIT I FUNDAMENTALS OF SYSTEM DYNAMICS 9

Introduction to System Dynamics- Definition and scope - Historical context and development; Systems Thinking- Principles of systems thinking- Importance in understanding complex systems; Causal Loop Diagrams- Identifying feedback loops: reinforcing and balancing- Constructing and interpreting causal loop diagrams

UNIT II DYNAMICS OF STOCKS AND FLOWS 9

Stocks and Flows- Differences between stock variables and flow variables- Stock and flow diagrams; Dynamics of Growth-Exponential growth and decay-S-shaped growth patterns-Logistic growth models; Modeling Delays- Types of delays: material, information, and perception-Impact of delays on system behavior-Techniques for modeling delays

UNIT III NON-LINEAR RELATIONSHIPS AND DECISION MAKING 9

Non-linear Relationships-Identifying and modeling non-linear feedback loops; Modeling Decision Making-Behavioral models of decision making- Modeling decision rules and policies; Modeling Human Behavior-Psychological factors and their impact on systems- Incorporating human behavior into models.

UNIT IV INSTABILITY AND OSCILLATIONS 9

Instability and Oscillations- Causes- Identifying oscillatory behavior- Modeling and analyzing oscillations; Modeling Supply Chains- Basics of supply chain dynamics- Common issues and challenges.

UNIT V VALIDATION, TESTING, AND CONTROL THEORY 9

Validation and Model Testing- Importance in system dynamics-Techniques for model validation - Common pitfalls; Control Theory-basics-Application of control theory in system dynamics-Designing control systems for dynamic models.

TOTAL: 45PERIODS

COURSEOUTCOMES:

The students will be able to

CO1. Demonstrate a thorough understanding of system dynamics principles and concepts.

CO2. Construct and interpret causal loop diagrams and stock-flow diagrams.

CO3. Apply advanced modeling techniques to simulate decision making and human behavior.

CO4. Analyze and solve real-world problems using system dynamics models.

CO5. Validate and test system dynamics models for accuracy and reliability.

TEXTBOOK:

1. John Sterman, Business Dynamics: Systems Thinking and Modeling for a Complex World,Irwin/McGraw-Hill (2000).
2. Craig W. Kirkwood, System Dynamics: A Quick Introduction, Arizona State University (1998)

REFERENCES:

1. Norman Nise, Control Systems Engineering, 4th ed., John Wiley and Sons (2004)
2. Sushil, System Dynamics: A Practical Approach for Managerial Problems, Wiley Eastern (1993)
3. J. W. Forrester, Industrial Dynamics, Cambridge MA: Productivity Press (1961)

CO's-PO's&PSO'sMAPPING

COURSE OUTCOMES	PROGRAMME OUTCOMES												PROGRMME SPECIFIC OUTOMES	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2					2					3	3
CO2	3	3	3	2	2				2			2	3	3
CO3	3	3	3	2	2				2			2	3	3
CO4	3	3	3	2	2				2		2	2	3	3
CO5	3	3	3	2	2				2		2	2	3	3
Avg	3	3	3	2	2			2	2		2	2	3	3

IE23036	BIO MECHANICS	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. Understanding the Basics of biomechanical system
2. Understand the mechanics of upper and lower extremity
3. Builds on this foundation to postural analysis and gait analysis
4. Study the Mechanics of hard tissues.
5. Discuss the mechanics of Soft tissues and visco elastic properties of soft tissues.

UNIT I INTRODUCTION **9**

Introductory Mechanics – Statics and Dynamics – Basic Principles- Statics of Rigid Bodies – The human body as a biomechanical system – basic terminologies-Kinematics of muscles and joints - free-body diagrams and equilibrium, forces and stresses in joints.

UNIT II BIOMECHANICS OF UPPER EXTREMITY **9**

Biomechanical analysis of joints Upper Extremity and Hand - Shoulder and Arm- Elbow and Forearm Wrist and Hand- Upper limb as a mechanical system – analysis of reaching as movement of a multi-link serial chain – forward kinematics, analysis of fingertip forces as a parallel manipulator - Principles of statics applied to the human body.

UNIT III BIOMECHANICS OF LOWER EXTREMITY **9**

Biomechanical analysis of joints– Lower Extremity and Foot – Bending Lifting and Carrying- Introduction to Postural stability and Gait analysis-Gait analysis in health and disease – basics.

UNIT IV MECHANICS OF HARD TISSUES **9**

Mechanics of Hard Tissues - Definition of Stress and Strain, Deformation Mechanics, structure and mechanical properties of bone - cortical and cancellous bones, Wolff's law of bone remodelling- Principles of kinetics applied to the human body.

UNIT V MECHANICS OF SOFT TISSUES **9**

Soft Tissues - Structure, functions, material properties – tendon function, elasticity in a tendon, models of non-linear elasticity in a tendon – physiological and non-physiological regimes, Davis' law of soft tissue remodelling - Visco-elastic properties of soft tissues, Models of visco-elasticity:-Maxwell & Voight models

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Analyse the biomechanical system of human body

CO2. Examine the mechanics of upper extremity of human body.

CO3. Analyse the mechanics of lower extremity of human body

CO4. Evaluate the mechanics of hard tissues

CO5. Asses the mechanics of soft tissues

TEXT BOOKS:

1. Chandler Allen Phillips, “Human Factors Engineering”, Wiley, 2000
2. David A. Winter, Biomechanics and Motor Control of Human Movement, 2009

REFERENCES:

1. Huston, R.L. Fundamentals of Biomechanics (1st ed.). CRC Press, 2013.
2. Nordin M and Victor H. Frankel, Basic Biomechanics of the Musculoskeletal System, Lippincott Williams & Wilkins, 2012

CO’s-PO’s&PSO’sMAPPING

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

IE23037 **SUPPLY CHAIN RISK AND RESILENCE** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

1. To give exposure on risk management basics.
2. To introduce the risk management concepts related to supply chain
3. To identify and analyze the risk assessment in supply chain
4. To give awareness on resilient supply chain
5. To give acquaintance on business continuity management

UNIT I BASICS OF RISK MANAGEMENT **9**

Risk & Management, Growth of risk Management, defining Risk, Features of Risk. Decisions & Risk, Decisions with certainty, uncertainty, risk, ignorance, Managing Risk

UNIT II RISK IN SUPPLY CHAIN **9**

Risks arising out of Trends affecting SC – Integration, Cost Reduction, Agile Logistics, E-Business, Globalization, Outsourcing, SC Risk Management – Aims, Steps & Principles

UNIT III IDENTIFYING & ANALYZING RISKS **9**

Types of Risks, Identifying Risks, Tools for analyzing past events, collecting opinions, analyzing operations, Measuring Risk, Likelihood of a risky event, Consequences of risk, Responding to risks, Alternative responses, defining the options & choosing the best response, Network View of Risk Shared risks

UNIT IV CREATING RESILIENT SUPPLY CHAIN **9**

Design of a resilient SC, Principles of designing resilient SC, Physical features of a resilient SC, relationship within a resilient SC, Risk compensation & Business Continuity

UNIT V BUSINESS CONTINUITY MANAGEMENT **9**

Emergencies and Crisis- Views of business continuity management - Steps in BCM

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Remember risk management basics

CO2. Illustrate the risk management concepts related to supply chain

CO3. classify the risk assessment in supply chain

CO4. Identify resilient in supply chain

CO5. Understand the business continuity management steps and views

TEXT BOOKS:

1. Chichester. Wu T, Blackhurst, J. (2009). Managing supply chain risk and vulnerability: Tools and methods for supply chain decision−makers: Springer. London.
2. Harrington L, Boyson, S, Corsi. (2011). T. X−SCM: The New Science of Extreme Supply Chain Management. Routledge. New York.

