KSR College of Engineering

NAAC ACCREDITED A++ | NBA ACCREDITED PROGRAMMES

AN AUTONOMOUS INSTITUTION

M.E. - INDUSTRIAL SAFETY AND ENGINEERING

Curriculum &
Syllabus for Semester I and II

REGULATIONS 2024

(Academic Year 2024-25 Onwards)

K.S.R. COLLEGE OF ENGINEERING : TIRUCHENGODE - 637 215

(Autonomous)

INDUSTRIAL SAFETY ENGINEERING

(REGULATIONS 2024)

Vision of the Institution

IV	We envision to achieve status as an excellent educational institution in the global knowledge hub, making self-learners, experts, ethical and responsible engineers, technologists, scientists, managers, administrators and entrepreneurs who will significantly contribute to research and environment friendly sustainable growth of the nation and the world.

Mission of the Institution

IM 1	To inculcate in the students self-learning abilities that enable them to become competitive and considerate engineers, technologists, scientists, managers, administrators and entrepreneurs by diligently imparting the best of education, nurturing environmental and social needs.
IM 2	To foster and maintain mutually beneficial partnership with global industries and Institutions through knowledge sharing, collaborative research and innovation.

Vision of the Department / Programme: (Industrial Safety Engineering)

DV	To be a centre of excellence in the field of Mechanical Engineering for providing its students and faculty with opportunities for excel in education and targeted research themes in emerging areas.

Mission of the Department / Programme: (Industrial Safety Engineering)

DM 1	To excel in academic and research activities that meet the industrial and social needs.
DM 2	To develop competent, innovative and ethical mechanical Engineers.

Programme Educational Objectives (PEOs) :(Industrial Safety Engineering)

The graduates of the programme will be able to

PEO 1	Enhance the skills and knowledge on safety, health and environment with respect to industry and research, for executing safe methods in complex engineering problems.
PEO 2	Understand the impact of safety, health and environmental solutions on productivity, quality and societal at large.
PEO 3	To comply with legal safety, ethical and contractual requirements, professional practices to contribute the community for the sustainable development of society.

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PROGRAMME OUTCOMES (POs) AND PROGRAMME SPECIFIC OUTCOMES (PSOs)

Programme Outcomes (POs)	
PO1	An ability to independently carry out research / investigation and development work to solve practical problems.
PO2	An ability to write and present a substantial technical report / document.
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be a level higher than the requirements in the appropriate bachelor program.
PO4	An ability to attain, identify and apply knowledge of mathematics, soft computing & soft skill and management for various academic and industrial needs.
Programme Specific Outcomes (PSOs)	
PSO1	Students should be able to use techniques and modern engineering tools for engineering practices in their immediate employment and/or entrepreneurial activities.
PSO2	Contribute to the core universal human values and social good to community with respect to industrial safety, health and environment.

KSR College of Engineering	**K. S. R COLLEGE OF ENGINEERING** **An Autonomous Institution** **Approved by AICTE and Affiliated to Anna University, Chennai** **Accredited by NBA,NAAC ('A++' Grade)**	**Curriculum PG R - 2024**
Department	**Department of Mechanical Engineering**	
Programme	**M.E. Industrial Safety Engineering**	

SEMESTER I

S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot		CA	ES	Tot
Induction Programme			-	-	-	-	-	-	-	-	-
THEORY COURSES											
1	MA24T13	Applied Statistics	FC	3	0	0	3	**3**	40	60	100
2	IS24T11	Principles of Safety Management	PCC	3	0	0	3	**3**	40	60	100
3	IS24T12	Environmental Safety	PCC	3	0	0	3	**3**	40	60	100
4	IS24T13	Industrial Safety, Health and Environment (SHE) Acts	PCC	3	0	0	3	**3**	40	60	100
5		Professional Elective – I	PEC	3	0	0	3	**3**	40	60	100
6		Professional Elective – II	PEC	3	0	0	3	**3**	40	60	100
EMPLOYABILITY ENHANCEMENT COURSES											
7	IS24P11	Technical Presentation - I	EEC	0	0	3	3	**2**	60	40	100
			TOTAL	**18**	**0**	**3**	**21**	**20**	**700**		

SEMESTER II

S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot		CA	ES	Tot
THEORY COURSES											
1	RM24T19	Research Methodology and IPR	RMC	3	0	0	3	**3**	40	60	100
2	IS24T21	Fire Engineering and Explosion Control	PCC	3	0	0	3	**3**	40	60	100
3	IS24T22	Electrical Safety	PCC	3	0	0	3	**3**	40	60	100
4	IS24T23	Occupational Health and Industrial Hygiene	PCC	3	0	0	3	**3**	40	60	100
5		Professional Elective – III	PEC	3	0	0	3	**3**	40	60	100
6		Professional Elective – IV	PEC	3	0	0	3	**3**	40	60	100
LABORATORY COURSES											
7	IS24P21	Industrial Safety Laboratory	PCC	0	0	3	3	**2**	60	40	100
EMPLOYABILITY ENHANCEMENT COURSES											
8	IS24P22	Technical Presentation - II	EEC	0	0	3	3	**2**	60	40	100
			TOTAL	**18**	**0**	**6**	**24**	**22**	**800**		

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Programme	**M.E. Industrial Safety Engineering**	

SEMESTER III

S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot		CA	ES	Tot
THEORY COURSES											
1	IS24T31	Human Factors Engineering	PCC	3	0	0	3	**3**	40	60	100
2		Professional Elective – V	PEC	3	0	0	3	**3**	40	60	100
3		Open Elective	OEC	3	0	0	3	**3**	40	60	100
EMPLOYABILITY ENHANCEMENT COURSES											
4	IS24P31	Project work Phase - I	EEC	0	0	12	12	**6**	60	40	100
5	IS24P32	Internship *	EEC	0	0	12	12	**6**	100	-	100
AUDIT COURSES											
6		Audit course	AC	2	0	0	2	**0**	100	-	100
TOTAL				**11**	**0**	**24**	**35**	**21**	**600**		

* **- Students should undergo internship during the II semester summer vacation**

SEMESTER IV

S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot		CA	ES	Tot
EMPLOYABILITY ENHANCEMENT COURSES											
1	IS24P41	Project work Phase - II	EEC	0	0	24	24	**12**	60	40	100
TOTAL				**0**	**0**	**24**	**24**	**12**	**100**		
TOTAL CREDITS								**75**			

TOTAL NUMBER OF CREDITS TO BE EARNED FOR AWARD OF THE DEGREE = 75

Note:FC **-** Foundation Courses, PCC - Professional core courses, PEC- Professional Elective courses, EEC - Employability Enhancement Coursesand AC- Audit courses.

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FOUNDATION COURSES (FC)

S. No.	Course Code	Course Title	Semester	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot		CA	ES	Tot
1	MA24T13	Applied Statistics	I	3	0	0	3	**3**	40	60	100
			TOTAL	**3**	**0**	**0**	**3**	**3**			

PROFESSIONAL CORE COURSES (PCC)

S. No.	Course Code	Course Title	Semester	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot		CA	ES	Tot
1	IS24T11	Principles of Safety Management	I	3	0	0	3	**3**	40	60	100
2	IS24T12	Environmental Safety	I	3	0	0	3	**3**	40	60	100
3	IS24T13	Industrial Safety, Health and Environment (SHE) Acts	I	3	0	0	3	**3**	40	60	100
4	IS24T21	Fire Engineering and Explosion Control	II	3	0	0	3	**3**	40	60	100
5	IS24T22	Electrical Safety	II	3	0	0	3	**3**	40	60	100
6	IS24T23	Occupational Health and Industrial Hygiene	II	3	0	0	3	**3**	40	60	100
7	IS24P21	Industrial Safety Laboratory	II	0	0	3	3	**2**	60	40	100
8	IS24T31	Human Factors Engineering	III	3	0	0	3	**3**	40	60	100
		TOTAL		**21**	**0**	**3**	**24**	**23**	**800**		

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No.	Course Code	Course Title	Semester	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot		CA	ES	Tot
1	IS24P11	Technical Presentation - I	I	0	0	3	3	**2**	60	40	100
2	IS24P22	Technical Presentation - II	II	0	0	3	3	**2**	60	40	100
3	IS24P31	Project work Phase - I	III	0	0	12	12	**6**	60	40	100
4	IS24P32	Internship *	III	0	0	12	12	**6**	100	-	100
5	IS24P41	Project work Phase - II	IV	0	0	24	24	**12**	60	40	100
			TOTAL	**0**	**0**	**54**	**54**	**28**			

PROFESSIONAL ELECTIVE COURSES (PEC)											
PROFESSIONAL ELECTIVES – I and II (SEMESTER – I)											
S. No.	**Course Code**	**Course Title**	**Semester**	**Periods / Week**				**Credit**	**Max. Marks**		
				L	**T**	**P**	**Tot**		**CA**	**ES**	**Tot**
1	IS24E01	Safety in Construction	I	3	0	0	3	**3**	40	60	100
2	IS24E02	Dock Safety	I	3	0	0	3	**3**	40	60	100
3	IS24E03	Artificial Intelligence and Expert systems	I	3	0	0	3	**3**	40	60	100
4	IS24E04	Plant Layout and Materials Handling	I	3	0	0	3	**3**	40	60	100
5	IS24E05	Additive Manufacturing	I	3	0	0	3	**3**	40	60	100
6	IS24E06	Advanced Materials	I	3	0	0	3	**3**	40	60	100
7	IS24E07	Safety in Mines	I	3	0	0	3	**3**	40	60	100
8	IS24E08	Fireworks safety	I	3	0	0	3	**3**	40	60	100
9	IS24E09	Welding Economics, Management and Safety	I	3	0	0	3	**3**	40	60	100
10	IS24E10	Food Processing, Preservation and Transport	I	3	0	0	3	**3**	40	60	100
PROFESSIONAL ELECTIVES – III and IV (SEMESTER – II)											
S. No.	**Course Code**	**Course Title**	**Semester**	**Periods / Week**				**Credit**	**Max. Marks**		
				L	**T**	**P**	**Tot**		**CA**	**ES**	**Tot**
1	IS24E11	OHSAS18001 and ISO14001	II	3	0	0	3	**3**	40	60	100
2	IS24E12	Safety in Chemical Industries	II	3	0	0	3	**3**	40	60	100
3	IS24E13	Non Destructive Testing and Evaluation	II	3	0	0	3	**3**	40	60	100
4	IS24E14	Reliability Engineering	II	3	0	0	3	**3**	40	60	100
5	IS24E15	Optimization Techniques in Manufacturing	II	3	0	0	3	**3**	40	60	100
6	IS24E16	Quality Engineering	II	3	0	0	3	**3**	40	60	100
7	IS24E17	Computer Aided Hazard Analysis	II	3	0	0	3	**3**	40	60	100
8	IS24E18	Advanced Metrology and Non Destructive Testing	II	3	0	0	3	**3**	40	60	100
9	IS24E19	Safety in Engineering Industry	II	3	0	0	3	**3**	40	60	100
10	IS24E20	Materials Testing and Characterization Techniques	II	3	0	0	3	**3**	40	60	100
PROFESSIONAL ELECTIVES – V (SEMESTER – III)											
S. No.	**Course Code**	**Course Title**	**Semester**	**Periods / Week**				**Credit**	**Max. Marks**		
				L	**T**	**P**	**Tot**		**CA**	**ES**	**Tot**
1	IS24E21	Work Study and Ergonomics	III	3	0	0	3	**3**	40	60	100
2	IS24E22	Safety in Powder Handling	III	3	0	0	3	**3**	40	60	100
3	IS24E23	Nuclear Engineering and Safety	III	3	0	0	3	**3**	40	60	100
4	IS24E24	Safety in Textile Industry	III	3	0	0	3	**3**	40	60	100
5	IS24E25	Transport Safety	III	3	0	0	3	**3**	40	60	100

6	IS24E26	Energy Conservation and Management	III	3	0	0	3	**3**	40	60	100
7	IS24E27	Plastics and Composite Materials	III	3	0	0	3	**3**	40	60	100
AUDIT COURSES (SEMESTER – III)											
S. No.	**Course Code**	**Course Title**	**Semester**	**Periods / Week**				**Credit**	**Max. Marks**		
				L	**T**	**P**	**Tot**		**CA**	**ES**	**Tot**
1	AX24A01	Disaster Management	III	2	0	0	2	**0**	100	-	100
2	AX24A02	Value Education	III	2	0	0	2	**0**	100	-	100
3	AX24A03	Constitution of India	III	2	0	0	2	**0**	100	-	100
4	AX24A04	Indian Knowledge System	III	2	0	0	2	**0**	100	-	100
RESEARCH METHODOLOGY COURSE (RMC)											
S. No.	**Course Code**	**Course Title**	**Semester**	**Periods / Week**				**Credit**	**Max. Marks**		
				L	**T**	**P**	**Tot**		**CA**	**ES**	**Tot**
1	RM24T19	Research Methodology and IPR	II	3	0	0	3	**3**	40	60	100
OPEN ELECTIVE COURSES											
S. No.	**Course Code**	**Course Title**	**Category**	**Periods / Week**				**Credit**	**Max. Marks**		
				L	**T**	**P**	**Tot**		**CA**	**ES**	**Tot**
COMPUTER SCIENCE AND ENGINEERING											
1	CS24O01	Machine learning and Deep Learning	OEC	3	0	0	3	**3**	40	60	100
2	CS24O02	Blockchain and Crypto Currency	OEC	3	0	0	3	**3**	40	60	100
3	CS24O03	Multimedia Technologies	OEC	3	0	0	3	**3**	40	60	100
BIG DATA ANALYTICS											
4	BD24O01	Big Data Analytics	OEC	3	0	0	3	**3**	40	60	100
5	BD24O02	Internet of Things and Cloud	OEC	3	0	0	3	**3**	40	60	100
6	BD24O03	Big Data Visualization	OEC	3	0	0	3	**3**	40	60	100
POWER ELECTRONICS AND DRIVE											
7	PE24O01	Switching Concepts and Power	OEC	3	0	0	3	**3**	40	60	100
8	PE24O02	Smart Grid Technology	OEC	3	0	0	3	**3**	40	60	100
9	PE24O03	Renewable Energy Technology	OEC	3	0	0	3	**3**	40	60	100
10	PE24O04	Energy Management and Conservation	OEC	3	0	0	3	**3**	40	60	100
EMBEDDED SYSTEMS TECHNOLOGY											
11	ET24O01	Embedded Systems	OEC	3	0	0	3	**3**	40	60	100
12	ET24O02	Embedded Control	OEC	3	0	0	3	**3**	40	60	100
13	ET24O03	Embedded Automation	OEC	3	0	0	3	**3**	40	60	100
INFORMATION TECHNOLOGY											
14	IT24O01	IoT for Smart System	OEC	3	0	0	3	**3**	40	60	100
15	IT24O02	Machine Learning for Intelligent	OEC	3	0	0	3	**3**	40	60	100
16	IT24O03	DevOps and Microservices	OEC	3	0	0	3	**3**	40	60	100