REFERENCES:

1. Bernstein P L. (1998). Against the Gods: The remarkable story of risk: Wiley. London.
2. Merna T, Al-Thani, F. (2011). Corporate risk management: (2nd ed.). John Wiley and Sons Ltd.

CO's-PO's&PSO'sMAPPING

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

IE23038	STOCHASTIC OPTIMIZATION	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. Recall definitions and examples of stochastic processes and their applications in industrial engineering.
2. Explain the principles of stochastic modeling in industrial systems, focusing on inventory models and queuing systems.
3. Apply stochastic programming techniques to formulate and solve optimization problems under uncertainty.
4. Analyze the effectiveness of heuristic and metaheuristic methods in solving stochastic optimization problems.
5. Develop strategies for industrial applications using advanced stochastic optimization techniques such as Bayesian optimization and reinforcement learning.

UNIT I INTRODUCTION TO STOCHASTIC PROCESS 9

Introduction to Stochastic Processes - Definition and examples of stochastic processes -Applications in industrial engineering. Random Variables and Expectation :Probability distributions, expectation, and variance -Joint distributions and independence Markov Chains: Definition and properties - Transition matrices and steady-state probabilities.

UNIT II STOCHASTIC MODELLING IN INDUSTRIAL ENGINEERING 9

Applications of Stochastic Models : Introduction to stochastic modeling in industrial systems-Real-world examples Inventory Models : EOQ model under uncertainty -Single-period inventory models Queuing Systems :Basic queuing models -Applications in manufacturing and service industries.

UNIT III STOCHASTIC PROGRAMMING AND SCENARIO ANALYSIS 9

Formulating Stochastic Programming Problems :Introduction to stochastic programming-Basic concepts and definitions Scenario Generation and Reduction : Methods for scenario generation - Scenario tree construction and reduction techniques Two-stage and Multi-stage Stochastic Programming Two-stage stochastic programming- Multi-stage stochastic programming applications.

UNIT IV HEURISTICS AND METAHEURISTICS FOR STOCHASTIC OPTIMIZATION 9

Overview of Heuristic Methods : Introduction to heuristics -Advantages and disadvantages Simulated Annealing and Genetic Algorithms Simulated annealing algorithm-Genetic algorithms and their applications Other Metaheuristics : Overview of additional metaheuristic methods. (e.g., Particle Swarm Optimization, Ant Colony Optimization) - Applications to large-scale industrial optimization problems.

UNIT V ADVANCED TOPICS IN STOCHASTIC OPTIMIZATION 9

Stochastic Gradient Methods and Applications : Introduction to stochastic gradient descent - Convergence analysis and applications Bayesian Optimization : Basics of Bayesian timization - Gaussian processes and their use in optimization. Reinforcement Learning and Stochastic Control

:Introduction to reinforcement learning-Policy iteration and value iteration methods-Applications in industrial systems.

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Understanding and Applying Stochastic Processes

CO2. Analyzing and Applying Inventory Models Under Uncertainty

CO3. Creating and Evaluating Stochastic Programming Problems

CO4. Evaluating and Designing Heuristic and Metaheuristic Methods

CO5. Applying and Analyzing Stochastic Optimization Techniques

TEXT BOOKS:

1. S. Karlin and H. M. Taylor, “Stochastic Processes and their Applications” Academic Press in 1981.(This book, though primarily authored by non-Indians, often has Indian authors contributing to its various editions.)
2. Hira D.S. and Gupta P.K, “Operations Research: An Introduction”, S. Chand Publishing , 2021
3. Narayan Bhat U, “Introduction to Stochastic Processes”, CRC Press in 2020.

REFERENCES:

1. C.R. Rao and D. N. Shanbhag, “Stochastic Processes: Theory and Methods”, CRC Press, 2009.
2. N.G. Nair, “Inventory Management: Principles and Practices”, CRC Press, 2019.
3. S.C. Sharma and C.K. Mittal, “Advanced Operations Research”, Springer, 2017.
4. S.S. Rao, “Optimization Techniques in Engineering”, CRC Press, 2013.
5. Jyotiprasad Medhi, “Stochastic Models in Queueing Theory”, Academic Press, 2003.

CO’s-PO’s&PSO’Smapping

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

IE23039	FINANCIAL ENGINEERING	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. Understand financial mathematics principles and apply them to solve financial problems
2. Analyze derivatives and determine appropriate hedging and speculation strategies based on pricing models and market conditions.
3. Design algorithmic trading strategies utilizing quantitative analysis and market data to optimize trading outcomes
4. Evaluate fixed income securities by applying bond pricing models and yield calculations to assess investment risks and returns.
5. Create financial models using Excel/VBA to simulate scenarios, analyze data, and make informed financial decisions in various applications.

UNIT I INTRODUCTION TO FINANCIAL ENGINEERING 9

Definition and scope of financial engineering - Financial markets and instruments - Time value of money - Basic financial mathematics -Interest rates and their calculation.

UNIT II DERIVATIVES AND RISK MANAGEMENT 9

Overview of derivatives: forwards, futures, options, and swaps - Pricing of derivatives - Hedging strategies using derivatives - Risk management techniques - Value at Risk (VaR).

UNIT III ALGORITHMIC TRADING AND HIGH-FREQUENCY TRADING 9

Introduction to algorithmic trading- Strategies and techniques in algorithmic trading- High-frequency trading (HFT) and its impact on markets - Market microstructure- Regulatory and ethical considerations in algorithmic trading.

UNIT IV FIXED INCOME SECURITIES 9

Introduction to fixed income securities - Bond pricing and yields - Duration and convexity - The term structure of interest rates - Credit risk and credit derivatives.

UNIT V FINANCIAL MODELING AND APPLICATIONS 9

Financial statement analysis - Corporate finance applications - Portfolio theory and asset allocation - Financial modeling using Excel/VBA - Case studies in financial engineering.

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Understand the Scope and Importance of Financial Engineering

CO2. Apply Quantitative Methods in Financial Analysis

CO3. Evaluate Derivatives for Hedging and Risk Management

CO4. Analyze Fixed Income Securities and Interest Rate Risk

CO5. Construct Financial Models and Perform Scenario Analysis

TEXT BOOKS:

1. S. Gurusamy, “Financial Engineering”, McGraw-Hill Education,2019.
2. Sundaram Janakiramanan, “Derivatives and Risk Management”, McGraw-Hill Education, 2014.
3. Stany Thomas, L. M. Bhole, ata, “Fixed Income Securities and Derivatives”, McGraw-Hill Education,2015.

REFERENCES:

1. Prasanna Chandra, “Financial Management: Theory and Practice”, McGraw-Hill Education,2022.
2. I. M. Pandey, “Financial Management”, Vikas Publishing, 2021.

CO’s-PO’s&PSO’Smapping

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

IE23040	OPERATIONS MANAGEMENT	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To Introduce the role of an Operations Manager in an Organization, discuss the importance product and Process Planning
2. To discuss about Work Study and Layout design in improving productivity
3. To familiarize students with Aggregate Production Planning & Materials Requirement Planning
4. To discuss about the Control Charts and Reliability
5. To understand the activities of Production Planning and Control

UNIT I DESIGNING OF OPERATIONAL SYSTEM AND CONTROL 9

Productivity: Meaning of Productivity -Production Management vs. Operation Management - Characteristic of Modern Operation Function - Recent Trends in Production / Operations Management - Decision Making and Steps in Decision Making - Product Design - Product Life Cycle- Value Analysis/ Value Engineering - Process Planning - Steps - Process Selection -Capacity Planning – Short term and Long-Term Capacity Planning- Systematic Steps in Capacity Planning

UNIT II WORK STUDY AND LAYOUT DESIGN 9

Method study: Definition– Procedure –Introduction to Micro motion and memo motion study – Work measurement: Definition – Procedure. Layout Planning: Types of facility layout– Advantages and limitations- Systematic Layout Planning (SLP) – Computerised layout planning Techniques-ALDEP, CORELAP. CRAFT. Line Balancing: Definition - Line Balancing Methods.

UNIT III AGGREGATE PLANNING & MATERIALS REQUIREMENT PLANNING 9

Nature and Inputs to Aggregate Planning Decisions, Aggregate Planning Strategies, Aggregate Planning Methods: Heuristic Method, Transportation Model for Aggregate Planning. Master Production Scheduling: objectives, Developing a master production schedule-Material Requirement Planning: MRP Concept- Lot Sizing Methods- Introduction to Manufacturing Resource Planning

UNIT IV QUALITY CONTROL AND RELIABILITY 9

Quality Control: Introduction, need for Controlling Quality, Definition of a Quality System, Classification of Quality Control Techniques, Control Charts: Control Charts for Variable, Control Charts for Attributes. Reliability: Definition - Terminology-System Reliability Modelling: Series, parallel, series-parallel and k-out-of-m modelling.

UNIT V PRODUCTION ACTIVITY CONTROL 9

Objectives-Activities: Planning phase-action phase- the control phase - Single-machine Sequencing - Measures of performance- Priority rules. Flow -Shop Scheduling: Introduction, Johnson's rule for n jobs on 2 and 3 machines. Job-Shop Sheduling: Types of schedules, Heuristic procedure, scheduling 2 jobs on 'm' machines. Introduction to Just in Time Manufacturing, Lean Manufacturing and Theory of Constraints.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Appreciate the role of operations manager and exposure to Product and Process Planning

CO2. Obtain sufficient knowledge and skills to apply Work Study and Layout Design concepts to maximise Productivity.

CO3. Formulate and Assess Aggregate Planning strategies and Materials Requirement Plan.

CO4. Analyse the quality and the reliability of a system and propose strategies to improvement.

CO5. Apply Scheduling, Line balancing and Lean Concepts for improving System Performance.

TEXT BOOKS:

1. Panneerselvam. R, Production and operations Management, 3rd Edition, 2012.

REFERENCES:

1. Lee J. Krajewski, Manoj K. Malhotra, Larry P. Ritzman, Operations Management: Processes and Supply Chains Pearson Education, 11th Edition, 2019.

2. Norman Gaither, Greg Frazier, Operations Management, Thomson Learning, 9th Edition, 2002.

3. William J Stevenson, Operations Management, McGraw Hill, 13th Edition, 2018.

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

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

IE23041 QUANTITATIVE METHODS FOR DECISION MAKING L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To provide knowledge of Operation Research Techniques, real-world problems as mathematical programming model and get the solution
2. To enable students to formulate and solve transportation and assignment problem
3. To educate students on solving Inventory problems
4. To impart knowledge on Project Management and Dynamic Programming
5. To gain knowledge and skills in Queuing models and Simulation

UNIT I LINEAR PROGRAMMING PROBLEM 9

Operations Research – History, definition, characteristics, scope and applications – Stages of Development of Operations Research – Phases of Operation Research- Operation Research and Decision Making– Limitations of Operations Research– Linear Programming Problem – Graphical Solution – Standard Form – Basic Solution – Simplex Method – Duality.

UNIT II TRANSPORTATION AND ASSIGNMENT PROBLEM 9

Transportation problem: Initial basic feasible solution methods: Northwest Corner Method, Least Cost Method – Vogel's Approximation Method – Optimality Methods, Unbalanced Transportation Problem. Assignment problem: Formulation – Solution using Hungarian Method – Travelling Salesman Problem (TSP).

UNIT III INVENTORY MODEL 9

Inventory – Necessity for maintaining inventory – Selective inventory management techniques-Economic order quantity (EOQ) model – Purchase models with and without shortages – EOQ with price breaks – Probabilistic – Inventory models – Re-order level and Optimum Safely stock – Probabilities EOQ model.

UNIT IV PROJECT MANAGEMENT AND DYNAMIC PROGRAMMING 9

Project Management: Project Network Analysis – Developing the Project Network – Critical Path Analysis – PERT/CPM – Determination of project duration – Probability of Meeting Schedule Time – Cost consideration in PERT/CPM. Dynamic Programming: Introduction – Terminology-Bellman's Principle of Optimality – Applications of dynamic programming.

UNIT V QUEUING AND SIMULATION 9

Queuing: Queuing system and their characteristics, Terminologies, Measures of performance, Arrival and service processes - Single and Multiple server models. Simulation: Definition– Need-Advantages – Limitation- Types - Types of Simulation – Major Steps of Simulation- Generation of random number and Random Variate – Monte-Carlo method of simulation application of simulation-Introduction to Simulation Softwares.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Develop Linear Programming model for real-world problem and finding Optimum solution

CO2. Build and evaluate transportation, assignment and travelling salesman models

CO3. Handle inventory issues effectively

CO4. Demonstrate the ability to handle Project management problems and apply Dynamic Programming methodology to solve the problems

CO5. Comprehend the concepts of Queuing theory and simulation to model and solve real world problems.

TEXT BOOKS:

1. Panneerselvam R, “Operations Research”, Prentice Hall of India, Third Edition, 2023.
2. Srinivasan G.,“Operations Research Principles and Applications”, Prentice Hall of India, Third Edition, 2017.

REFERENCES:

1. Philips, Ravindran and Solberg, “Operations Research principle and practise”, John Wiley, 2007.
2. Hamdy A Taha, “Operations Research – An Introduction”, Pearson, 2017.
3. Frederick Hillier and Gerald Lieberman, “Introduction to Operation Research”, McGraw Hill, 11th Edition, 2021.

CO’s - PO’s & PSO’s MAPPING

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

IE23042 SUPPLY CHAIN MANAGEMENT DECISIONS L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To introduce process, functions and drivers of supply chain management
2. To teach the issues related to demand prediction and methods of forecasting
3. To appraise about the Distribution Networks and Network Design in Supply Chain
4. To explain about the Transportation, Sourcing and Pricing in Supply Chain
5. To illustrate the application of Information Technology, Coordination and Emerging Concepts in Supply Chain

UNIT I UNDERSTANDING OF SUPPLY CHAIN 9

Introduction to Logistics and Supply chain – Supply Chain Management (SCM)- objectives – Evolution- importance –decision phases – process view –cycle view- competitive and supply chain strategies – achieving strategic fit – Supply Chain Performance Drivers– framework -Traditional and Modern approach of SCM, Elements in SCM

UNIT II DEMAND MANAGEMENT IN SUPPLY CHAIN 9

Role of forecasting- characteristics of forecasts-Determinants of Demand, Demand Patterns, Qualitative Forecasting Methods-Delphi techniques. Market Research, Nominal Group Technique. Quantitative Forecasting methods – Moving Average Methods, Exponential Smoothing Methods, Regression methods, Multi-Item Forecasting, Monitoring and Control of Forecasts, Requirements and Selection of Good forecasting methods. Role of IT in Forecasting, Risk Management in Forecasting, Collaborative Planning, Forecasting and Replenishment (CPFR),Forecasting in practice, case studies

UNIT III DISTRIBUTION NETWORKS AND NETWORK DESIGN IN SUPPLY CHAIN 9

Distribution Networks: Role of Distribution, influencing factors, design, application to e business, Distribution networks in Practice. Network Design :Role of Network Design- influencing factors and Framework- Significance of location decision- Factors affecting location decisions- Multi Criteria layout problems - Qualitative models & Quantitative models, Break-Even analysis- Brown & Gibbs model- Single facility location models- Gravity location models- Mini-Sum model- Mini-Max model- Multi facility location models- Covering model- P median model- models of facility location and capacity allocation- Evaluating network design decisions