17	IT24O04	Cyber security and Digital Awareness	OEC	3	0	0	3	**3**	40	60	100
CONSTRUCTION ENGINEERING AND MANAGEMENT											
18	CN24O01	Energy Efficient Building	OEC	3	0	0	3	**3**	40	60	100
19	CN24O02	Economics and Finance management	OEC	3	0	0	3	**3**	40	60	100
20	CN24O03	Stress management	OEC	3	0	0	3	**3**	40	60	100
STRUCTURAL ENGINEERING											
21	ST24O01	Principles of Sustainable	OEC	3	0	0	3	**3**	40	60	100
22	ST24O02	Failure Analysis of Structures	OEC	3	0	0	3	**3**	40	60	100
23	ST24O03	Smart materials and Smart Structures	OEC	3	0	0	3	**3**	40	60	100
COMMUNICATION SYSTEMS											
24	CU24O01	Principles of Multimedia	OEC	3	0	0	3	**3**	40	60	100
25	CU24O02	Software Defined Radio	OEC	3	0	0	3	**3**	40	60	100
26	CU24O03	MEMS & NEMS	OEC	3	0	0	3	**3**	40	60	100
27	CU24O04	Introduction to cognitive Radio Network	OEC	3	0	0	3	**3**	40	60	100
CAD/CAM											
28	CC24O01	Digital Manufacturing	OEC	3	0	0	3	**3**	40	60	100
29	CC24O02	Design for Manufacturing and Assembly	OEC	3	0	0	3	**3**	40	60	100
30	CC24O03	Smart Materials and Structures	OEC	3	0	0	3	**3**	40	60	100

OPEN ELECTIVE COURSES OFFERED BY INDUSTRIAL SAFETY ENGINEERING

S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot		CA	ES	Tot
1	IS24O01	Industrial Safety Engineering	OEC	3	0	0	3	**3**	40	60	100
2	IS24O02	Fire Engineering and Protection	OEC	3	0	0	3	**3**	40	60	100
3	IS24O03	Food and Bio-safety	OEC	3	0	0	3	**3**	40	60	100

Summary

Name of the Programme: M.E Industrial Safety Engineering

CATEGORY	I	II	III	IV	TOTAL CREDITS	%
FC	3				**3**	**04.00**
PCC	9	11	3		**23**	**30.66**
PEC	6	6	3		**15**	**20.00**
OEC			3		**3**	**04.00**
EEC	2	2	12	12	**28**	**37.33**
AC			✓			**-**
RMC		3			**3**	**04.00**
Total	**20**	**22**	**21**	**12**	**75**	**100**

MA24T13	APPLIED STATISTICS	Category	L	T	P	C
		FC	3	0	0	3

PREREQUISITE

The students should have basic knowledge in data collection, data analysis, data interpretation and research design.

OBJECTIVES:

- Understand the concept of hypothesis testing.
- Learn to select and apply the appropriate statistical test.
- Develop the skills in design of experiments.
- Experience the concepts of correlation, regression, and time series.
- Use various charts to represent the quality of the process.

UNIT – I	PARAMETRIC TESTS	9

Sampling distributions - Test for significance of small samples: Student's t- test for testing single sample mean - two sample mean - Fiducial limits for population mean - Testing Significance of large samples (Z-test) for mean of a random sample - testing difference between means of two samples (Independent and dependent samples) - Chi square distribution - Independent of Attributes - F-Ratio test for equality of variances.

UNIT - II	NON-PARAMETRIC TESTS	9

Advantages of Non-Parametric tests – The Sign test, A rank sum test: The Mann-Whitney U test, The Kruskal - Wallis or H-test, One sample Run test.

UNIT - III	DESIGN OF EXPERIMENTS	9

Analysis of variance – One-way and two-way classifications – Completely randomized design – Randomized block design –Latin square design.

UNIT - IV	CORRELATION, REGRESSION & TIME SERIES ANALYSIS	9

Karl Pearson's Co efficient of Correlation - Spearman's rank correlation - Regression analysis - Principle of least squares- Fitting straight line trends.

UNIT - V	QUALITY CONTROL	9

Introduction – Types of control Charts – Advantage and limitation of Statistical Quality Control -$\bar{X}$and R charts – Control charts for P and nP charts - Control chart for the standard deviations σ-chart.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Formulate and test hypotheses using appropriate statistical tests.	Understand
CO2	Apply non-parametric tests to real world data to understand the advantages of them.	Apply
CO3	Design and analyze the experiments using various designs such as CRD, RBD, and LSD.	Analyze
CO4	Assess relationships between variables using correlation, regression and time series.	Apply
CO5	Construct and interpret control charts for process monitoring to improve the quality control.	Analyze

TEXT BOOKS:

1. Freund John, E and Miller, Irvin, "Probability and Statistics for Engineering", Prentice Hall, 5th Edition 2013.

2. S.P. Gupta , "Statistical Methods ", Sultan Chand & sons, New Delhi, 19thEdition 2022.

REFERENCES:

1.Gupta S.C., Kapoor V.K., "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, New Delhi, 12th Edition 2022.

2.Devore, J. L., "Probability and Statistics for Engineering and the Sciences",Cengage Learning, 9th Edition 2020.

3. Eugene L. Grant, Richard S. Leavenworth, "Statistical Quality Control", McGraw-Hill Publications, 7thEdition 2017.

4.Richard A. Johnson, Dean W. Wichern, "Applied Multivariate Statistical Analysis", Pearson Education, Asia, 6th Edition 2012.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	-	-	-	-	-	-	-	-	-	-	2	-
CO4	3	-	-	-	-	-	-	-	-	-	-	2	-
CO5	3	-	-	-	-	-	-	-	-	-	-	2	-
Avg.	3	-	-	-	-	-	-	-	-	-	-	2	-

1-low, 2-medium, 3-high

IS24T11	PRINCIPLES OF SAFETY MANAGEMENT	Category	L	T	P	C
		PCC	3	0	0	3

PREREQUISITE:

Courses in industrial safety often require foundational knowledge of engineering disciplines such as mechanical, civil, or electrical engineering.

OBJECTIVES:

- To understand key safety management concepts, frameworks, and standards.
- To promote safety audit and to prepare a report for the audit.
- To Apply risk management techniques to minimize incidents and accidents in industrial settings.
- To evaluate the effectiveness of safety strategies and continuously improve safety performance.
- To Develop and implement safety management systems and programs.

UNIT - I	CONCEPTS AND TECHNIQUES	(9)

Content Evolution of modern safety concept - Safety Management functions - planning for safety for optimization of productivity -productivity, quality and safety - line and staff functions for safety - safety committee - budgeting for safety - safety policy - Statutory Provisions for safety management.
Incident Recall Technique (IRT), disaster control, job safety analysis, safety survey, safety inspection, safety sampling, evaluation of performance of supervisors on safety

UNIT - II	SAFETY AUDIT - INTRODUCTION	(9)

Components of safety audit, types of audit, audit methodology, non conformity reporting (NCR), audit checklist and report - review of inspection, remarks by government agencies, consultants, experts - perusal of accident and safety records, formats - implementation of audit indication - liaison with departments to ensure co-ordination - check list - identification of unsafe acts of workers and unsafe conditions in the shop floor

UNIT - III	SAFETY AUDIT - INTRODUCTION	(9)

Basic Principle of Accident & Prevention concept of an accident, reportable and non reportable accidents, reporting to statutory authorities - principles of accident prevention - accident investigation and reporting - Accident analysis - based on causes & injury - records for accidents, departmental accident reports, documentation of accidents - unsafe act and condition - Accident causation theories - domino sequence - supervisory role - role of safety committee - cost of accident

UNIT - IV	SAFETY AUDIT - INTRODUCTION	(9)

ANSI (Z16.1) Recommended practices for compiling and measuring work injury experience - permanent total disabilities, permanent partial disabilities, temporary total disabilities - Calculation of accident indices, frequency rate, severity rate, frequency severity incidence, incident rate, accident rate, safety "t" score, safety activity rate - problems.

UNIT - V	SAFETY EDUCATION AND TRAINING	(9)

Importance of training - identification of training needs - training methods such as hands on training and tabletop exercise - Programme, seminars, conferences, competitions - method of promoting safe practice – motivation - communication -safety attitude and culture - role of government agencies and private consulting agencies in safety training - creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign - Domestic Safety and Training.

TOTAL: 45 PERIODS

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

COs	Course Outcome	Cognitive Level
CO1	Analyze the concepts and techniques of safety management functions.	.Analyze
CO2	Recall about safety audit and to prepare a report for the audit.	Understand
CO3	Acquire knowledge on the principles of accident and its control methods.	Understand
CO4	Evaluate the accident cost using supervisors report and data.	Understand
CO5	Recall the role of various agencies in safety education and training.	Understand

TEXT BOOKS:

1. Blake, R.B., Industrial Safety, Prentice Hall Inc, Delhi, Third Edition, 2009.
2. Heinrich, H.W., Industrial Accident Prevention, McGraw-Hill Company, New York, Fifth Edition, 2019.

REFERENCES:

1. Relevant India Acts and Rules, Government of India.
2. Krishnan, N.V., Safety Management in Industry, Jaico Publishing House, Bombay, Second Edition, 2017.
3. Lees, F.P., Loss Prevention in Process Industries, Butterworth publications, London, Second edition, 2001.
4. John Ridley., Safety at Work, Butterworth and Co, London, Seventh Edition, 2003.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	**1**	**2**	**3**	-	-	-	-	-	-	-	**2**	**3**
CO2	-	**1**	**2**	**3**	-	-	-	-	-	-	-	**2**	**3**
CO3	-	**1**	**2**	**3**	-	-	-	-	-	-	-	**2**	**3**
CO4	-	**1**	**2**	**3**	-	-	-	-	-	-	-	**2**	**3**
CO5	-	**1**	**2**	**3**	-	-	-	-	-	-	-	**2**	**3**
Avg.	-	**1**	**2**	**3**	-	-	-	-	-	-	-	**2**	**3**

1-low, 2-medium, 3-high

IS24T12	ENVIRONMENTAL SAFETY	Category	L	T	P	C
		PCC	3	0	0	3

PREREQUISITE

Understanding of ecological systems, pollution, and environmental regulations.

OBJECTIVES:

- To Learn to recognize various environmental risks, such as pollution, hazardous materials, and waste management issues.
- To know about the water pollutants and its health hazards
- To gain the health and safety concepts with respect to hazardous waste management.
- To Conduct environmental impact assessments and environmental measurement and its control
- To Develop and apply health and safety practices in controlling risks for different engineering activities

UNIT - I	AIR POLLUTION	(9)

Classification and properties of air pollutants - Pollution sources - Effects of air pollutants on human beings, Animals, Plants and Materials - automobile pollution - hazards of air pollution - concept of clean coal combustion technology - ultra violet radiation, infrared radiation, radiation from sun - hazards due to depletion of ozone - deforestation - ozone holes -automobile exhausts - chemical factory stack emissions - CFC Statutory provisions related to air pollution.

UNIT - II	WATER POLLUTION	(9)

Classification of water pollutants - health hazards - sampling and analysis of water - water treatment - different industrial effluents and their treatment and disposal - advanced wastewater treatment - effluent quality standards and laws - chemical industries, tannery, textile effluents - common treatment - Statutory provisions related to water pollution.

UNIT - III	HAZARDOUS WASTE MANAGEMENT	(9)

Hazardous waste management in India - waste identification, characterization and classification technological options for collection, treatment and disposal of hazardous waste - selection charts for the treatment of different hazardous wastes -methods of collection and disposal of solid wastes - health hazards - toxic and radioactive wastes - incineration and vitrification - hazards due to bio-process - dilution standards and restrictions - recycling and reuse - statutory provisions related to hazardous waste management & handling.

UNIT - IV	ENVIRONMENTAL MEASUREMENT AND CONTROL	(9)

Sampling and analysis - dust monitor - gas analyzer, particle size analyzer - Lux meter - pH meter - gas chromatograph - atomic absorption spectrometer. Gravitational settling chambers - cyclone separators - scrubbers - electrostatic precipitator - bag filter - maintenance - control of gaseous emission by adsorption, absorption and combustion methods -Pollution Control Board - laws

UNIT - V	POLLUTION CONTROL IN PROCESS INDUSTRIES	(9)

Pollution control in process industries like cement, paper and petroleum - petroleum products - textile - tanneries thermal power plants - dying and pigment industries - eco-friendly energy

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Gain about the air pollution effects and its control.	Remember
CO2	Analyze about the water pollutants and its health hazards.	Analyze
CO3	Apply the health and safety concepts with respect to hazardous waste management.	Apply

CO4	Acquire knowledge on environmental measurement and its control.	Understand
CO5	Demonstrate the health and safety practices in controlling risks for different engineering activities.	Understand

TEXT BOOKS:

1. Rao, C.S. ,Environmental Pollution Engineering, Wiley Eastern Limited,New Delhi, Third Edition, 2020.
2. Mahajan, S.P., Pollution Control in Process Industries, Tata McGraw Hill Publishing Company,New Delhi, Fifth Edition, 2001.

REFERENCES:

1. Rao, C.S., Environmental Pollution Engineering, Wiley Eastern Limited,New Delhi, Third Edition, 2020.
2. Mahajan, S.P. ,Pollution Control in Process Industries, Tata McGraw Hill Publishing Company,New Delhi, Fifth Edition, 2001.
3. Varma and Braner, Air Pollution Equipment, Springer Publishers, New Delhi, Second Edition,2017.
4. Rao, C.S., Environmental Pollution Engineering, Wiley Eastern Limited, New Delhi, Third Edition, 2020.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	**1**	**2**	**3**	-	-	-	-	-	-	-	**2**	**3**
CO2	-	**1**	**2**	**3**	-	-	-	-	-	-	-	**2**	**3**
CO3	-	**1**	**2**	**3**	-	-	-	-	-	-	-	**2**	**3**
CO4	-	**1**	**2**	**3**	-	-	-	-	-	-	-	**2**	**3**
CO5	-	**1**	**2**	**3**	-	-	-	-	-	-	-	**2**	**3**
Avg.	-	**1**	**2**	**3**	-	-	-	-	-	-	-	**2**	**3**

1-low, 2-medium, 3-high

IS24T13	INDUSTRIAL SAFETY, HEALTH AND ENVIRONMENT (SHE) ACTS	Category	L	T	P	C
		PCC	3	0	0	3

PREREQUISITE

Familiarity with workplace health and safety regulations, including risk assessments and health management practices.