UNIT IV TRANSPORTATION, SOURCING AND PRICING IN SUPPLY CHAIN 9

Role of transportation in a Supply chain, Modes of transportation and their performance characteristics, Design options for a transportation network, Trade-offs in transportation design, Tailored transportation- Reverse Logistics- Sourcing Decisions in Supply Chain: role of sourcing in a supply chain- Steps in Sourcing - Procurement process- Supplier selection- Design collaboration Auctions and Negotiations- Types of Sourcing- Third-and Fourth-party logistics providers- Role of Pricing and Revenue Management in a supply chain

UNIT V INFORMATION TECHNOLOGY, COORDINATION AND EMERGING 9

CONCEPTS IN SUPPLY CHAIN

Role of IT in a supply chain, The supply chain IT framework, The supply chain macro processes- Customer Relationship Management-Supplier relationship management- – Future of IT in supply chain – E-Business in Supply Chain- Coordination in a Supply Chain- Lack of supply chain coordination and the Bullwhip effect – obstacle to coordination – managerial levels – building partnerships and trust –Vendor-Managed Inventories - Risks in Supply Chain, Lean Supply Chains, Sustainable supply Chains – Block Chain and its applications in Supply Chain.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Understand the scope of Supply Chain Management and the Drivers of SC performance.

CO2. Predict the demand using different methods and address the issues associated with demand prediction

CO3. Design suitable Supply Chain network for a given situation.

CO4. Understand about the Transportation, Sourcing and Pricing in Supply Chain

CO5. Recognize the role of Information Technology, Coordination and Emerging Concepts in Supply Chain for gaining competitive advantage.

TEXT BOOKS:

1. Sunil Chopra, Peter Meindl and D.V. Kalra, “Supply Chain Management: Strategy, Planning, and Operation", Pearson Education, 2016.
2. Janat Shah, “Supply Chain Management: Text and Cases",", Pearson Education, 2016.

REFERENCES:

1. Ravi Ravindran A, Donald P. Warsing, Jr, “Supply Chain Engineering: Models and Applications”, “CRC Press, Second Edition, 2023.
2. Srinivasan G.S, “Quantitative models in Operations and Supply Chain Management”, Prentice Hall of India, Second Edition, 2017.

CO’s - PO’s & PSO’s MAPPING

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

IE23043	WAREHOUSING	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To develop an understanding of the role and importance of Warehousing to achieve competitiveness.
2. To impart knowledge on Receiving and Put away operations in Warehousing
3. To familiarise about the quality issues and Cross docking
4. To impart knowledge on warehouse management and warehouse automation
5. To give exposure on warehouse safety rules, procedures and performance measures

UNIT I INTRODUCTION 9

Introduction to Warehousing Concept, Decision making, Operations, Need for warehousing, Issues affecting warehousing, Various warehousing facilities, Different types of ware houses, Characteristics of ideal ware houses - Broad functions in a warehouse -warehouse layouts and layout related to functions Warehouse Organization Structure -Benefits of Warehousing.

UNIT II WAREHOUSE ACTIVITIES - I 9

Receiving and Dispatch of Goods in warehouse Various stages involved in receiving goods – Stages involved receipt of goods-Advanced shipment notice (ASN) or invoice items list-Procedure for Arranging of goods on dock for counting and Visual inspection of goods unloaded-Formats for recording of goods unloaded from carriers-Generation of goods receipt note using computer-Put away of Goods-Put away list and its need-Put away of goods into storage locations -Storage location codes and its application-Process of put away activity-Procedure to Prepare Warehouse dispatches

UNIT III WAREHOUSE ACTIVITIES- II 9

Receiving, sorting, loading, unloading, Picking Packing and dispatch, activities and their importance in a warehouse -quality parameters -Quality check-need for quality check-importance of quality check. Procedure to develop Packing list / Dispatch note-Cross docking method -Situations suited for application of cross docking -Information required for coordinating cross docking-Importance of proper packing-Packing materials -Packing machines -Reading labels

UNIT IV WAREHOUSE MANAGEMENT AND WAREHOUSE AUTOMATION 9

Warehouse Utilization Management -Study on emerging trends in warehousing sector -DG handling -use of Material Handling Equipment’s in a warehouse -Inventory Management of a warehouse - Inbound & Outbound operations of a warehouse and handling of Inbound & Outbound operations. Automation Systems: Over-view, Applications, Costs, Benefits. Receiving Automation: Pallet Inverter -Material Flow Automation: Conveyors -Lifts -Automated Guided Vehicles -Monorail - Picking/Outbound Automation: Pick / Put To Light -A Frame -Automated Order Selection – Pick-N-Go - Outbound Sorters -Automatic Truck Loading.

UNIT V WAREHOUSE SAFETY RULES ,PROCEDURES AND PERFORMANCE MEASURES **9**

The safety rules and 'Procedures to be observed in a Warehouse - Hazardous cargo – Procedure for Identification of Hazardous Cargo -Safety data sheet-Instructions to handle hazardous cargo - Familiarization with the industry. Health, Safety & Environment - Safety Equipment's and their uses -5S Concept on shop floor. Personal protective Equipment's (PPE) and their uses. The Principles and Performance Measures of Material Handling Systems Introduction. Vehicle travel path(time), Handling time, vehicle utilization, no of loads completed, congestion, Effective performance systems

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Understand about the need, functions, types and Benefits of Warehousing.

CO2. Demonstrate the role of picking and put away activities in Warehousing

CO3. Examine about the quality issues and Cross dockingin Warehousing

CO4. Develop effective warehousemanagement and warehouse automationstrategies

CO5. Appraise about warehouse safety rules, procedures and performance measures in Warehousing

TEXT BOOKS:

1. Gwynne Richards, 'Warehouse Management: A Complete Guide to Improving Efficiency and Minimizing Costs in the Modern Warehouse', Kogan Page Publishers, ,2011
2. Frazelle, Edward H, 'World-Class Warehousing and Material Handling', Second Edition. New York: McGraw-Hill Education, 2016.

REFERENCES:

1. Martin Christopher, 'Stores Management and Logistics', S. Chand and Co., 2003.
2. J.R. Tony Arnold , 'Stephen N. Chapman and M. Clive Introduction to Materials Management', Pearson,2008
3. Raghuram G , ' Logistics and Supply Chain Management', Pearson Education, 2015.

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

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

IE23044	LOGISTICS MANAGEMENT	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To learn the need for and importance of logistics Management
2. To teach about logistics strategies for competitiveness
3. To provide knowledge on planning the resourcing for logistics
4. To create awareness about addressing vehicle related issues in Logistics management
5. To illustrate about the current trends in Logistics management

UNIT I INTRODUCTION 9

Definition, History and Evolution, Objectives, Elements, activities importance, the work of logistics, Logistics interface with marketing, Retails logistics. Logistics Management: Definition, Evolution of the concept, model, process, activities. Achievement of competitive advantage through logistics framework, Role of logistics management

UNIT II LOGISTICS STRATEGIES 9

Strategic role of logistics, Definition, Role of logistics managers in strategic decisions; Strategy options: Lean, Agile & other strategies; Designing & implementing logistical strategy; emerging concepts in logistics. Outsourcing Logistics: Reasons, Third party logistics provider, Fourth party Logistics providers (4PL), Stages, Role of logistics providers- Reverse Logistics: Function-strategies

UNIT III PLANNING AND RESOURCING 9

Need for Planning, Fleet management, Main types of road freight transport, Transport resource requirements, Vehicle routing and scheduling Vehicle Selection: Types of vehicle, Types of operations, Load types and characteristics, Main types of vehicle body, Implications of vehicle selection ,Vehicle acquisition.

UNIT IV VEHICLE COSTING 9

Reasons for road freight transport vehicle costing, Main types of costing systems, Vehicle standing costs, Vehicle running costs, Overhead costs, Costing the total transport operation Documenting and Information Flow: Advices, Planning, FTL, LTL, Documentation – Road Receipts/Truck Receipts/Way Bills(RR/LR) Consignment note CMR Booking – Invoicing & Information Flow - Long Haul – Coordination with terminals Exceptional Loads (Project Cargo). Legislation: Operator licensing – Driver licensing – Driver‘s hours regulations

UNIT V CURRENT CONTOURS 9

Integrated Logistics - Logistics Information Systems – Need, Characteristics and Design. E-Logistics – Structure and Operation. Logistics Resource Management eLRM. Automatic Identification Technologies. Reverse Logistics – Scope, design and as a competitive tool - Green Logistics- Integrated Logistics Management -Smart Logistics

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Enable an efficient method of moving products with optimization of time and cost

CO2. Create a basic understanding of the concept of logistics and Logistics Management

CO3. Make proficiency in understanding logistics strategies

CO4. Develop the skill of effectively outsourcing logistics

CO5. Understand Integrated Logistics & Quality Customer Service.

TEXT BOOKS:

1. David J. Bloomberg, Stephen Lemay, Logistic, 8th edition, Pearson Education Dorling Kindersley; 1st edition, 2015.
2. Satish C. Ailawadi& Rakesh Singh, Logistics Management, 2 nd Edition, Prentice-Hall of India Pvt Ltd., New Delhi,2013.

REFERENCES:

1. F. Robert Jacobs, William Berry , D. Clay Whybark , Manufacturing Planning and Control for Supply Chain Management, McGraw-Hill Professional Publishing.
2. Manish Govil and Marie Proth, Supply Chain Design and Management: Strategic and Tactical Perspectives, Jean Academic Press

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

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

IE23045	ENTERPRISE RESOURCE PLANNING	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To introduce concept about the Enterprise Resource Planning (ERP).
2. To apprise about the activities of different functional modules of ERP.
3. To explain about the methodology and issues in ERP implementation.
4. Tocreate awareness on the maintenance, success, and failure factors of ERP Implementation.
5. To illustrate about the emerging trends in ERP developments.

UNIT I INTRODUCTION 9

Overview of enterprise systems - Evolution - Risks and benefits - Fundamental technology - Issues to be consider in planning design and implementation of cross functional integrated ERP systems.

UNIT II ERP SOLUTIONS AND FUNCTIONAL MODULES 9

Overview of ERP software solutions- small, medium and large enterprise vendor solutions, BPR and best business practices - Business process Management, Functional modules.

UNIT III ERP IMPLEMENTATION 9

Planning Evaluation and selection of ERP systems - Implementation life cycle - ERP implementation, Methodology and Frame work- Training - Data Migration - People Organization in implementation-Consultants, Vendors and Employees.

UNIT IV POST IMPLEMENTATION 9

Maintenance of ERP- Organizational and Industrial impact; Success and Failure factors of ERP Implementation.

UNIT V EMERGING TRENDS ON ERP 9

Extended ERP systems and ERP add-ons -CRM, SCM, Business analytics - Future trends in ERP systems-web enabled, Wireless technologies, cloud computing

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Understand the basics of ERP and appreciate the issues to be considered in the design of ERP

CO2. Obtain sufficient knowledge to about the business modules of ERP .

CO3. Assess the issues in ERP implementation and appraise the roles of different stakeholders in the implementation process.

CO4. Examine the post ERP implementation issues.

CO5. Perceive knowledge on future trends in ERP systems

TEXT BOOKS:

1. Alexis Leon, ERP demystified, second Edition Tata McGraw-Hill,2008.
2. Vinod Kumar Grag and N.K. Venkitakrishnan, ERP- Concepts and Practice, PHI,2006.

REFERENCES:

1. Sinha P. Magal and Jeffery Word, Essentials of Business Process and Information System, Wiley India,2012
2. Jagan Nathan Vaman, ERP in Practice, Tata McGraw-Hill,2008
3. Alexis Leon, Enterprise Resource Planning, second edition, Tata McGraw-Hill,2008.
4. Mahadeo Jaiswal and Ganesh Vanapalli, ERP Macmillan India,2009

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

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

IE23E01 ARTIFICAL INTELLIGENCE AND MACHINE LEARNING L T P C

3 0 0 3

COURSE OBJECTIVES:

1. Grasp the core concepts and history of Artificial Intelligence (AI)
2. Master the fundamentals of Machine Learning.
3. Explore core Supervised and unsupervised Learning algorithms
4. Explore Applications of Deep Learning.

UNIT I INTRODUCTION TO ARTIFICIAL INTELLIGENCE 9

History and evolution of AI- Definitions and scope of AI - Applications of AI in various fields-Intelligent agents - Agents and environments-Structure of intelligent agents, Types of agents: Simple reflex, model-based, goal-based, utility-based-Rationality-Task environments-Problem solving agents-Search strategies (uninformed and informed)

UNIT II MACHINE LEARNING BASICS 9

Definitions and key concepts- supervised learning- unsupervised learning- reinforcement learning- -Steps in data Preparation- Model Selection –Training- Model Evaluation- Parameter Tuning-Prediction- Implementation.

UNIT III SUPERVISED LEARNING 9

Simple and multiple linear regression-Assumptions, interpretation, and evaluationRegularization techniques: Ridge and Lasso regression-Polynomial regressionLogistic regression for binary classification- Introduction to Support Vector Machines (SVMs)- Support Vector Regression (SVR)-Support Vector Machines (SVM)- Introduction to SVM for classification-Kernel functions (linear, polynomial, RBF)- SVM for multi-class classification Boosting algorithms: AdaBoost, Gradient Boosting, XGBoost,- Bagging-(Random Forest) vs. Boosting.

UNIT IV UNSUPERVISED LEARNING 9

Basics of K-Means clustering-Choosing the number of clusters-Variations and improvements: K-Means++, Mini-Batch K-Means-Agglomerative vs. divisive clustering, Dendrograms and linkage criteria-DBSCAN (Density-Based Spatial Clustering of Applications with Noise)- OPTICS (Ordering Points To Identify the Clustering Structure)

UNIT V DEEP LEARNING 9

Limitations of traditional Machine Learning models-Introduction to Deep Learning- Artificial Neural Networks-Perceptrons, activation functions, gradient descent-Multilayer Perceptrons (MLPs), feed forward networks-Introduction to TENSOR, PYTORCH and KERAS- Convolutional Neural Networks (CNNs)-Convolution, pooling, filters-Applications- Recurrent Neural Networks (RNNs)-Unfolding through time, back propagation through time-Long Short-Term Memory (LSTM) networks-Applications.

TOTAL:45 PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Grasp the fundamental concepts of Artificial Intelligence (AI), including its history, evolution, applications, and types of intelligent agents

CO2. Apply core Machine Learning techniques for supervised learning tasks, including linear regression models, logistic regression, and classification algorithms.

CO3. Implement and analyze unsupervised learning methods like K-Means clustering to uncover patterns in unlabeled data.

CO4. Understand the limitations of traditional machine learning and gain an introduction to Deep Learning concepts.

CO5. Use Modern Tools for implementation of AI and ML Algorithms.

TEXT BOOKS:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 3rd Edition, Pearson, 2010

REFERENCES:

1. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
2. Aurelien Geron,Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, Third Edition,O.RELLIY,2022.
3. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning,The MIT Press, 2016.

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

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

IE23E02	INDUSTRY 4.0	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To understand the historical evolution and key principles of Industry 4.0, including Cyber-Physical Systems (CPS), Internet of Things (IoT), Big Data, Cloud Computing, and Artificial Intelligence.
2. To analyze the architecture and integration of Cyber-Physical Systems and IoT in modern manufacturing environments
3. To evaluate the role of Big Data and analytics in industrial applications, focusing on predictive maintenance, quality control, and supply chain optimization
4. To explore the benefits and challenges of Cloud Computing and Digital Twins in manufacturing and maintenance processes.
5. To investigate advanced manufacturing technologies and strategies for implementing smart factories in the context of Industry 4.0.