OBJECTIVES:

- Learn how to interpret specific acts and regulations and apply them effectively in industrial operations to ensure compliance.
- To know the environment act with respect to air and water pollution.
- To understand the responsibilities of occupier according to manufacture, storage and import of chemical rules
- To evaluate the legislation acts pertaining to health and safety.
- To List out the various international acts and rules.

UNIT - I	FACTORIES ACT - 1948	(9)

Statutory authorities - inspecting staff, health, safety, provisions relating to hazardous processes, welfare, working hours, employment of young person's - special provisions - penalties and procedures - Tamilnadu Factories Rules 1950 under Safety and health chapters of Factories Act 1948, forms, registers and notices - Amendments.

UNIT - II	ENVIRONMENT ACT - 1986	(9)

General powers of the central government, prevention, control and abatement of environmental pollution - Biomedical waste (Management and Handling) Rules, 1989 - The Noise Pollution (Regulation and control) Rules, 2000 - The Batteries (Management and Handling) Rules, 2001 - No Objection certificate from statutory authorities like pollution control board.

Air Act 1981 and Water Act 1974:Central and state boards for the prevention and control of air pollution - powers and functions of boards - prevention and control of air pollution and water pollution – fund - accounts and audit, penalties and procedures**.**

UNIT - III	MANUFACTURE, STORAGE AND IMPORT OF CHEMICAL RULES 1989	(9)

Definitions - duties of authorities - responsibilities of occupier - notification of major accidents - information to be furnished - preparation of offsite and onsite plans - list of hazardous and toxic chemicals - safety reports - safety data sheets.

UNIT - IV	OTHER ACTS AND RULES	(9)

Indian Boiler Act 1923, Static and Mobile Pressure Vessel Rules (SMPV), Motor Vehicle Rules, Mines Act 1952, Workman Compensation Act, Rules - Electricity Act and Rules - Hazardous Wastes (Management and Handling) Rules, 1989, with amendments in 2000 - The Building and Other Construction Workers Act 1996., Petroleum rules, Gas cylinder rules - Explosives Act 1983 - Pesticides Act.

UNIT - V	INTERNATIONAL ACTS AND STANDARDS	(9)

Occupational Safety and Health Act of USA (The Williams - Steiger Act of 1970) - Health and Safety Work Act (HASAWA) 1974, UK - SHAS 18001 - ISO 45001 - American National Standards Institute (ANSI).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Gain the health and welfare provisions as given in factories act	. Understand

CO2	Acquire knowledge on environment act with respect to air and water pollution.	Understand
CO3	Analyze the responsibilities of occupier according to manufacture, storage and import of chemical rules	Analyze
CO4	Apply the other legislation acts pertaining to health and safety.	Apply
CO5	List out the various international acts and rules.	Remember

TEXT BOOKS:

1. The Factories Act 1948, Madras Book Agency, Chennai, 2000.
2. The Environment Act (Protection) 1986, Commercial Law Publishers (India) Pvt. Ltd., New Delhi, Second Edition, 2019.

REFERENCES:

1. The Indian boilers act 1923, Commercial Law Publishers (India) Pvt. Ltd., Allahabad, Second Edition, 2011
2. The Mines Act 1952, Commercial Law Publishers (India) Pvt. Ltd., Allahabad, Second Edition, 2019.
3. National seminar on hazardous waste management ,National Safety council, Ministry of environment and forests, Government of India, United State - Asia environmental partnership, Tamilnadu pollution control board and Indian chemical manufacturers association, April 2009.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	**2**	**2**	**3**	-	-	-	-	-	-	-	**2**	**3**
CO2	-	**2**	**2**	**3**	-	-	-	-	-	-	-	**2**	**3**
CO3	-	**2**	**2**	**3**	-	-	-	-	-	-	-	**2**	**3**
CO4	-	**2**	**2**	**3**	-	-	-	-	-	-	-	**2**	**3**
CO5	-	**2**	**2**	**3**	-	-	-	-	-	-	-	**2**	**3**
Avg.	-	**2**	**2**	**3**	-	-	-	-	-	-	-	**2**	**3**

1-low, 2-medium, 3-high

IS24P11	TECHNICAL PRESENTATION - I	Category	L	T	P	C
		EEC	0	0	3	2

PREREQUISITE

Familiarity with presentation software such as Microsoft PowerPoint, Google Slides, or other tools used to create technical presentations.

OBJECTIVES:

- To recognize the problems in general area of interest by the student.
- To integrate the area / problem by referring journals, conference proceedings etc.
- To improve the collective skills between theoretical knowledge and real time problems.
- To grow the knowledge on the problem by presentation and review.
- To get idea on report writing and presentation.

1. The students have to refer the journals and conference proceedings and collect the published literature.
2. By mutual discussions with the faculty in-charge the student can decide a topic in general.
3. The student is expected to collect at least 20 such research papers published in the last 5 years.
4. Using OHP / Power Point, the student has to make presentation for 20 minutes followed by 10 minutes discussion.
5. The student has to make five presentations in the semester.

The student has to write a technical report for about 30 - 50 pages (Title page, One page Abstract, Review of Research paper under various sub - headings, concluding remarks and list of references). The technical report has to be submitted to the course coordinator one week before the final presentation.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	identify the problems in general area of interest by the student.	Understand
CO2	Incorporate the area / problem by referring journals, conference proceedings etc.	Remember
CO3	Enhance the collective skills between theoretical knowledge and real time problems.	Understand
CO4	Gain knowledge on the problem by presentation and review.	Remember
CO5	Acquire idea on report writing and presentation.	Understand

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	3	1	2	-	-	-	-	-	-	-	2	3
CO2	2	3	1	2	-	-	-	-	-	-	-	2	3
CO3	2	3	1	2	-	-	-	-	-	-	-	2	3
CO4	2	3	1	2	-	-	-	-	-	-	-	2	3
CO5	2	3	1	2	-	-	-	-	-	-	-	2	3
Avg.	2	3	1	2	-	-	-	-	-	-	-	2	3

1-low, 2-medium, 3-high

RM24T19	RESEARCH METHODOLOGY AND IPR	Category	L	T	P	C
		RMC	3	0	0	3

(Common to PED, EST,CAD/CAM,ISE and CS)

PREREQUISITE:A basic understanding of academic writing and critical thinking skills to analyze research literature, familiarity with fundamental statistical concepts for data analysis, and a strong grasp of core subject knowledge relevant to the student's field. Additionally, a general awareness of legal principles related to intellectual property, ethical research practices, and innovation trends will enhance the student's ability to engage with both research methodologies and IPR concepts.

OBJECTIVES:

- To equip students with the ability to design and conduct rigorous research, employing appropriate methodologies, and critically analyzing results.
- To foster the ability to critically evaluate academic literature, identify research gaps, and formulate research questions.
- To enable students to effectively communicate research findings and legal arguments, both in written form and through presentations, to academic and professional audiences.
- To instill an understanding of ethical issues in research, including responsible conduct, data integrity, and the ethical use of intellectual property.
- To provide a comprehensive understanding of intellectual property rights, including patents, trademarks, copyrights, and their application in various industries.

UNIT - I	RESEARCH DESIGN	(9)

Overview of research process and design – Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies – Experiments and surveys.

UNIT - II	DATA COLLECTION AND SOURCES	(9)

Measurements: Measurement Scales – Questionnaires and Instruments – Sampling and Methods. Data - Preparing, Exploring, Examining and displaying.

UNIT - III	DATA ANALYSIS AND REPORTING	(9)

Overview of Multivariate analysis – Hypotheses testing and Measures of Association – Presenting Insights and findings using written reports and oral presentation.

UNIT - IV	INTELLECTUAL PROPERTY RIGHTS	(9)

Intellectual Property – The concept of IPR, Evolution and development of the concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Biodiversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT - V	PATENTS	(9)

Patents – objectives and benefits of patent – Concept, features of patent, Inventive step, Specification – Types of patent application, process E-filling – Examination of patent – Grant of patent, Revocation, Equitable Assignments. Licenses – Licensing of related patents – patent agents, – Registration of patent agents.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1:	Develop a suitable research process to solve real-time problems.	Apply
CO2:	Apply appropriate methods to collect qualitative and quantitative data for analysis.	Apply
CO3:	Apply appropriate statistical tools to analyze data and solve research problems.	Apply
CO4:	Describe the types and features of intellectual property and its role in IPR establishment.	Apply
CO5:	Illustrate the patent procedures, E-filling, register of patents, and licensing of patents.	Apply

TEXT BOOKS:

1	Cooper Donald, R., Schindler Pamela, S., and Sharma, J.K., "Business Research Methods", Tata McGraw Hill Education, Eleventh Edition, 2012.
2	Catherine J. Holland, Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets, Entrepreneur Press, 2007.

REFERENCES:

1	David Hunt, Long Nguyen, Matthew Rodgers, Patent Searching: Tools & Techniques, Wiley, 2007.
2	The Institute of Company Secretaries of India, Statutory body under an Act of Parliament, Professional Programme Intellectual Property Rights, Law and Practice, September 2013.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PSO1	PSO2
CO1	3	3	1	1	1	1
CO2	3	3	1	1	1	1
CO3	3	3	1	1	1	1
CO4	3	3	1	1	1	1
CO5	3	3	1	1	1	1
Avg.	**3**	**3**	**1**	**1**	**1**	**1**

1 - Low, 2 - Medium, 3 - High

IS24T21	FIRE ENGINEERING AND EXPLOSION CONTROL	Category	L	T	P	C
		PCC	3	0	0	3

PREREQUISITE

A basic understanding of safety protocols, hazard management, and risk assessment in industrial environments.

OBJECTIVES:

- To recollect about the fire properties of solid, liquid and gases and understand the principle of fire and combustion Theory.
- To get knowledge about the fire prevention and fire protection systems.
- To gain knowledge on different sources of ignition, classes of fires and their extinguishing medium
- To Able to know the objective of building fire safety and relevant standards.
- To Apply the principles of explosion and understand about their protecting systems.

UNIT - I	PHYSICS AND CHEMISTRY OF FIRE	(9)

Fire properties of solid, liquid and gases - fire spread - toxicity of products of combustion - theory of combustion and explosion - vapour clouds - flash fire - jet fires - pool fires - unconfined vapour cloud explosion, shock waves - auto - ignition - boiling liquid expanding vapour explosion - case studies - Flixborough, Mexico disaster, Pasadena Texas, Piper Alpha, Peterborough & Bombay Victoria dock ship explosions.

UNIT - II	FIRE PREVENTION AND PROTECTION	(9)

Sources of ignition - fire triangle - principles of fire extinguishing - active and passive fire protection systems - various classes of fires - A, B, C, D - types of fire extinguishers - fire stoppers - hydrant pipes – hoses - monitors - fire watchers - layout of stand pipes - fire station - fire alarms and sirens - maintenance of fire trucks - foam generators - escape from fire rescue operations - fire drills - notice - first aid for burns.

UNIT - III	INDUSTRIAL FIRE PROTECTION SYSTEMS	(9)

Sprinkler - hydrants - stand pipes - special fire suppression systems like deluge and emulsifier, selection criteria of the above installations, reliability, maintenance, evaluation and standards - alarm and detection systems. Other suppression systems - CO_2 system, foam system, dry chemical powder (DCP) system and halon system - need for halon replacement - smoke venting. Portable extinguishers - flammable liquids - tank farms - indices of inflammability - fire fighting

UNIT - IV	BUILDING FIRE SAFETY	(9)

Objectives of fire safe building design, fire load, fire resistant material and fire testing - structural fire protection - structural integrity - concept of egress design - exits - width calculations - fire certificates - fire safety requirements for high rise buildings - snookers

UNIT - V	EXPLOSION PROTECTING SYSTEMS	(9)

Principles of explosion - detonation and blast waves - explosion parameters - Explosion Protection, Containment, Flame Arrestors, isolation, suppression, venting, explosion relief of large enclosure - explosion venting - inert gases, plant for generation of inert gas - rupture disc in process vessels and lines explosion, suppression system based on carbon dioxide (CO 2) and halons - hazards in LPG, ammonia (NH_3), sulphur dioxide (SO_3), chlorine (Cl_2) etc.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Recall about the fire properties of solid, liquid and gases and understand the principle of fire and combustion Theory.	Understand

CO2	Gain knowledge about the fire prevention and fire protection systems.	Understand
CO3	Acquire knowledge on different sources of ignition, classes of fires and their extinguishing medium	. Understand
CO4	Ability to know the objective of building fire safety and relevant standards.	Understand
CO5	Apply the principles of explosion and understand about their protecting systems.	Apply

TEXT BOOKS:

1. Derek, James, Fire Prevention Hand Book, Butter Worths and Company,London, Ninth edition, 2016 .
2. Gupta, R.S., Hand Book of Fire Technology, Orient Longman, Bombay, Second Edition, 1993.

REFERENCES:

1. Accident Prevention manual for industrial operations, N.S.C., Chicago,Second Edition,1982.
2. DinkoTuhtar, Fire and explosion Protection,E.Horwood, Second Edition, 1989
3. Davis Daniel et al, Hand Book of fire technology.
4. Fire fighters hazardous materials reference book for Fire Prevention in Factories, Van Nostrand Rein Hold, Second Edition, New York, 1991.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	**1**	**2**	**2**	**3**	-	-	-	-	-	-	-	**2**	**3**
CO2	**1**	**2**	**2**	**3**	-	-	-	-	-	-	-	**2**	**3**
CO3	**1**	**2**	**2**	**3**	-	-	-	-	-	-	-	**2**	**3**
CO4	**1**	**2**	**2**	**3**	-	-	-	-	-	-	-	**2**	**3**
CO5	**1**	**2**	**2**	**3**	-	-	-	-	-	-	-	**2**	**3**
Avg.	**1**	**2**	**2**	**3**	-	-	-	-	-	-	-	**2**	**3**

1-low, 2-medium, 3-high

IS24T22	ELECTRICAL SAFETY	Category	L	T	P	C
		PCC	3	0	0	3

PREREQUISITE

Basic understanding of physical principles related to electricity and electromagnetism.

OBJECTIVES:

- To make known the basic concepts in electrical circuit and hazards involved in it.
- To study the different types of electrical hazards in industries
- To obtain knowledge about the different types of protection systems
- To apply the knowledge in the selection, installation, operation and maintenance of portable tools.
- To categorize the different hazardous zones in Industries.