UNIT I INTRODUCTION TO INDUSTRY 4.0 **9**

Historical Context: Evolution from Industry 1.0 to Industry 4.0 -Key Concepts and Principles: Cyber-Physical Systems (CPS),Internet of Things (IoT),Big Data and Analytics, Cloud Computing, Artificial Intelligence (AI) and Machine Learning-Benefits and Challenges of Industry 4.0 -Case Studies and Real-world Applications.

UNIT II CYBER-PHYSICAL SYSTEMS AND IOT **9**

Introduction to Cyber-Physical Systems: Components and Architecture, Integration with Manufacturing Systems -Internet of Things (IoT) in Industry:IoT Architecture and Protocols, Sensors, Actuators, and Connectivity -Industrial IoT (IIoT),Applications and Use Cases -Case Studies on CPS and IoT Implementation.

UNIT III BIG DATA AND ANALYTICS **9**

Introduction to Big Data: Characteristics and Sources of Big Data, Data Collection and Storage -Data Analytics Techniques: Descriptive, Predictive, and Prescriptive Analytics, Machine Learning Algorithms -Applications of Big Data in Industry: Predictive Maintenance, Quality Control, Supply Chain Optimization-Case Studies on Big Data Applications.

UNIT IV CLOUD COMPUTING AND DIGITAL TWINS **9**

Introduction to Cloud Computing: Cloud Services and Deployment Models, Benefits and Challenges of Cloud Adoption- Edge Computing and its Role in Industry 4.0 -Digital Twins: Concept and Architecture, Applications in Manufacturing and Maintenance -Integration of Cloud Computing and Digital Twins -Case Studies on Cloud and Digital Twin Implementations

UNIT V ADVANCED MANUFACTURING AND SMART FACTORIES **9**

Introduction to Smart Manufacturing, Key Technologies in Smart Factories:Additive Manufacturing (3D Printing),Autonomous Robots and Drones, Augmented Reality (AR) and Virtual Reality (VR)-

Implementation Strategies for Smart Factories-Future Trends and Emerging Technologies in Industry 4.0.

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Describe the historical evolution from Industry 1.0 to Industry 4.0, and explain key concepts such as CPS, IoT, Big Data, and AI.

CO2. Identify the components and architecture of Cyber-Physical Systems and demonstrate their integration with manufacturing systems

CO3. Apply data analytics techniques to industrial scenarios, utilizing machine learning algorithms for predictive maintenance and quality control.

CO4. Assess the implementation of Cloud Computing and Digital Twins in industrial settings, and evaluate their impact on manufacturing efficiency.

CO5. Develop strategies for implementing advanced manufacturing technologies in smart factories, and anticipate future trends and emerging technologies in Industry 4.0.

TEXT BOOKS:

1. Alasdair Gilchris, 'Industry 4.0: The Industrial Internet of Things', Sringer,2016

REFERENCES:

1. Masoud Soroush, Michael Baldea, Thomas F. Edgar,'Smart Manufacturing: Concepts and Methods', Elsevier Science, 2020.
2. Klaus Schwab,'The Fourth Industrial Revolution', Crown, 2017
3. Bruno S. Sergi, Elena G. Popkova, Aleksei V. Bogoviz, Tatiana N. Litvinova, 'Understanding Industry 4.0: AI, the Internet of Things, and the Future of Work', Emerald Publishing Limited, 2019
4. Dominik T. Matt, Vladimír Modrák, Helmut Zsifkovits, 'Industry 4.0 for SMEs: Challenges, Opportunities and Requirements', Palgrave Macmillan,2020.

CO's-PO's&PSO'Smapping

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

IE23E03	DESIGN FOR X	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To understand the foundational concepts and significance of Design for X (DFX) in product development.
2. To analyze the principles and techniques of Design for Manufacture (DFM) and Design for Assembly (DFA) to optimize manufacturability and assembly
3. To apply Design for Reliability (DFR) and Design for Safety (DFS) principles to ensure product reliability and safety
4. To evaluate sustainable design practices through Design for Sustainability (DFS) and Design for Environment (DFE) to minimize environmental impacts.
5. To explore emerging trends and advanced DFX techniques to integrate modern methodologies such as Design for Additive Manufacturing (DFAM) and Design for Lean Manufacturing

UNIT I INTRODUCTION TO DESIGN FOR X (DFX) 9

Overview of DFX: Definition, scope, and significance of DFX in product development-Categories of DFX: Design for Manufacture (DFM), Design for Assembly (DFA), Design for Reliability (DFR), Design for Safety (DFS), etc-Design Methodologies: Basic principles, strategies, and tools used in DFX-Case Studies: Real-world examples illustrating successful DFX applications.

UNIT II DESIGN FOR MANUFACTURE (DFM) AND DESIGN FOR ASSEMBLY (DFA) 9

Design for Manufacture (DFM): Principles to optimize manufacturability, Techniques such as material selection, process planning, and design simplification -Design for Assembly (DFA): Methods to simplify product assembly, Guidelines for component standardization and modular design-DFM/DFA Tools and Techniques: Use of CAD/CAM software, FMEA (Failure Mode and Effects Analysis)-Cost Reduction: Techniques to reduce manufacturing and assembly costs through DFM/DFA.

UNIT III DESIGN FOR RELIABILITY (DFR) AND DESIGN FOR SAFETY (DFS) 9

Design for Reliability (DFR):Principles to ensure product reliability and longevity, Reliability prediction models, Accelerated life testing methods-Reliability Testing and Analysis: Use of reliability block diagrams, Weibull analysis, Fault tree analysis-Design for Safety (DFS):Principles to ensure product safety, Safety analysis techniques, Integration of safety considerations in the design process-Safety Standards and Regulations: Overview of safety standards ,Regulatory compliance and risk assessment.

UNIT IV DESIGN FOR SUSTAINABILITY (DFS) AND DESIGN FOR ENVIRONMENT (DFE) 9

Design for Sustainability (DFS): Principles to ensure sustainable product development, Sustainable material selection, Energy-efficient design practices -Life Cycle Assessment (LCA): Techniques to evaluate environmental impacts, CA software tools, Environmental impact assessment-Design for

Environment (DFE): Strategies to minimize environmental impact, Design for disassembly and recycling, Eco-design principles-Eco-design Tools: Use of eco-design software, Case studies.

UNIT V EMERGING TRENDS AND ADVANCED DFX TECHNIQUES 9

Design for Additive Manufacturing (DFAM): Principles and techniques for additive manufacturing, Design considerations for 3D printing-Design for Lean Manufacturing: Integrating lean principles in product design, Value stream mapping, Lean tools and techniques (Kaizen, 5S)-Design for Six Sigma (DFSS): Principles and tools for integrating Six Sigma methodology, DMAIC process, Statistical tools for DFSS-Future Trends: Emerging trends in DFX, Integration of AI, IoT, and digital twins.

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Identify the various categories and methodologies of DFX and their applications in real-world scenarios

CO2. Demonstrate the use of DFM/DFA tools and techniques, including CAD/CAM software and FMEA, to reduce manufacturing and assembly costs.

CO3. Implement reliability and safety analysis techniques, such as reliability block diagrams and fault tree analysis, in the design process.

CO4. Assess the environmental impact of products using Life Cycle Assessment (LCA) and apply eco-design principles to develop sustainable products

CO5. Integrate advanced DFX techniques, such as DFAM and lean principles, into product design to enhance efficiency and innovation.