UNIT - I	CONCEPTS AND STATUTORY REQUIREMENTS	(9)

Introduction - electrostatics, electro magnetism, stored energy, energy radiation and electromagnetic interference - Working principles of electrical equipment - Indian electricity act and rules - statutory requirements from electrical inspectorate - International standards on electrical safety - first aid - cardio pulmonary resuscitation(CPR).

UNIT - II	ELECTRICAL HAZARDS	(9)

Primary and secondary hazards - shocks, burns, scalds, falls - human safety in the use of electricity.

Energy leakage - clearances and insulation - classes of insulation - voltage classifications - excess energy - current surges - Safety in handling of war equipments - over current and short circuit current - heating effects of current - electromagnetic forces - corona effect - static electricity - definition, sources, hazardous conditions, control, electrical causes of fire and explosion - ionization, spark and arc-ignition energy - national electrical safety code ANSI.High voltage Hazards,

Lightning, hazards, lightning arrestor, installation - earthing, specifications, earth resistance, earth pit maintenance

UNIT - III	PROTECTION SYSTEMS	(9)

Fuse, circuit breakers and overload relays - protection against over voltage and under voltage - safe limits of amperage – voltage - safe distance from lines - capacity and protection of conductor - joints and connections, overload and short circuit protection - no load protection - earth fault protection.

FRLS insulation - insulation and continuity test - system grounding - equipment grounding - earth leakage circuit breaker (ELCB) - cable wires - maintenance of ground - ground fault circuit interrupter - use of low voltage - electrical guards -Personal protective equipment - safety in handling hand held electrical appliances tools and medical equipments.

UNIT - IV	SELECTION, INSTALLATION, OPERATION AND MAINTENANCE	(9)

Role of environment in selection - safety aspects in application - protection and interlock - self diagnostic features and fail safe concepts - lock out and work permit system - discharge rod and earthing devices - safety in the use of portable tools - cabling and cable joints - preventive maintenance.

UNIT - V	HAZARDOUS ZONES	(9)

Classification of hazardous zone - Intrinsically safe and explosion proof electrical apparatus - increase safe equipment -their selection for different zones - temperature classification - grouping of gases - use of barriers and isolators -equipment certifying agencies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Familiarize the basic concepts in electrical circuit and hazards involved in it.	Remember
CO2	Analyze the different types of electrical hazards in industries	Analyze

CO3	Acquire knowledge about the different types of protection systems.	Understand
CO4	Apply the knowledge in the selection, installation, operation and maintenance of portable tools	Apply
CO5	Classify the different hazardous zones in Industries.	Understand

TEXT BOOKS:

1. Dr.Massim A.G. Mitolo., Electrical safety of Low voltage systems, McGraw Hill, Second Edition, 2009
2. Accident prevention manual for industrial operations, N.S.C., Chicago, Third edition,2008.

REFERENCES:

1. Fordham Cooper, W., Electrical Safety Engineering., Butterworth and Company, London, Third edition,2002
2. Accident prevention manual for industrial operations, N.S.C., Chicago, Third edition,2008.
3. Indian Electricity Act and Rules, Government of India,2003
4. Power Engineers – Handbook of TNEB, Chennai, 1989.
5. Martin Glove Electrostatic Hazards in powder handling, Research Studies Pvt Ltd., England, Second Edition,1988.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO2	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO3	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO4	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO5	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
Avg.	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

1-low, 2-medium, 3-high

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IS24T23	OCCUPATIONAL HEALTH AND INDUSTRIAL HYGIENE	Category	L	T	P	C
		PCC	3	0	0	3

PREREQUISITE

Familiarity with the basic concepts of industrial hygiene, including hazard identification and control measures.

OBJECTIVES:

- To gain knowledge on the various physiological functions of our body, their effects and control
- To remember the various types of chemical hazards and their control methods.
- To study the various types of occupational diseases arising out of biological agents.
- To exhibit effectively about the occupational health and toxic nature among the employees and with society at large
- To remind about the physiology of work with the working environment.

UNIT - I	PHYSICAL HAZARDS	(9)

Noise, types, Industrial noise, compensation aspects, noise exposure regulation and control, properties of sound, occupational damage, risk factors, sound measuring instruments, octave band analyzer, noise networks, noise surveys, noise control programmes, industrial audiometry, hearing conservation programmes.

Vibration, types, effects, instruments, surveying procedure, permissible exposure limit and control.

Ionizing radiation, types, effects, monitoring instruments, control programmes, OSHA standard - non-ionizing radiations, effects, types, radar hazards, microwaves and radio-waves, lasers TLV - cold environments, hypothermia, wind chill index, control measures - hot environments, thermal comfort, heat stress indices, acclimatization, estimation and control.

UNIT - II	CHEMICAL HAZARDS	(9)

Recognition of chemical hazards - dust, fumes, mist, vapor, fog, gases, types, concentration, Exposure vs dose, TLV - Methods of Evaluation, process or operation description, field survey, sampling methodology, Industrial hygiene calculations, Comparison with OSHAS Standard.

Air Sampling instruments, types, measurement procedures, instruments procedures, gas and vapor monitors, dust sample collection devices, personal sampling.

Methods of Control - engineering control, design, maintenance considerations, design specifications - general control methods - training and education

UNIT - III	BIOLOGICAL AND ERGONOMICAL HAZARDS	(9)

Classification of Bio-hazardous agents - examples, bacterial agents, rickettsial and chlamydial agents, viral agents, fungal, parasitic agents and infectious diseases - biohazard control programmes, employee health programmes - laboratory safety programmes - animal care and handling - biological safety cabinets - building design.

Work Related Musculoskeletal Disorders - carpal tunnel syndrome (CTS) - Tendon pain - disorders of the neck - back injuries.

UNIT - IV	OCCUPATIONAL HEALTH AND TOXICOLOGY	(9)

Concept and spectrum of health - functional units and activities of occupational health services, pre - employment and post - employment medical examinations - occupational related diseases, levels of prevention of diseases, notifiable occupational diseases such as silicosis, asbestosis, pneumoconiosis, siderosis, anthracosis, aluminosis and anthrax.

Lead - nickel, chromium and manganese toxicity, gas poisoning (such as CO, ammonia, coal and dust etc) their effects and prevention - cardio pulmonary resuscitation, audiometric tests, eye tests, vital function tests.

Industrial toxicology, local, systemic and chronic effects, temporary and cumulative effects, carcinogens entry into human systems.

UNIT - V	OCCUPATIONAL PHYSIOLOGY	(9)

Man as a system component - allocation of functions - efficiency - occupational work capacity - aerobic and

anaerobic work - evaluation of physiological requirements of jobs - parameters of measurements - categorization of job heaviness - work organization - stress - strain – fatigue - rest pauses - shift work - personal hygiene

TOTAL: 45 PERIODS

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

COs	Course Outcome	Cognitive Level
CO1	Acquire knowledge on the various physiological functions of our body, their effects and control.	Understand
CO2	Recall the various types of chemical hazards and their control methods.	Understand
CO3	Analyze the various types of occupational diseases arising out of biological agents.	Analyze
CO4	Demonstrate effectively about the occupational health and toxic nature among the employees and with society at large.	Apply
CO5	Recall about the physiology of work with the working environment.	Understand

REFERENCES:

1. Hand book of Occupational Safety and Health, National Safety Council, Chicago,Second Edition, 2012.
2. Encyclopedia of Occupational Health and Safety, Vol - I and II, International Labour Office,Geneva, Fourth Edition, 2000.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	**1**	**-**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**
CO2	**1**	**-**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**
CO3	**1**	**-**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**
CO4	**1**	**-**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**
CO5	**1**	**-**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**
Avg.	**1**	**-**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**

1-low, 2-medium, 3-high

IS24P21	INDUSTRIAL SAFETY LABORATORY	Category	L	T	P	C
		PCC	0	0	3	2

PREREQUISITE

Knowledge of basic laboratory safety procedures and protocols, including the use of personal protective equipment (PPE) and safe handling of materials

OBJECTIVES:

- To study about the various equipments to bring out the safety environment in the industry.
- To put on knowledge about the various sources of particular matter and assess the impact of air pollution
- To be trained about the usage of fire extinguishers and its operation.
- To attain knowledge on insulation and earth resistance
- To express the use of software and hence to predict the real situations on major accidents.

LIST OF EXPERIMENTS

1. Carryout the Noise level Measurement for a given area and compare with the standards.
2. Find the illumination level of a given area using the Lux meter.
3. Find the percentage of CO_2, CO, SO_2 and O_2 present in the exhaust gas of a given diesel/petrol engine using Exhaust gas analyzer under different loading conditions.
4. Find the total mass of the suspended particulate matter in a given area using the respirable dust sampler.
5. Determine the earth resistance and resistivity by using the earth resistance for the given soil.
6. Find the insulation resistance for the given motor and cable using insulation tester.
7. Identify the given PPE's and explain in detail about its usage.
8. Identify the various types of fire extinguishers and elaborate in detail about its operation and method of extinguishing.
9. Find the toxic and flammable level of the given chemical using dispersion modeling (ALOHA) software.
10. What is meant by First-aid and what are the items to be kept in the first-aid box? Explain briefly.

LIST OF EQUIPMENTS

1. Noise level meter - 1 no.
2. Lux meter - 1 no.
3. Exhaust gas analyzer- 1 no.
4. Respirable dust sampler - 1 no.
5. Earth resistance tester - 1no.
6. Insulation tester - 1no.
7. PPE se - 1no.
8. Fire extinguisher se - 1no.
9. ALOHA Software (*on-line – trial version)- 1no.
10. First-aid kit - 1no.

TOTAL: 30 PERIODS

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

COs	Course Outcome	Cognitive Level
CO1	Analyze about the various equipments to bring out the safety environment in the industry.	Analyze
CO2	Gain knowledge about the various sources of particular matter and assess the impact of air pollution.	Understand
CO3	Learn about the usage of fire extinguishers and its operation.	Understand
CO4	Acquire knowledge on insulation and earth resistance.	Understand
CO5	Demonstrate the use of software and hence to predict the real situations on major accidents.	Apply

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	**1**	**2**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO2	**1**	**2**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO3	**1**	**2**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO4	**1**	**2**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO5	**1**	**2**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
Avg.	**1**	**2**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

1-low, 2-medium, 3-high

IS24P22	TECHNICAL PRESENTATION - II	Category	L	T	P	C
		EEC	0	0	3	2

PREREQUISITE

Familiarity with presentation software such as Microsoft PowerPoint, Google Slides, or other tools used to create technical presentations.

OBJECTIVES:

- To recognize the problems in general area of interest by the student.
- To integrate the area / problem by referring journals, conference proceedings etc.
- To improve the collective skills between theoretical knowledge and real time problems.
- To grow the knowledge on the problem by presentation and review.
  To get idea on report writing and presentation.

- The students have to refer the journals and conference proceedings and collect the published literature.
- By mutual discussions with the faculty in-charge the student can decide a topic related to area /subject.
- The student is expected to collect at least 20 such research papers published in the last 5 years.
- Using OHP / Power Point, the student has to make presentation for 20 minutes followed by 10 minutes discussion.
- The students should visit an industry, has to make five presentations and a report of the same in the semester.
- The student has to write a technical report for about 30 - 50 pages (Title page, One page Abstract, Review of Research paper under various sub - headings, concluding remarks and list of references). The technical report has to be submitted to the course coordinator one week before the final presentation, after the approval of the faculty in-charge.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Identify the problems in general area of interest by the student.	Understand
CO2	Explore the area / problem by referring journals, conference proceedings etc.	Understand
CO3	Enhance the collective skills between theoretical knowledge and real time problems.	Understand
CO4	Gain knowledge on the area by presentation and review.	Understand
CO5	Acquire idea on report writing and presentation related to the area.	Understand

Mapping of COs with POs and PSOs													
COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**2**	**3**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO2	**2**	**3**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO3	**2**	**3**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO4	**2**	**3**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO5	**2**	**3**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
Avg.	**2**	**3**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
1-low, 2-medium, 3-high													

IS24E01	SAFETY IN CONSTRUCTION	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

Understanding of construction processes, methods, and terminology.

OBJECTIVES:

- To express about the accident causes and the management systems.
- To make known about the hazards in construction and their prevention.
- To study the safety procedure for working at heights during construction.
- To pertain knowledge about selecting, operations, inspection and testing of various construction machinery.
- To record out construction regulations and Indian standards for construction and demolition work.

UNIT - I	ACCIDENTS CAUSES AND MANAGEMENT SYSTEMS	(9)

Problems impeding safety in construction industry - causes of fatal accidents, types and causes of accidents related to various construction activities, human factors associated with these accident - construction regulations, contractual clauses - Pre contract activates, preconstruction meeting - design aids for safe construction - permits to work - quality assurance in construction – compensation - recording of accidents and safety measures - education and training.

UNIT - II	HAZARDS OF CONSTRUCTION AND PREVENTION	(9)

Excavations, basement and wide excavation, trenches, shafts - scaffolding , types, causes of accidents, scaffold inspection checklist - false work - erection of structural frame work, dismantling - tunneling - blasting, pre blast and post blast inspection - confined spaces - working on contaminated sites - work over water - road works - power plant constructions - construction of high rise buildings.`

UNIT - III	WORKING AT HEIGHTS	(9)

Fall protection in construction OSHA 3146 - OSHA requirement for working at heights, Safe access and egress - safe use of ladders - Scaffoldings , requirement for safe work platforms, stairways, gangways and ramps - fall prevention and fall protection , safety belts, safety nets, fall arrestors, controlled access zones, safety monitoring systems - working on fragile roofs, work permit systems, height pass - accident case studies.

UNIT - IV	SAFETY IN CONSTRUCTION MACHINERY	(9)

Selection, operation, inspection and testing of hoisting cranes, mobile cranes, tower cranes, crane inspection checklist - builder's hoist, winches, chain pulley blocks - use of conveyors - concrete mixers, concrete vibrators - safety in earth moving equipment, excavators, dozers, loaders, dumpers, motor grader, concrete pumps, welding machines, use of portable electrical tools, drills, grinding tools, manual handling scaffolding, hoisting cranes - use of conveyors and mobile cranes - manual handling.

UNIT - V	SAFETY IN DEMOLITION WORK	(9)

Safety in demolition work, manual, mechanical, using explosive - keys to safe demolition, pre survey inspection, method statement, site supervision, safe clearance zone, health hazards from demolition - Indian standard - trusses, girders and beams - first aid - fire hazards and preventing methods - interesting experiences at the construction site against the fire accidents.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Demonstrate about the accident causes and the management systems.	*Understand*
CO2	Familiarize about the hazards in construction and their prevention.	*Understand*

CO3	Analyze the safety procedure for working at heights during construction.	*Analyze*
CO4	Apply knowledge selecting, operations, inspection and testing of various construction machinery.	*Apply*
CO5	List out construction regulations and Indian standards for construction and demolition work.	*Remember*

TEXT BOOKS:

1. Rita Yi Man Li, Sun WahPoon, Construction Safety, Springer Heidelberg New York, Dordrecht London, First Edition, 2013.
2. Safety Handbook for the Building and Construction, Incolink (Australian constructionassociation), Australia,First Edition, 2013.

REFERENCES:

1. Charles D. Reese and James V. Edison, Handbook of OSHA Construction safety and health, CRC press, UK, Second Edition, 2006.
2. JnatheaD.Sime, Safety in the Build Environment, London, Second Edition, 1988.
3. Davies, V.J., and Thomas, K., Construction Safety Hand Book, Thomas Telford Ltd., London, 1990.
4. Hudson, R.,Construction hazard and Safety Hand book, Butter Worth's, New Delhi,Second Edition, 1985.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	**1**	**-**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**
CO2	**1**	**-**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**
CO3	**1**	**-**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**
CO4	**1**	**-**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**
CO5	**1**	**-**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**
Avg.	**1**	**-**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**

1-low, 2-medium, 3-high

IS24E02	DOCK SAFETY	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

Knowledge of basic maritime operations, including docking procedures and vessel handling.

OBJECTIVES:

- To establish the history of legislation towards dock safety.
- To call to mind about the cargo ships and the safety precautions in the use of transport equipment.
- To organize the different types of lifting appliances and its construction and maintenance
- To get knowledge on various types of transport equipment and their handling of cargos.
- To apply the emergency action plan for fire and explosions and understand about the dock regulations.

UNIT - I	HISTORY OF SAFETY LEGISLATION	(9)

History of dock safety statues in India-background of present dock safety statues- dock workers (safety, health and welfare) act 1986 and the rules and regulations framed there under, other statues like marking of heavy packages act 1951 and the rules framed there under - manufacture, storage and import of hazardous chemicals. Rules 1989 framed under the environment (protection) act, 1989 - few cases laws to interpret the terms used in the dock safety statues.

Responsibility of different agencies for safety, health and welfare involved in dock work - responsibilities of port authorities - dock labour board - owner of ship master, agent of ship - owner of lifting appliances and loose gear etc. - employers of dock workers like stevedores - clearing and forwarding agents - competent persons and dock worker. Forums for promoting safety and health in ports - safe committees and advisory committees, their functions, training of dock workers.

UNIT - II	WORKING ON BOARD THE SHIP	(9)

Types of cargo ships - working on board ships - Safety in handling of hatch beams - hatch covers including its marking, mechanical operated hatch covers of different types and its safety features - safety in chipping and painting operations on board ships - safe means of accesses - safety in storage etc. - illumination of decks and in holds - hazards in working inside the hold of the ship and on decks - safety precautions needed - safety in use of transport equipment - internal combustible engines like fort-lift trucks - pay loaders etc. Working with electricity and electrical management - storages - types, hazardous cargo.

UNIT - III	LIFTING APPLIANCES	(9)

Different types of lifting appliances - construction, maintenance and use, various methods of rigging of derricks, safety in the use of container handling / lifting appliances like portainers, transtainer, top lift trucks and other containers - testing and examination of lifting appliances - portainers - transtainers - top lift trucks - derricks in different rigging etc. Use and care of synthetic and natural fiber ropes - wire rope chains, different types of slings and loose gears.

UNIT - IV	TRANSPORT EQUIPMENT	(9)

The different types of equipment for transporting containers and safety in their use safety in the use of self-loading container vehicles, container side lifter and fork lift truck, dock railways, conveyors and cranes. Safe use of special lift trucks inside containers - testing, examination and inspection of containers - carriage of dangerous goods in containers and maintenance and certification of containers for safe operation Handling of different types of cargo - stacking and un stacking both on board the ship and ashore - loading and unloading of cargo identification of berths/walking for transfer operation of specific chemical from ship to shore and vice versa - restriction of loading and unloading operations.

UNIT - V	EMERGENCY ACTION PLAN AND DOCK WORKERS (SHW) REGULATIONS 1990	(9)

Emergency action Plans for fire and explosions - collapse of lifting appliances and buildings, sheds etc. - gas leakages and precautions concerning spillage of dangerous goods etc. - Preparation of on-site emergency plan and safety report. Dock workers (SHW) rules and regulations 1990 - related to lifting appliances, Container handling, loading and unloading, handling of hatch coverings and beams, cargo handling, conveyors, dock

railways, forklift.

TOTAL: 45 PERIODS

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

COs	Course Outcome	Cognitive Level
CO1	Determine the history of legislation towards dock safety.	Understand
CO2	Recall about the cargo ships and the safety precautions in the use of transport equipment.	Understand
CO3	Classify the different types of lifting appliances and its construction and maintenance.	. Understand
CO4	Acquire knowledge on various types of transport equipment and their handling of cargos.	Understand
CO5	Apply the emergency action plan for fire and explosions and understand about the dock regulations.	Apply

TEXT BOOKS:

1. Bindra S R ,Course in Dock and Harbour Engineering, DhanpatRai Publications (P) Ltd., New Delhi, 2013.
2. Srinivasan ,Harbour, Dock and Tunnel Engineering, Charotar Publishing House Pvt. Limited, New Delhi, 29th Edition, 2011.

REFERENCES:

1. International Labour Organization, Safety and Health in Dock Work, New York,second edition, 1997.
2. Safety and Health in Dock work, ILO, Third edition, 1992
3. Indian Dock Labourers Act 1934 with rules 1948, Law Publishers (India) Pvt. Ltd., Allahabad, Second Edition, 1932.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO2	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO3	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO4	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO5	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
Avg.	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

1-low, 2-medium, 3-high

IS24E03	ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

Familiarity with foundational concepts in machine learning can be beneficial for understanding more advanced AI techniques.

OBJECTIVES:

- To investigate about the measuring intelligence, historical back ground and its applications
- To remind the cognitive psychology for identifying real objects and factory vision systems
- To get knowledge engineering based on fuzzy logic and sematic networks.
- To pertain the concept of expert system for knowledge acquisition, system structure and its applications.
- To make known about the neural network architecture and its learning methods.

UNIT - I	INTRODUCTION	(9)

Intelligence - definition, types cognitive aspect approach, measuring intelligence - early efforts, IQ and AI: aspects of intelligence - learning, problem solving, creativity, behavior and biology. Artificial intelligence: Historical background, applications of AI, objections and myths, AI languages: Introduction to PROLOG and LISP.

UNIT - II	COGNITIVE PSYCHOLOGY	(9)

The mind - informative and cybernetics, components for thought, modes of perception - visual, auditory and other systems: memory mechanisms, problem solving - planning, search, the GPS systems; types of learning - rote, parameter, method and concept: Game playing, reasoning, Artificial Vision - picture processing - identifying real objects; Vision programs, factory vision systems.

UNIT - III	KNOWLEDGE ENGINEERING	(9)

Introduction - role of knowledge engineer, knowledge representation - psychology, production rules, logic and programming, Common sense and fuzzy logic, semantic networks, learning systems.

UNIT - IV	EXPERT SYSTEMS	(9)

Introduction, knowledge acquisition for expert system, features of expert systems - system structure, inference engines, uncertainties, memory mechanisms, range of applications, actual expert systems - VP expert. Assignment - development of a simple expert system.

UNIT - V	INTRODUCTION TO NEURAL NETWORKS	(9)

Neural Network Architecture - Learning methods - Architecture of a Back Propagation Network - Selection of parameters - Simple variation of BPN.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Explore about the measuring intelligence, historical back ground and its applications.	Understand
CO2	Recall the cognitive psychology for identifying real objects and factory vision systems	Understand
CO3	Acquire knowledge engineering based on fuzzy logic and sematic networks.	Remember
CO4	Apply the concept of expert system for knowledge acquisition, system structure and its applications.	Apply

CO5	Familiarize about the neural network architecture and its learning methods.	Understand

TEXT BOOKS:

1. Elaine, R., Kevin and Shivashankar B Nair., Artificial Intelligence 3E (Sie), Tata McGraw Hill, US, Third Edition, 2019.
2. Rajasekaran, S and VijayalakshmiPai., G.A, Neural Networks, Fuzzy Logic and Evolutionary Algorithms - Synthesis and Applications, PHI, Second Edition, 2017.

REFERENCES:

1. Rajendra Akerkar., Introduction to Artificial Intelligence., PHI Learning , Second Edition, 2014.
2. Dan W.Patterson., Introduction to Artificial Intelligence and Expert Systems, Prentice Hall of India, New Delhi,Third revision, 1992.
3. Winston, P.H., Artificial Intelligence, Addison Wesley, UK, Third Edition, 1990.
4. Nilsson, N.J., Principles of AI, Narosa Publishing House, UK, Reprint, 1990.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**
CO2	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**
CO3	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**
CO4	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**
CO5	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**
Avg.	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**3**

1-low, 2-medium, 3-high

IS24E04	PLANT LAYOUT AND MATERIALS HANDLING	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

Knowledge of logistics, inventory management, and supply chain principles can be beneficial for understanding the broader context of materials handling.

OBJECTIVES:

- To get knowledge on plant locations and the safe storage of chemicals.
- To study the plant layout and their safety for various types of process industry.
- To decide the principles of good ventilation and illumination
- To grow knowledge on the benefits of an efficient material handling system and lifting tackles.
- To categorize the various types of mechanical material handling devices.

UNIT - I	PLANT LOCATION	(9)

Selection of plant locations, territorial parameters, considerations of land, water, electricity, location for waste treatment and disposal, further expansions. Safe location of chemical storages, LPG, LNG, CNG, acetylene, ammonia, chlorine, explosives and propellants.

UNIT - II	PLANT LAYOUT	(9)

Safe layout, equipment layout, safety system, fire hydrant locations, fire service rooms, facilities for safe effluent disposal and treatment tanks, site considerations, approach roads, plant railway lines, security towers. Safe layout for process industries, engineering industry, construction sites, pharmaceuticals, pesticides, fertilizers, refineries, food processing, nuclear power stations, thermal power stations, metal powders manufacturing, fireworks and match works.

UNIT - III	WORKING CONDITIONS	(9)

Principles of good ventilation, purpose, physiological and comfort level types, local and exhaust ventilation, hood and duct design, air conditioning, ventilation standards, application.

Purpose of lighting, types, advantages of good illumination, glare and its effect, lighting requirements for various work, standards - Housekeeping, principles of 5S.

UNIT - IV	MANUAL MATERIAL HANDLING AND LIFTING TACKLES	(9)

Preventing common injuries, lifting by hand, team lifting and carrying, handling specific shape machines and other heavy objects - accessories for manual handling, hand tools, jacks, hand trucks, dollies and wheel barrows - storage of specific materials - problems with hazardous materials, liquids, solids – storage and handling of cryogenic liquids - shipping and receiving, stock picking, dock boards, machine and tools, steel strapping and sacking, glass and nails, pitch and glue, boxes and cartons and car loading - personal protection - ergonomic considerations.

Fiber rope, types, strength and working load inspection, rope in use, rope in storage - wire rope, construction, design factors, deterioration causes, sheaves and drums, lubrication, overloading, rope fitting, inspection and replacement – slings, types, method of attachment, rated capacities, alloy chain slings, hooks and attachment, inspection.

UNIT - V	MECHANICAL MATERIAL HANDLING	(9)

Hoisting apparatus, types - cranes, types, design and construction, guards and limit devices, signals, operating rules, maintenance safety rules, inspection and inspection checklist - conveyors, precautions, types, applications.

Powered industrial trucks, requirements, operating principles, operators selection and training and performance test, inspection and maintenance, electric trucks, gasoline operated trucks, LPG trucks – power elevators, types of drives, hoist way and machine room emergency procedure, requirements for the handicapped, types- Escalator, safety devices and brakes, moving walks - man lifts, construction, brakes, inspection.

TOTAL: 45 PERIODS

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

COs	Course Outcome	Cognitive Level
CO1	Acquire knowledge on plant locations and the safe storage of chemicals.	Understand
CO2	Analyze the plant layout and their safety for various types of process industry.	Analyze
CO3	Determine the principles of good ventilation and illumination	. Understand
CO4	Gain knowledge on the benefits of an efficient material handling system and lifting tackles.	Understand
CO5	Classify the various types of mechanical material handling devices.	Understand

TEXT BOOKS:

1. Apple M. James., Plant layout and material handling, John Wiley & sons, New York,Third edition, 1977
2. Reymond, A.Kulwice.,Material Handling Hand Book - II, John Wiley and Sons, New York, 1985.

REFERENCES:

1. Safety and good housekeeping, N.P.C. New Delhi, 1985.
2. Industrial ventilation (A manual for recommended practice), American conference of government industrial Hygiene, Thirty Edition, USA, 1984.
3. Rudenko, N., Material handling Equipments, Mir Publishers, Fifth Edition, 1981.
4. Accident prevention manual for industrial operations, N.S.C., Fourth Edition, Chicago, 1982.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO2	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO3	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO4	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO5	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
Avg.	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**

1-low, 2-medium, 3-high

IS24E05	ADDITIVE MANUFACTURING	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

Proficiency in creating and interpreting engineering drawings or using computer-aided design (CAD) software, essential for designing 3D models.

OBJECTIVES:

- To get the concepts of rapid prototyping in product design and development.
- To choose the suitable liquid based rapid prototyping system for a specific application.
- To pick the suitable solid based rapid prototyping system for a specific application.
- To opt for the suitable powder based rapid prototyping system for a specific application.
- To pertain the concepts of rapid prototyping in product design and development.

UNIT - I	INTRODUCTION TO ADDITIVE MANUFACTURING	(9)

Introduction to Additive Manufacturing: Evolution, fundamental fabrication processes, CAD for RPT, product design and rapid product development - Need for time compression in product development - Conceptual design - Detail design, Prototype fundamentals - Fundamentals of RP systems – RP process chain - 3D modelling -3D solid modeling software and their role in RPT - Data format - STL files- History of RP systems - Classification of RP systems - Benefits of RPT.

UNIT - II	LIQUID BASED RP SYSTEMS	(9)

Liquid based RP systems: Stereo Lithography Apparatus (SLA): Principle, Photo polymers, Post processes, Process parameters, Machine details, Advantages. Solid Ground Curing (SGC): Principle, Process parameters, Process details, Machine details, Limitations. Solid Creation System (SCS): Principle, Process parameters, Process details, Machine details, Applications.