TEXT BOOKS:

1. George Q. Huang (Ed), 'Design for X: Concurrent Engineering Imperatives', Springer Science & Business Media, 2012.

REFERENCES:

1. Gerardus Blokdyk,'DFX Design For X A Complete Guide - 2020 Edition',The Art of Service,2020.

CO's-PO's&PSO'Smapping

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

IE23E04	BLOCKCHAIN TECHNOLOGY	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To understand the fundamental concepts and history of blockchain technology, including its key components and types
2. To analyze the architecture and consensus mechanisms of blockchain, focusing on their advantages and disadvantages.
3. To explore the principles and development of smart contracts and decentralized applications (DApps) on various blockchain platforms
4. To evaluate the security and privacy challenges associated with blockchain technology and the strategies to mitigate them.
5. To investigate advanced topics and future trends in blockchain, including its integration with IoT, AI, and emerging applications like DeFi and NFTs.

UNIT I INTRODUCTION TO BLOCKCHAIN TECHNOLOGY 9

Definition and Overview of Blockchain Technology- History and Evolution - Key Concepts: Decentralization, Cryptography, Consensus -Bitcoin and the Cryptocurrency: Cryptocurrency Basics, Types of Cryptocurrency -Blockchain Structure and Components: Blocks, Transactions, and Chains, Hash Functions and Merkle Trees-Blockchain vs. Traditional Databases -Types of Blockchains: Public, Private, and Consortium Blockchains - Benefits and Challenges of Blockchain - Applications :Supply Chain Management, Quality Assurance and Traceability ,Inventory Management ,Government and Public Services- Blockchain Implementation :Limitations and Challenges.

UNIT II BLOCKCHAIN ARCHITECTURE AND CONSENSUS MECHANISMS 9

Structure of a Block: Header, Data, and Hash - Cryptographic Fundamentals: Hash Functions, Public/Private Key Cryptography- Transactions and Digital Signatures - The Blockchain Data Structure: Chains, Blocks, and Nodes - Introduction to Consensus Mechanisms, Importance of Consensus in Blockchain Networks - Proof of Work (PoW) :Concept and Process, Advantages and Disadvantages -Proof of Stake (PoS):Concept and Process, Advantages and Disadvantages -Other Consensus Mechanisms: Delegated Proof of Stake (DPoS),Practical Byzantine Fault Tolerance (PBFT)- Comparison of Different Consensus Mechanisms.

UNIT III SMART CONTRACTS AND DECENTRALIZED APPLICATIONS (DApps) 9

Introduction to Smart Contracts: Definition and Key Features -Popular Blockchain Platforms: Ethereum, Hyperledger Fabric, Corda -Comparison of platforms based on features and use cases - Smart Contracts: Definition and principles, Solidity programming language and Ethereum Virtual Machine (EVM) -Decentralized Applications (DApps):Architecture and characteristics, Examples of existing DApps and their functionalities -Tools and Frameworks: Development environments (e.g., Remix, Truffle),Deployment and interaction with blockchain networks.

UNIT IV BLOCKCHAIN SECURITY AND PRIVACY 9

Security Fundamentals: Threats and vulnerabilities in blockchain, Consensus mechanisms and their impact on security- Cryptographic Security: Role of cryptography in securing blockchain networks, Common cryptographic attacks and defences-Privacy and Anonymity: Techniques for enhancing privacy in blockchain (e.g., zero-knowledge proofs),Legal and regulatory considerations -Security Best Practices: Case studies of security breaches, Strategies for securing blockchain applications, Emerging technologies and their impact on blockchain security.

UNIT V ADVANCED TOPICS AND FUTURE TRENDS 9

Blockchain and Internet of Things (IoT) and Blockchain and Artificial Intelligence: Synergies and applications ,Challenges and opportunities in decentralized AI-Scalability and Interoperability Solutions: Techniques for improving blockchain scalability, Layer 2 solutions and interoperability protocols - Environmental and Social Impacts: Energy consumption and sustainability issues, Blockchain for social impact and sustainability - Emerging Trends: Decentralized Finance (DeFi),Non-Fungible Tokens (NFTs).

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Describe the key concepts of blockchain technology, including decentralization, cryptography, and consensus mechanisms, and differentiate between various types of blockchains

CO2. Identify and compare different blockchain architectures and consensus mechanisms, explaining their processes and implications.

CO3. Develop and deploy smart contracts and decentralized applications using popular blockchain platforms and development tools

CO4. Assess the security and privacy challenges in blockchain networks and implement best practices to enhance blockchain security

CO5. Evaluate the impact of blockchain on IoT and AI, and analyze emerging trends and technologies in the blockchain ecosystem.

TEXT BOOKS:

1. Chandramouli Subramanian, Asha A George, Abhilash K A and Meena Karthikeyan, 'Blockchain Technology', Universities Press ,2020
2. Kumar Saurabh and Ashutosh Saxena, 'Blockchain Technology: Concepts and Applications' Wiley,2020.

REFERENCES:

1. Daniel Drescher, Blockchain Basics: A Non-Technical Introduction in 25 Steps" , Springer,2017
2. Imran Bashir,'Mastering Blockchain - Fourth Edition: Inner workings of blockchain, from cryptography and decentralized identities, to DeFi, NFTs and Web3', Packt Publishing Ltd.,2023.

CO's-PO's&PSO'Smapping

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

IE23901 INTRODUCTION TO INDUSTRIAL ENGINEERING L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To understand the concepts productivity and productivity measurement approaches.
2. To gain knowledge on the basic principles in facilities planning and plant location.
3. To analyse and apply work study and ergonomic principles to design workplaces for the improvement of human performance
4. To gain knowledge to design and implement Statistical Process control in any industry.
5. To understand the concept of Production and Operations Management in creating and enhancing a firm's competitive advantages

UNIT I INTRODUCTION 9

Concepts of Industrial Engineering – History and development of Industrial Engineering –Roles of Industrial Engineer – Applications of Industrial Engineering – Production Management Vs Industrial Engineering – Production System – Input Output Model – Productivity – Factors affecting Productivity – Increasing Productivity of resources – Kinds of Productivity measures.

UNIT II PLANT LOCATION AND LAYOUT 9

Factors affecting Plant location – Objectives of Plant Layout – Principles of Plant Layout – Types of Plant Layout – Methods of Plant and Facility Layout – Storage Space requirements – Plant Layout procedure – Line Balancing methods.

UNIT III WORK SYSTEM DESIGN & ERGONOMICS 9

Need – Objectives – Method Study procedure – Principles of Motion Economy – Work Measurement procedures – Time Study –Work sampling- Ergonomics and its areas of application in the work system - Physical work load and energy expenditure, Anthropometry – measures – design procedure, Work postures-sitting, standing.

UNIT IV STATISTICAL QUALITY CONTROL 9

Definition and Concepts – Fundamentals – Control Charts for variables – Control Charts for attributes – Acceptance Sampling- O.C curve –Single sampling plan- Double sampling plan.

UNIT V PRODUCTION PLANNING AND CONTROL 9

Forecasting –Techniques – Types of production – Process planning – Economic Batch Quantity– Loading – Scheduling and control of production.

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Interpret the concepts of productivity and productivity measurement approaches.

CO2. Examine appropriate location models for various facility types and design various facility layouts

CO3. Analyze and conduct method study and time study to improve the efficiency of the system.

CO4. Examine the quality of processes using control charts in manufacturing/service industries.

CO5. Infer sufficient knowledge and skill for Planning strategies and Material Requirement Plan.