UNIT - III	SOLID BASED RP SYSTEMS	(9)

Solid based RP systems: Fusion Deposition Modeling (FDM): Principle, Raw materials, BASS, Water soluble support system, Process parameters, Machine details, Advantages and limitations. Laminated Object Manufacturing (LOM): Principle, Process parameters, Process details, Advantages and limitations. Solid Deposition Manufacturing (SDM): Principle, Process parameters, Process details, Machine details, Applications.

UNIT - IV	POWDER BASED RP SYSTEMS	(9)

Powder based RP systems: Selective Laser Sintering (SLS): Principle, Process parameters, Process details, Machine details, Advantages and applications. 3-Dimensional Printers (3DP): Principle, Process parameters, Process details, Machine details, Advantages and limitations. Laser Engineered Net Shaping (LENS): Principle, Process details, Advantages and applications.

UNIT - V	RAPID TOOLING AND APPLICATIONS OF RP	(9)

Rapid Tooling and Applications of RP-Different input data types- Direct Rapid Tooling, Indirect Rapid Tooling: Soft tooling and Hard tooling. Applications of RP in Product design, Automotive industry, and Medical field – Conversion of CT/MRI scan data - Customized implant - Case studies -Reverse engineering.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Apply the concepts of rapid prototyping in product design and development	*Apply*
CO2	Select the suitable liquid based rapid prototyping system for a specific application .	*Apply*
CO3	Select the suitable solid based rapid prototyping system for a specific application .	*Apply*

CO4	Select the suitable powder based rapid prototyping system for a specific application	*Apply*
CO5	Apply the concepts of rapid prototyping in product design and development.	*Apply*

TEXT BOOKS:

1. Chua.C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and Applications", World scientific, Newjersy, 2010.
2. Pham D.T. and Dimov S.S, "Rapid Manufacturing", Springer -Verlag, London, 2011.

REFERENCES:

1. Amitabha Ghosh, "Rapid Manufacturing a brief Introduction", Affiliated East West Press, New Delhi, 2011.
2. Gibson, I., Rosen, D.W. and Stucker, B., Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.
3. Liou, L.W. and Liou, F.W., Rapid Prototyping and Engineering applications: A tool box for prototype development, CRC Press, Second Edition, 2011

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO2	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO3	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO4	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO5	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
Avg.	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**

1-low, 2-medium, 3-high

IS24E06	ADVANCED MATERIALS	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

Knowledge of mechanical behavior of materials, including stress, strain, and deformation.

OBJECTIVES:

- To grasp the construction of composite materials.
- To extend the production process of polymer matrix composites.
- To obtain to build the different manufacturing methods.
- To discover the shape memory alloys and applications.
- To learn the nano materials and applications.

UNIT - I	INTRODUCTION	(9)

INTRODUCTION TO COMPOSITE MATERIALS: Introduction, classification: polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon–carbon composites, fiberreinforced composites and nature-made composites, and applications.

REINFORCEMENTS: Fibres- glass, silica, kevlar, carbon, boron, silicon carbide, and born carbide fibres.

UNIT - II	POLYMER MATRIX COMPOSITE	(9)

Polymer composites, thermoplastics, thermosetting plastics, manufacturing of PMC, MMC & CCC and their applications.

UNIT - III	MANUFACTURING METHODS	(9)

Autoclave, tape production, moulding methods, filament winding, hand layup, pultrusion, RTM.

UNIT - IV	SHAPE MEMORY ALLOYS	(9)

FUNCTIONALLY GRADED MATERIALS: Types of functionally graded materials-classificationdifferent systems-preparation-properties and applications of functionally graded materials.

SHAPE MEMORY ALLOYS: Introduction-shape memory effect-classification of shape memory alloyscomposition-properties and applications of shape memory alloys.

UNIT - V	NANO MATERIALS	(9)

Introduction-properties at nano scales-advantages & disadvantages-applications in comparison with bulk materials (nano – structure, wires, tubes, composites). State of art nano advanced- topic delivered by student.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Comprehend the construction of composite materials	.Understand
CO2	Develop the production process of polymer matrix composites.	Analyze
CO3	Acquire to build the different manufacturing methods.	Understand
CO4	Explore the shape memory alloys and applications.	Understand
CO5	Discover the nano materials and applications.	Analyze

TEXT BOOKS:

1. Mechanics of Composite Materials / R. M. Jones/ McGraw Hill Company, New York, 1975.
2. Analysis of Laminated Composite Structures / L. R. Calcote/Van NostrandRainfold,NY 1969

REFERENCES:

1. Analysis and performance of fibre Composites /B. D. Agarwal and L. J. Broutman /Wiley-Interscience, New York, 1980
2. Mechanics of Composite Materials – Second Edition (Mechanical Engineering) /AutarK.Kaw / CRC Press
3. Nano material /A.K. Bandyopadyay, New age Publishers.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO2	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO3	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO4	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO5	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
Avg.	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**

1-low, 2-medium, 3-high

IS24E07	SAFETY IN MINES	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

Basic understanding of geological formations and mining geology, as it relates to identifying and managing geological hazards

OBJECTIVES:

- To get knowledge on open cast mines and safe handling of explosives.
- To obtain knowledge on underground mines and their working conditions.
- To express about the hazards and safety measures in tunneling.
- To investigate about the concept of risk assessment techniques
- To study about accident analysis and its management systems.

UNIT - I	OPEN CAST MINES	(9)

Causes and prevention of accident from: Heavy machinery, belt and bucket conveyors, drilling, hand tools - pneumatic systems, pumping, water, dust, electrical systems and fire prevention. Garage safety - accident reporting system - working condition - safe transportation - handling of explosives.

UNIT - II	UNDERGROUND MINES	(9)

Fall of roof and sides - effect of gases-fire and explosions - water flooding - warning sensors - gas detectors - occupational hazards - working conditions - winding and transportation.

UNIT - III	TUNNELLING	(9)

Hazards from: ground collapse, inundation and collapse of tunnel face, falls from platforms and danger from falling bodies. Atmospheric pollution (gases and dusts) - trapping - transport - noise - electrical hazards - noise and vibration from: pneumatic tools and other machines - ventilation and lighting - personal protective equipment.

UNIT - IV	RISK ASSESSMENT	(9)

Basic concepts of risk - reliability and hazard potential - elements of risk assessment - statistical methods - control charts - appraisal of advanced techniques - fault tree analysis - failure mode and effect analysis - quantitative structure - activity relationship analysis - fuzzy model for risk assessment.

UNIT - V	ACCIDENT ANALYSIS AND MANAGEMENT	(9)

Accidents classification and analysis - fatal, serious, minor and reportable accidents - safety audits - recent development of safety engineering approaches for mines - frequency rates - accident occurrence - investigation - measures for improving safety in mines - cost of accident - emergency preparedness - disaster management.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Acquire knowledge on open cast mines and safe handling of explosives.	Understand
CO2	Gain knowledge on underground mines and their working conditions.	Understand
CO3	Demonstrate about the hazards and safety measures in tunneling.	Understand
CO4	Analyze about the concept of risk assessment techniques	Analyze
CO5	Learn about accident analysis and its management systems.	Understand

TEXT BOOKS:

1. D**h**illon, S Balbir*Mine., safety- A modern Approach,* Springer Publication,2010.
2. Hartmann, *Introduction to mining engineering,* Wiley Publications, 2007.

REFERENCES:

1. Fred G. Bell, J. Laurance, *Mining and its impact on environment*, Taylor andFrancis,2006.
2. DGMS Circulars-Ministry of Labour, Government of India press, OR Lovely Prakashan-DHANBAD, 2002.
3. Kejiriwal, B.K., Safety in Mines, GyanPrakashan, Dhanbad, 2001.
4. Michael Karmis ed., Mine Health and Safety Management, SME, Littleton, Co.2001.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO2	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO3	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO4	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO5	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
Avg.	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

1-low, 2-medium, 3-high

IS24E08	FIREWORKS SAFETY	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

Basic knowledge of the principles and safety considerations of explosives and pyrotechnic materials.

OBJECTIVES:

- To obtain knowledge on the properties of the chemicals used in the fireworks.
- To make about the static charge and dust in fireworks factories.
- To keep in mind about the various types of process in risk related fireworks.
- To study the material handling techniques and transportation of explosives in fireworks
- To conclude the concepts of waste control and user safety in fireworks.

UNIT - I	PROPERTIES OF FIREWORKS CHEMICALS	(9)

Fire properties - potassium nitrate (KNO_3), potassium chlorate ($KClO_3$), barium nitrate ($BaNO_3$), calcium nitrate ($CaNO_3$), Sulphur (S), Phosphorous (P), Antimony (Sb), Pyro Aluminum (A1) powder - Reactions - metal powders, Borax, ammonia (NH_3) - Strontium Nitrate, Sodium Nitrate, Potassium per chloride. Fire and explosion, impact and friction sensitivity.

UNIT - II	STATIC CHARGE AND DUST	(9)

Concept - prevention - earthling - copper plates - dress materials - static charge meter lightning, causes - effects - hazards in fireworks factories - lightning arrestor: concept - installation - earth pit – maintenance - resistance - legal requirements - case studies.

Dust: size - respirable, non-respirable - biological barriers - hazards - personal protective equipment - pollution prevention.

UNIT - III	PROCESS SAFETY	(9)

Safe - quantity, mixing - filling - fuse cutting - fuse fixing – finishing - drying at various stages – packing - storage - hand tools - materials, layout: building - distances - factories act - explosive act and rules - fire prevention and control - risk related fireworks industries.

UNIT - IV	MATERIAL HANDLING	(9)

Manual handling - wheel barrows - trucks - bullock carts - cycles - automobiles - fuse handling - paper caps handling -nitric acid handling in snake eggs manufacture - handling the mix in this factory - material movement - godown - waste pit.

Transportation: Packing - magazine - design of vehicles for explosive transports loading into automobiles - transport restrictions - case studies - overhead power lines - driver habits - intermediate parking - fire extinguishers - loose chemicals handling and transport.

UNIT - V	WASTE CONTROL AND USER SAFETY	(9)

Concepts of wastes - wastes in fireworks – disposal - spillages - storage of residues.

Consumer anxiety - hazards in display - methods in other countries - fires, burns and scalds - sales outlets - restrictions -role of fire service.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Acquire knowledge on the properties of the chemicals used in the fireworks.	Understand
CO2	Familiarize about the static charge and dust in fireworks factories.	Understand
CO3	Recall about the various types of process in risk related fireworks.	Understand
CO4	Analyze the material handling techniques and transportation of explosives in fireworks	Analyze

CO5	Determine the concepts of waste control and user safety in fireworks	Understand

TEXT BOOKS:

1. Morgan J. Hurley, Daniel T. Gottuk, John R. Hall Jr., SFPE Handbook of Fire Protection Engineering , First Edition, 2015
2. John A. Purkiss, Long-Yuan Li , Fire Safety Engineering Design of Structures, CRC press, UK, Third Edition, 2013.

REFERENCES:

1. Proceedings of National seminar on Fireworks Safety - 1999, MSEC -1999.
2. Purkiss, J.A., Fireworks - Fire Safety Engineering,UK, Third Edition, 1996
3. Bill of Ofca, Fireworks Safety manual,1991
4. Ghosh, K.N., Principles of fireworks, Khatsuria, H., Sivakasi, Second Edition, 1987.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO2	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO3	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO4	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO5	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
Avg.	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

1-low, 2-medium, 3-high

IS24E09	WELDING ECONOMICS, MANAGEMENT AND SAFETY	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE
Understanding of fundamental welding processes, techniques, and equipment.

OBJECTIVES:

- To expand knowledge on various factors influencing the welding cost.
- To estimate the standard welding time using various methods for the welding processes.
- To estimate the welding cost for the different welding process.
- To get knowledge on various requirements on setting up a welding plant layout.
- To achieve knowledge on safety measures during welding processes and planning operations.

UNIT - I	FACTORS INFLUENCING WELDING ECONOMICS	(9)

Welding design- selection of electrodes, size, type and metal recovery – electrode efficiency, sub, thrown away electrodes – over welding and joint fit – up welding position - operation factor – jigs, fixtures, positioners, Operator efficiency.

UNIT - II	ESTIMATION OF WELDING TIME	(9)

Need for time standard – definition of standard time- various methods of computing standard time – analytical calculation – computerisation of time standards

UNIT - III	ESTIMATION ANDCOSTING FOR WELDING	(9)

Definition of terms – composition of welding costs, cost of consumables – labour cost – cost over heads - formulae for total cost – cost curves for different processes like GMAW, SAW, ESW, Mechanization in welding – job shop operation.

UNIT - IV	PROCESS AND PLANT LAY OUT	(9)

Process vs product lay out – construction – service consideration – employees- services, welding shop equipment, oxy acetylene stations- resistance welding stations – inert gas welding stations – arc welding stations – crane forges - jigs and fixtures; power tools - blast cleaning supplies- welding equipment repair shop - proper arrangement of the above in the welding shop for maximum convenience and ease of production.

UNIT - V	SAFE PRACTICES IN WELDING	(9)

Selection and installation of equipments, safe handling equipment - fire prevention- eye and face protection - respiratory protection - ventilation -protective extra clothing -electric shock- safety analysis.
Planning for welding operations, production control planning for welding processes- pre- production planning- routing - scheduling. Activating, monitoring, materials management in welding-Inventory control-Basic aspects of financial management and man-power planning.

TOTAL: 45 PERIODS

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

COs	Course Outcome	Cognitive Level
CO1	Gain knowledge on various factors influencing the welding cost.	Understand
CO2	Estimate the standard welding time using various methods for the welding processes.	Analyze
CO3	Calculate the welding cost for the different welding process.	Apply
CO4	Gain knowledge on various requirements on setting up a welding plant layout.	Understand

CO5	Gain knowledge on safety measures during welding processes and planning operations.	Understand

TEXT BOOKS:

1. ASM Metals Handbook, Vol.6, "Welding, Brazing and Soldering", ASM, New York, 1998.
2. AWS Welding Handbook, vol.5, "Engineering Costs, Quality and Safety", 9th edition, AWS,2015.

REFERENCES:

1. John Norrish, "Arc Welding Processes - Technologies and process control", Woodhead Publishing and Maney Publishing on behalf of The Institute of Materials, Minerals & Mining, 2006.
2. standard Data for Arc Welding – The Welding Institute, U.K., 1994.
3. Bathy. J., "Industrial Administration and Management", 1984.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO2	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO3	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO4	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO5	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
Avg.	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**

1-low, 2-medium, 3-high

IS24E10	FOOD PROCESSING, PRESERVATION AND TRANSPORT	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

Understanding of microbial growth, control, and the impact of microorganisms on food safety and preservation.

OBJECTIVES:

- To remember the methods of food processing.
- To study the food processing and preservation methods.
- To learn the freezing and drying processes.
- To sketch *the* cold storage and instrumentation.
- To Analysis of packing and transporting the food products.

UNIT - I	INTRODUCTION	(9)

Microbiology of Food Products, Mechanism of food spoilage critical microbial growth requirements, Design for control of micro organisms, The role of HACCP, Sanitation, Regulation and standards.

UNIT - II	PROCESSING & PRESERVATION	(9)

Thermodynamic properties and Transfer properties, Water content, Initial freezing temperature, Ice fraction, Transpiration of fresh fruits & vegetables, Food processing techniques for Dairy products, Poultry, Meat, Fruits & Vegetables.

UNIT - III	FREEZING & DRYING	(9)

Precooling, Freeze drying principles, Cold storage & freezers, Freezing drying limitations, Irradiation techniques, Cryofreezing, Numerical and analytical methods in estimating Freezing, Thawing times, Energy conservation in food industry.

UNIT - IV	COLD STORAGE DESIGN & INSTRUMENTATION	(9)

Initial building consideration, Building design, Specialized storage facility, Construction methods, Refrigeration systems, Insulation techniques, Control & instrumentation, Fire protection, Inspection & maintenance

UNIT - V	PACKAGING AND TRANSPORT	(9)

Refrigerated transportation, Refrigerated containers & trucks, Design features, Piping & Role of cryogenics in freezing & transport. Basic packaging materials, types of packaging, Packaging design. Packaging for different types of foods.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Recall the methods of food processing.	*Understand*
CO2	Analysis of food processing and preservation methods.	Analyze
CO3	Analyze the freezing and drying processes.	Analyze
CO4	Design the cold storage and instrumentation.	*Understand*
CO5	Analysis of packing and transporting the food products.	Analyze

TEXT BOOKS:

1. DS Warris., Food Processing and Preservation, CBS, New York, Second Edition, 2020.

2. Srivastava., Fruit and Vegetable Preservation, CBS, New York, Third Edition, 2019.

REFERENCES:

1. G. Subbulakshmi., Food Processing and Preservation, New Age Publishers, New Delhi, Second Edition, 2006.
2. IbrahamDincer., Heat Transfer in Food Cooling Applications, Tailor & Francis Pub., UK, Fourth Edition, 1997.
3. Clive V.I. Dellino, Cold and Chilled Storage Technology, VanNostrand Reinhold Pub. New York, Second Edition, 1991.
4. Stanley E. Charm, Fundamentals of Food Engineering,AVI Pub. Company Inc., New Delhi, Third Edition, 1989.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO2	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO3	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO4	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO5	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
Avg.	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

1-low, 2-medium, 3-high

IS24E11	OHSAS18001 AND ISO14001	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

Familiarity with general concepts of quality management systems, as they provide a framework relevant to both OHSAS 18001 and ISO 14001.

OBJECTIVES:

- To get knowledge on the basic concepts of OSHA standard
- To look at the details of OHSAS 18000 policy and planning with their guidelines and methods.
- To pertain the concepts of implementation, review and improvement plan.
- To study about ISO 14000 and 45001 policies with its planning.
- To obtain knowledge on environmental impact assessment, types & control.

UNIT - I	OHSAS STANDARD	(9)

Introduction - development of OHSAS standard - Structure and features of OSHAS 18001 - benefits of certification-certification procedure - OH & S management system element, specification and scope - correspondence between OHSAS 18001, ISO 14001:1996 and ISO 9001:1994 – guidelines (18002:2000) for implementing OHSAS 18001.

UNIT - II	OHSAS 18000 POLICY & PLANNING	(9)

Developing OH & S policy – guidelines - developments - procedure - content of OH & S policy – General principle, strategy and planning, specific goals, compliance - methodology.

Planning - guidelines, methodology steps developing action plan - analysis and identification of priorities, objective & targets, short term action plan, benefits and cost of each option, Development of action plan.

UNIT - III	IMPLEMENTATION, REVIEW AND IMPROVEMENT PLAN	(9)

Guidelines for structure and Responsibilities, Top level management, middle level management, co-ordinator and employees - developing procedures, identifying training needs, providing training, documentation of training, Training methodology consultation and communications.

Checking & Review; performance measurement and monitoring, proactive and reactive monitoring, measurement techniques, inspections, measuring equipment - accidents reports, Process & procedures, recording, investigation corrective action and follow up - records and records management. Handling documentation, information, records.

UNIT - IV	ISO 14000 POLICY, ISO 45001 POLICY & PLANNING	(9)

EMS, ISO 14001, specifications, objectives, Environmental Policy, Guidelines & Principles (ISO 14004), clauses 4.1 to 4.5. Documentation requirements, 3 levels of documentation for an ISO 14000 based EMS, steps in ISO 14001.

Implementation plan, Registration, importance of ISO 14000 to the Management. Auditing ISO14000-General principles of Environmental Audit, Auditor, steps in audit, Audit plan.

ISO 45001 – Scope, Terms and definitions,OH&S Policy, Planning, Objectives, Documentation, Importance, Evaluation, Management Review.

UNIT - V	ENVIRONMENT IMPACT ASSESSMENT	(9)

ISO 14040 (LCA), General principles of LCA, Stages of LCA, Report and Review. ISO 14020 (Eco labeling) - history, 14021, 14024, Type I labels, Type II labels, ISO 14024, principles, rules for eco labeling before company attempts for it, advantages, EIA in EMS, types of EIA, EIA methodology - EIS, Scope, Benefits. Audit - methodology, auditors audit results, management review - Continual improvement.

TOTAL: 45 PERIODS

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

COs	Course Outcome	Cognitive Level
CO1	Acquire knowledge on the basic concepts of OSHA standard	. Understand
CO2	Explore the details of OHSAS 18000 policy and planning with their guidelines and methods.	Understand
CO3	Apply the concepts of implementation, review and improvement plan.	Apply
CO4	Analyze about ISO 14000 and 45001 policies with its planning.	Analyze
CO5	Acquire knowledge on environmental impact assessment, types & control.	Understand

REFERENCES:

1. ISO 9000 to OHSAS 18001, Dr. K.C. Arora, S.K. Kataria& Sons, Delhi, First Edition, 2003.
2. NQA-ISO-45001-Implementation-Guide.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO2	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO3	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO4	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO5	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
Avg.	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

1-low, 2-medium, 3-high

IS24E12	SAFETY IN CHEMICAL INDUSTRIES	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE
Familiarity with chemical processes, equipment, and operations used in the chemical industry.

OBJECTIVES:

- To obtain knowledge on Chemical plant design, process, facilities and inherent safe design
- To investigate the commissioning phases and their documentation
- To study the operating procedures and emergency procedures during plant operations.
- To pertain the concepts of plant maintenance, modification and emergency planning.
- To organize the different types of chemical storages and their safety measures.

UNIT - I	SAFETY IN PROCESS DESIGN AND PRESSURE SYSTEM	(9)

Design process, conceptual design and detail design, assessment, inherently safer design - chemical reactor, types, batch reactors, reaction hazard evaluation, assessment, reactor safety, operating conditions, unit operations and equipments, utilities. Pressure system, pressure vessel design, standards and codes - pipe works and valves, heat exchangers - process machinery - over pressure protection, pressure relief devices and design, fire relief, vacuum and thermal relief, special situations and disposal - flare and vent systems - failures in pressure system.

UNIT - II	PLANT COMMISSIONING AND INSPECTION	(9)

Commissioning phases and organization, pre-commissioning documents, process commissioning, commissioning problems, post commissioning documentation Plant inspection, pressure vessel, pressure piping system, non destructive testing, pressure testing, leak testing and monitoring - plant monitoring, performance monitoring, condition, vibration, corrosion, acoustic emission - pipe line inspection.

UNIT - III	PLANT OPERATIONS	(9)

Operating discipline, operating procedure and inspection, format, emergency procedures - hand over and permit system - start up and shut down operation, refinery units - operation of fired heaters, driers, storage - operating activities and hazards - trip systems - exposure of personnel.

UNIT - IV	PLANT MAINTENANCE, MODIFICATION AND EMERGENCY PLANNING	(9)

Management of maintenance, hazards - preparation for maintenance, isolation, purging, cleaning, confined spaces, permit system - maintenance equipment - hot works - tank cleaning, repair and demolition - online repairs - maintenance of protective devices, modification of plant, problems - controls of modifications. Emergency planning, disaster planning, onsite emergency - offsite emergency, APELL.

UNIT - V	STORAGES	(9)

General consideration, petroleum product storages, storage tanks and vessel - storages layout - segregation, separating distance, secondary containment - venting and relief, atmospheric vent, pressure, vacuum valves, flame arrestors, fire relief - fire prevention and protection - LPG storages, pressure storages, layout, instrumentation, vaporizer, refrigerated storages - LNG storages, hydrogen storages, toxic storages, chlorine storages, ammonia storages, other chemical storages - underground storages - loading and unloading facilities - drum and cylinder storage - ware house, storage hazard assessment of LPG and LNG.

TOTAL: 45 PERIODS

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

COs	Course Outcome	Cognitive Level
CO1	Acquire knowledge on Chemical plant design, process, facilities and	Understand

	inherent safe design.	
CO2	Explore the commissioning phases and their documentation	.Understand
CO3	Analyze the operating procedures and emergency procedures during plant operations.	Analyze
CO4	Apply the concepts of plant maintenance, modification and emergency planning.	Apply
CO5	Classify the different types of chemical storages and their safety measures.	Remember

TEXT BOOKS:

1. Lees, F.P., Loss Prevention in Process Industries, Butterworths and Company, U.S., Fourth Edition, 2012.
2. Quantitative Risk Assessment in Chemical Process Industries, American Institute of Chemical Industries, Centre for Chemical Process safety, U.S., Second Edition,1999.

REFERENCES:

1. Fawcett, H.H. and Wood, Safety and Accident Prevention in Chemical Operations, Wiley inters, U.S., Second Edition, 2008.
2. Accident Prevention Manual for Industrial Operations, NSC, Chicago, Third edition, 2008.
3. GREEN, A.E., High Risk Safety Technology, John Wiley and Sons, U.K., Second Edition, 2003.
4. Petroleum Act and Rules, Government of India.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO2	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO3	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO4	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO5	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
Avg.	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

1-low, 2-medium, 3-high

IS24E13	NON DESTRUCTIVE TESTING AND EVALUATION	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

Familiarity with general testing and inspection concepts used in engineering and manufacturing.

OBJECTIVES:

- To study the working principle, types and characteristics of various NDT processes.
- To know different surface NDT methods and its applications
- To evaluate the application of Thermography and Eddy current testing.
- To get the Ultrasonic Testing and Acoustic Emission process.
- To pertain the working principle and applications of Radiography techniques.

UNIT - I	OVERVIEW OF NDT	(9)

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

UNIT - II	SURFACE NDE METHODS	(9)

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

UNIT - III	THERMOGRAPHY AND EDDY CURRENT TESTING (ET)	(9)

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

UNIT - IV	ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE)	(9)

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

UNIT - V	RADIOGRAPHY (RT)	(9)

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Explore the working principle, types and characteristics of various NDT processes.	.Understand
CO2	Recognize different surface NDT methods and its applications	Understand
CO3	Analyze the application of Thermography and Eddy current testing.	Analze
CO4	Comprehend the Ultrasonic Testing and Acoustic Emission process.	Understand

CO5	Apply the working principle and applications of Radiography techniques.	Apply

TEXT BOOKS:

1. ASM Metals Handbook,Non-Destructive Evaluation and Quality Control, American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17
2. Dr.V.Jayakumar,Dr.K.Elangovan, Non-Destructive Testing of Materials, Lakshmi Publications,Chennai,2017.

REFERENCES:

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu ,Practical Non-Destructive Testing, Narosa Publishing House, 2009 .
2. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010.
3. Charles, J. Hellier, Handbook of Nondestructive evaluation, McGraw Hill, New York , Second Edition,2001 .
4. Paul E Mix, Introduction to Non-destructive testing: a training guide, Wiley, New Jersey, Second Edition,2005

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO2	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO3	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO4	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO5	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
Avg.	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

1-low, 2-medium, 3-high

IS24E14	RELIABILITY ENGINEERING	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

Reliability engineering is a key part of the engineering field, and involves assessing and evaluating product reliability throughout its lifecycle.

OBJECTIVES:

- To get knowledge about the priori and post priori concepts, mortality curve and ability to calculate the system effectiveness.
- To gain knowledge on failure data analysis and their limitations.
- To pertain the principles of reliability prediction models and its applications.
- To study about the improvement of components and their computational procedures.
- To decide the objectives of reliability and quality management approaches.

UNIT - I	RELIABILITY CONCEPT	(9)

Reliability function - failure rate - mean time between failures (MTBF) - mean time to failure (MTTF) - A priori and a posteriori concept - mortality curve - useful life – availability – maintainability - system effectiveness.

UNIT - II	FAILURE DATA ANALYSIS	(9)

Time to failure distributions - Exponential, Normal, Gamma, Weibull - ranking of data - probability plotting techniques - Hazard plotting.

UNIT - III	RELIABILITY PREDICTION MODELS	(9)

Series and parallel systems - RBD approach - Standby systems - Application of Bayes' theorem - cut and tie set method - Markov analysis - Fault Tree Analysis - limitations.

UNIT - IV	RELIABILITY IMPROVEMENT	(9)

Introduction - Improvement of components - Element, Unit, Standby Redundancies - Redundancy Optimization - Computational Procedures.

UNIT - V	RELIABILITY MANAGEMENT	(9)

Integrated reliability programs - Management policies and decisions - Reliability Management by objectives - Managing people for reliability - Managing lower level suppliers - Customer management - Quality management approaches -Reliability data acquisition and analysis - Life cycle costs - Reliability allocation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Gain knowledge about the priori and post priori concepts, mortality curve and ability to calculate the system effectiveness.	Understand
CO2	Acquire knowledge on failure data analysis and their limitations.	Understand
CO3	Apply the principles of reliability prediction models and its applications.	Understand
CO4	Analyze about the improvement of components and their computational procedures.	Apply
CO5	Determine the objectives of reliability and quality management approaches.	Analyze

REFERENCES:

1. Srinath L.S, Reliability Engineering, Affiliated East-West Press Pvt Ltd, New Delhi, Fourth Edition, 2005.
2. Patrick O Connor, Reliability Engineering John Wiley & Sons, Ltd, New Delhi, Fifth Edition, 2006.
3. Balagurusamy. E., Reliability Engineering, Tata McGraw Hill Education Pvt Ltd, Ninth Edition, New Delhi, Second Edition, 1984.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO2	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO3	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO4	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO5	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
Avg.	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

1-low, 2-medium, 3-high

IS24E15	OPTIMIZATION TECHNIQUES IN MANUFACTURING	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

Knowledge of fundamental operations research concepts, including linear programming, integer programming

OBJECTIVES:

- To begin the various optimization techniques.
- To extend the classic optimization techniques
- To pertain the non linear programming methods in optimum design
- To make the dynamic programming and network techniques.
- To concern the algorithms and simulation.