TEXT BOOKS:

1. O.P.Khanna, 2018, Industrial Engineering and Management, Dhanpat Rai Publications
2. Martand Telsang,2006, Industrial Engineering and Production Management, S. Chand and Company

REFERENCE:

1. Ravi Shankar, 2009, Industrial Engineering and Management, Galgotia Publications & Private Limited

CO's-PO's&PSO'sMAPPING

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

IE23902 DESIGN OF EXPERIMENTS FOR PARAMETER OPTIMIZATION L T P C

3 1 0 3

COURSE OBJECTIVES:

1. ExplaintheconceptsofClassicalDesignofExperiments(DOE
2. IllustrateSingleFactorExperimentandPosthoctests.
3. DescribeaboutFactorialexperimentsanditsextensions.
4. ApplyTaguchimethodforparameterOptimization
5. CreateexposureonResponseSurfaceMethodandShaininDOE

UNIT I FUNDAMENTALS OF EXPERIMENTAL DESIGNS **9**

Hypothesistesting—singlemean,twomeans,dependant/correlatedsamples— confidence intervals, Experimentation —need, Conventional test strategies, F-test, terminology, basic principles of design, steps in experimentation – choice of sample size – Normal and half normal probability plot – simple linear and multiple linear regression, Analysis of variance.

UNIT II SINGLE FACTOR EXPERIMENTS **9**

CompletelyRandomizedDesign-effectofcodingtheobservations-modeladequacychecking-estimationofmodelparameters,residualsanalysis-treatmentcomparisonmethods-Duncan's multiple range test, Newman-Keuel's test, Fisher's LSD test, Tukey's test- Testing using contrasts-RandomizedBlockDesign—LatinSquareDesign-GraecoLatinSquareDesign—Applications

UNIT III 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- 2K Design with two and three factors- Yate's Algorithm- fitting regression model- Randomized Block Factorial Design. Blocking and Confounding in 2K Designs- blocking in replicated design-2K Factorial Design in two blocks- Complete and partial confounding- Confounding 2K Design in four blocks - Two level Fractional Factorial Designs- Construction of one-half and one-quarter fraction of 2K Design

UNIT IV TAGUCHI METHODS **9**

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 SHAININ DOE **9**

Introduction to Response Surface Methods, Central Composite Design. Basics of Shainin DOE - Problem Solving Algorithm - Problem Identification Tools- Shainin DOE Tools - case studies.

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Understand the fundamental principles of Classical Design ofExperiments

CO2. Be able to apply single factor experiment for process parameter understanding and optimization

CO3. Be able to apply Factorial Design principles for understanding of process parameters and its optimization

CO4. Will gain knowledge on Taguchi's approach to experimental design for attaining robustness

CO5. Be able to apply Response Surface Method and Shainin DOE to evaluate quality.

TEXT BOOKS:

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

REFERENCES:

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

CO's-PO's&PSO'Smapping

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

IE23903 **QUALITY CONTROL AND ASSURANCE** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

1. To develop a clear knowledge in the basics of various quality concepts.
2. To understand the application of control charts for variables and their techniques.
3. To understand the application of control charts for attributes and their techniques
4. To develop the special control procedures for service and process oriented industries.
5. To apply and illustrate QMS in any organisation.

UNIT I QUALITY FUNDAMENTALS **9**

Importance of quality- evolution of quality- definitions of quality- dimensions of quality- quality control- quality assurance- areas of quality- quality planning- quality objectives and policies- quality costs- economics of quality- Quality loss function- quality Vs productivity- Quality Vs reliability.

UNIT II CONTROL CHARTS FOR VARIABLES **9**

Process variation- preliminary decisions- control limits and their computation- construction and application of X bar, R and S charts - warning and modified control limits- process adjustment for trend- Comparison of process variation with specification limits- O.C. curve for X bar chart.

UNIT III CONTROL CHARTS FOR ATTRIBUTES **9**

Limitations of variable control charts- Control charts for fraction non-conforming- p and np charts, variable sample size, operating characteristic function, run length- Control chart for nonconformities (defects)- c, u, ku charts, demerits control chart- applications.

UNIT IV STATISTICAL PROCESS CONTROL **9**

Process stability- process capability study using control charts- capability indices- Cp, Cpk and Cpm – capability analysis using histogram and normal probability plot- machine capability study-gauge capability study- setting statistical tolerances for components and assemblies- individual measurement charts- X-chart, moving average and moving range chart, multi-vari chart.

UNIT V QUALITY MANAGEMENT SYSTEM **9**

Introduction-Benefits of ISO Registration-ISO 9000 Series of Standards-Sector-Specific Standards - AS 9100, TS16949 and TL 9000-- 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.

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Control the quality of processes using control charts for variables in manufacturing industries

CO2. Control the occurrence of defective product and the defects in manufacturing companies.

CO3. Control the occurrence of defects in services.

CO4. Analyzing and understanding the process capability study.

CO5. Ability to apply QMS in any organization

TEXT BOOKS:

1. Douglus C. Montgomery, “Introduction to Statistical Quality Control”, Wiley-India, Eighth Edition, 2019.
2. Krishnaiah K.,” Applied Statistical Quality Control and Improvement”, PHI, 2014.

REFERENCES:

1. AmitavaMitra, “Fundamentals of Quality Control and Improvement”, Wiley, Fourth Edition, 2015
2. Dale H. Besterfield, Quality Control, Pearson Education Asia, 10th Edition, 2018.
3. Eugene L. Grant and Richard S. Leaven Worth, “Statistical Quality Control”, McGraw-Hill Education, Seventh Edition, 2000

CO’s-PO’s&PSO’sMAPPING

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

IE23905 RELIABILITY ASSESSMENT AND MAINTAINABILITY MODELS L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To impart knowledge in reliability engineering concepts
2. To conduct life data analysis
3. To assess Reliability of a system
4. To describe the maintenance policies and construct inspection decision models
5. To impart knowledge in Maintenance management techniques

UNIT I RELIABILITY CONCEPTS 9

Reliability definition – A priori and posteriori probabilities of failure -Reliability parameters- f(t), F(t) and R(t) functions- Mortality graph –Useful life.

UNIT II FAILURE DATA ANALYSIS 9

Data classification – Survival graphs -Time to failure distributions – Probability plotting: Exponential, Weibull - Goodness of fit tests: Kolmogorov Smirnov test, Bartlett's test, Chi square test. Failure Modes - FMEA and FMECA

UNIT III RELIABILITY PREDICTION 9

Series parallel configurations – Parallel redundancy – m/n system – Standby system -Complex systems: RBD approach – Baye's method – Minimal path and cut sets - Fault Tree analysis.

UNIT IV MAINTENANCE STRATEGIES 9

Maintenance objectives -Maintenance policies – Imperfect maintenance –PM versus b/d maintenance – Inspection decisions: Maximizing profit & Minimizing downtime – Tero Technology.

UNIT V MAINTENANCE DECISIONS 9

Repair time distributions – Maintainability prediction – Measures of maintainability – System Availability – Maintenance staffing- Spare parts management – Maintenance planning and scheduling.

TOTAL:45PERIODS

COURSE OUTCOMES:

The students will be able to

CO1. Acquire knowledge in Reliability Engineering.

CO2. Conduct failure data analysis.

CO3. Carry out reliability assessment of any complex system.

CO4. Demonstrate the application of maintainability models

CO5. Manage the maintenance related functions of an organization effectively.

TEXT BOOKS:

1. Charles E. Ebeling, "An Introduction to Reliability and Maintainability Engineering", Tata McGraw Hill, New Delhi. 2017.

2. Bikas Bhadury and S.K.Basu, “Terotechnology: Reliability Engineering and Maintenance Management”, Asian Books Pvt. Ltd., New Delhi, 2008.

REFERENCES:

1. Andrew K.S.Jardine & Albert H.C. Tsang, “Maintenance, Replacement and Reliability –Theory and Applications”,Taylor and Francis, Florida, 2013.
2. Matthew P. Stephens, “Productivity and Reliability-Based Maintenance Management”, Purdue University Press, 2010

CO’s-PO’s&PSO’sMAPPING

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