UNIT - I	INTRODUCTION	(9)

Optimization – Historical Development – Engineering applications of optimization – Statement of an Optimization problem – classification of optimization problems.

UNIT - II	CLASSIC OPTIMIZATION TECHNIQUES	(9)

Linear programming - Graphical method – simplex method – dual simplex method – revised simplex method – duality in LP – Parametric Linear programming – Goal Programming.

UNIT - III	NON-LINEAR PROGRAMMING	(9)

Introduction – Lagrangeon Method – Kuhn-Tucker conditions – Quadratic programming – Separable programming – Stochastic programming – Geometric programming.

UNIT - IV	INTEGER PROGRAMMING AND DYNAMIC PROGRAMMING AND NETWORK TECHNIQUES	(9)

Integer programming - Cutting plane algorithm, Branch and bound technique, Zero-one implicit enumeration – Dynamic Programming – Formulation, Various applications using Dynamic Programming. Network Techniques – Shortest Path Model – Minimum Spanning Tree Problem – Maximal flow problem.

UNIT - V	ADVANCES IN SIMULATION	(9)

Genetic algorithms – simulated annealing – Neural Network and Fuzzy systems

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Introduce the various optimization techniques.	Understand
CO2	Develop the classic optimization techniques	Apply
CO3	Apply the non linear programming methods in optimum design	Apply
CO4	Construct the dynamic programming and network techniques.	Apply
CO5	Apply the algorithms and simulation.	Apply

TEXT BOOKS:

1. R. Panneerselvam, "Operations Research", Prentice Hall of India Private Limited, New Delhi 1 – 2005
2. Ravindran, Philips and Solberg, Operations Research Principles and Practice, John Wiley & Sons, Singapore, 1992

REFERENCES:

1. Hamdy A. Taha, Operations Research – An Introduction, Prentice Hall of India, 1997
2. J.K.Sharma, Operations Research – Theory and Applications – Macmillan India Ltd., 1997
3. P.K. Guptha and Man-Mohan, Problems in Operations Research – Sultan chand & Sons, 1994

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO2	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO3	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO4	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO5	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
Avg.	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**

1-low, 2-medium, 3-high

IS24E16	QUALITY ENGINEERING (PROFESSIONAL ELECTIVE-III and IV)	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

Familiarity with general principles of industrial processes and operations management to understand quality within the broader production system.

OBJECTIVES:

- To get knowledge on quality objectives, quality control and knows the importance of quality assurance.
- To study about the online quality control and its measurement.
- To decide about the online quality control attributes and methods for process improvement.
- To concern the concept of preventive maintenance schedule and TPM.
- To get knowledge on six sigma and its implementation.

UNIT - I	INTRODUCTION TO QUALITY ENGINEERING AND LOSS FUNCTION	(9)

Quality value and engineering - overall quality system - quality engineering in product design - quality engineering in design of production processes - quality engineering in production - quality engineering in service. Loss function derivation - use - loss function for products / system - justification of improvements - loss function and inspection - quality evaluations and tolerances - N type, S type, L type.

UNIT - II	ON-LINE QUALITY CONTROL	(9)

On-line feedback quality control variable characteristics - control with measurement interval - one unit, multiple units -control systems for lot and batch production. On-line process parameter control variable characteristics - process parameter tolerances feedback control systems - measurement error and process control parameters.

UNIT - III	ON-LINE QUALITY CONTROL ATTRIBUTES AND METHODS FOR PROCESS IMPROVEMENT	(9)

Checking intervals - frequency of process diagnosis. Production process improvement method - process diagnosis improvement method - process adjustment and recovery improvement methods.

UNIT - IV	QUALITY ENGINEERING AND TPM	(9)

Preventive maintenance schedules - PM schedules for functional characteristics - PM schedules for large scale systems. Quality tools - fault tree analysis, event tree analysis, failure mode and effect analysis - ISO quality systems.

UNIT - V	SIX SIGMA AND ITS IMPLEMENTATION	(9)

Introduction - definition - methodology - impact of implementation of six sigma - DMAIC method - roles and responsibilities - leaders, champion, black belt, green belts. Do's and dont's - readiness of organization - planning - management role - six sigma tools - sustaining six sigma.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Acquire knowledge on quality objectives, quality control and knows the importance of quality assurance.	Understand
CO2	Analyze about the online quality control and its measurement.	Analyze
CO3	Determine about the online quality control attributes and methods for process improvement.	Understand

CO4	Apply the concept of preventive maintenance schedule and TPM.	. Apply
CO5	Gain knowledge on six sigma and its implementation.	Understand

TEXT BOOKS:

1. De Feo, J A and Barnard, W., Six Sigma: Breakthrough and Beyond, Tata McGraw- Hill, New Delhi, Second Edition, 2005.
2. Rachel Silvestrini, Sarah E. Burke, The Certified Quality Engineering Handbook, ASQ Quality Press, New Delhi, 2017.

REFERENCES:

1. Brue, G., Six Sigma for Managers, Tata-McGraw Hill, New Delhi, Second Reprint, 2002.
2. Pyzdek, T and Berger, R.W., Quality Engineering Handbook, Tata-McGraw Hill, New Delhi, Second Edition, 1996.
3. Taguchi, G, Elsayed, E.A and Hsiang, T.C., Quality Engineering in Production Systems, Mc-Graw Hill Book company, Singapore, International Edition, 1989.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO2	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO3	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO4	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO5	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
Avg.	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**

1-low, 2-medium, 3-high

IS24E17	COMPUTER AIDED HAZARD ANALYSIS	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

Understanding the basic concepts of workplace hazards, safety regulations, and preventive measures.

OBJECTIVES:

- To look at the basic concepts in risk and hazard assessment.
- To study the use of different types of instruments for various testing.
- To pertain the risk assessment technique to quantify the risk using different software.
- To resolve the consequence analysis for plotting the damages towards hazardous situations.
- To exhibit the various types of disasters based on past accident analysis.

UNIT - I	HAZARD, RISK ISSUES AND HAZARD ASSESSMENT	(9)

Introduction, hazard, hazard monitoring - risk issue, group or societal risk, individual risk, voluntary and involuntary risk, social benefits Vs technological risk, approaches for establishing risk acceptance levels, risk estimation. Hazard assessment, procedure, methodology, safety audit, checklist analysis, what - if analysis, safety review, Preliminary Hazard Analysis (Pre HA), human error analysis, Hazard Operability studies (HAZOP), safety warning systems.

UNIT - II	COMPUTER AIDED INSTRUMENTS	(9)

Applications of Advanced Equipments and Instruments, Thermo Calorimetry, Differential Scanning Calorimeter(DSC), Thermo Gravimetric Analyzer(TGA), Accelerated Rate Calorimeter(ARC), Reactive Calorimeter(RC), Reaction System Screening Tool(RSST) - Principles of operations, Controlling parameters, applications, advantages. Explosive Testing, Deflagration Test, Detonation Test, Ignition Test, Minimum ignition energy Test, Sensitiveness Test, Impact Sensitiveness Test(BAM) and Friction Sensitiveness Test (BAM), Shock Sensitiveness Test, Card Gap Test.

UNIT - III	RISK ANALYSIS QUANTIFICATION AND SOFTWARES	(9)

Fault Tree Analysis & Event Tree Analysis, Logic symbols, methodology, minimal cut set ranking - Fire Explosion and Toxicity Index (FETI), various indices - Hazard Analysis(HAZAN) - Failure Mode and Effect Analysis(FMEA), Layer of Protection Analysis(LOPA) and Safety integrity level(SIL) - Software on Risk analysis, ALOHA, Hamsagars modules on Heat radiation, Pool fire, Jet, Explosion. Reliability software on FMEA for mechanical and electrical systems.

UNIT - IV	CONSEQUENCES ANALYSIS	(9)

Logics of consequences analysis - Estimation - Hazard identification based on the properties of chemicals - Chemical inventory analysis - identification of hazardous processes - Estimation of source term, Gas or vapour release, liquid release, two phase release - Heat radiation effects, BLEVE, Pool fires and Jet fire – Gas / vapour dispersion - Explosion, UVCE and Flash fire, Explosion effects and confined explosion - Toxic effects - Plotting the damage distances on plot plant / layout.

UNIT - V	CREDIBILITY OF RISK ASSESSMENT TECHNIQUES	(9)

Past accident analysis as information sources for Hazard analysis and consequences analysis of chemical accident, Mexico disaster, Flixborough, Bhopal, Seveso, Pasadena, Feyzin disaster (1966), Port Hudson disaster,Vizag HPCL 1997 incident,LG Polymer Vizag incident 2020- convey report, hazard assessment of non-nuclear installation - Rijnmond report, risk analysis of size potentially Hazardous Industrial objects - Rasmussen masses report, Reactor safety study of Nuclear power plant.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Explore the basic concepts in risk and hazard assessment.	Understand

CO2	Analyze the use of different types of instruments for various testing.	Analyze
CO3	Apply the risk assessment technique to quantify the risk using different software.	Apply
CO4	Determine the consequence analysis for plotting the damages towards hazardous situations.	Apply
CO5	Demonstrate the various types of disasters based on past accident analysis.	Remember

TEXT BOOKS:

1. Frank P. Less, Loss Prevention in Process Industries, Butterworth -Hein UK 1990 (Vol.I, II & III), UK ,Third edition , 2005
2. Methodologies for Risk and Safety Assessment in Chemical Process Industries, Commonwealth Science Council, UK, 1990

REFERENCES:

1. Course Material – Intensive Training Programme on Consequence Analysis, Process Safety Centre, Indian Institute of Chemical Technology, Tarnaka& CLRI, Chennai, Second Edition, 1987.
2. Major Hazard control- A practical Manual, ILO, Geneva, Third Edition, 1993.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO2	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO3	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO4	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO5	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
Avg.	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

1-low, 2-medium, 3-high

IS24E18	ADVANCED METROLOGY AND NON DESTRUCTIVE TESTING	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

Understanding material properties (mechanical, thermal, etc.), which is essential for analyzing and interpreting test results in NDT.

OBJECTIVES:

- To make obvious techniques used to quantify and comparison of products to required standards.
- To up to date with the newer technologies used in metrology.
- To aim procedures which will incorporate quality in the product as per the customer's needs.
- To exhibit his or her knowledge in developing control mechanism to check variation in attributes and variables.
- To choose suitable ND testing method for the contemporary issues.

UNIT - I	INTRODUCTION	(9)

Measuring Machines - Tool Maker's microscope - Co-ordinate measuring machines - Universal measuring machine - Laser viewers for production profile checks - Images shearing microscope- Use of computers- Machine vision technology - Microprocessors in metrology.

UNIT - II	STATISTIAL QUALITY CONTROL	(9)

Statistical Quality Control - Data presentation - Statistical measures and tools - Process capability - Confidence and tolerance limits - Control charts for variables and for fraction defectives - Theory of probability - Sampling - ABC standard - reliability and life testing

UNIT - III	BASIC NDT TESTS	(9)

Liquid penetrants and magnetic particle tests - characteristics of liquid penetrants - different washable systems - Developers - applications - method of production of magnetic fields - Principles of operation of magnetic particle test - applications -Advantages and limitations

UNIT - IV	RADIOGRAPY	(9)

Radiography - Sources of ray - x- ray production - properties of d and x rays - film characteristics – exposure charts-contrasts-operational characteristics of x ray equipment - applications.

UNIT - V	ULTRASONIC TESTING METHODS	(9)

Ultrasonic and acoustic emission techniques - Production of ultrasonic waves - different types of waves - general characteristics of waves - pulse echo method -A, B, C scans -Principles of acoustics emission technique - Advantage and limitations - Instrumentation – applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Demonstrate techniques used to quantify and comparison of products to required standards.	Understand
CO2	Conversant with the newer technologies used in metrology.	Understand
CO3	Design procedures which will incorporate quality in the product as per the customer's needs.	Apply
CO4	Demonstrate his or her knowledge in developing control mechanism to check variation in attributes and variables.	Understand
CO5	Select suitable ND testing method for the contemporary issues.	Remember

TEXT BOOKS:

1. Jain,R.K."Engineering Metrology ", Khanna Publishers, 2009
2. Barry Hull and Vernon John ," Non Destructive Testing ", Mac Millan, 2009

REFERENCES:

1. American Society for Metals ,"Metals Hand Book ", Vol II ,1976.
2. Progress in Acoustics Emission, " Proceedings of 10th International Acoustics Emission Symposium ", Japanese Society for NDI,1990.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	-	2	3	-	-	-	-	-	-	-	3	2
CO2	1	-	2	3	-	-	-	-	-	-	-	3	2
CO3	1	-	2	3	-	-	-	-	-	-	-	3	2
CO4	1	-	2	3	-	-	-	-	-	-	-	3	2
CO5	1	-	2	3	-	-	-	-	-	-	-	3	2
Avg.	1	-	2	3	-	-	-	-	-	-	-	3	2

1-low, 2-medium, 3-high

IS24E19	SAFETY IN ENGINEERING INDUSTRY	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

Understanding of industrial processes, systems, and environments where safety measures are needed.

OBJECTIVES:

- To establish the General safety rules, principles, maintenance, Inspections of metal and wood working machinery.
- To relate the concepts of safety in design, use and maintenance of machines.
- To remind about welding, common hazards in welding, personal protective equipment and safety precautions in welding.
- To evaluate the safety in cold working and hot working of metals.
- To get knowledge on safety in finishing, inspection and testing of machines.

UNIT - I	SAFETY IN METAL WORKING MACHINERY AND WOOD WORKING MACHINES	(9)

General safety rules, principles, maintenance, Inspections of turning machines, boring machines, milling machine, planning machine and grinding machines, CNC machines, Wood working machinery, types, safety principles, electrical guards, work area, material handling, inspection, standards and codes - saws, types, Hazards.

UNIT - II	SAFETY IN DESIGN, USE & MAINTENANCE OF MACHINES	(9)

Basic Principle of Machine guarding during maintenance, Zero Mechanical State (ZMS), Definition, Policy for ZMS -guarding of hazards - point of operation protective devices, machine guarding, types, fixed guard, interlock guard, automatic guard, trip guard, electron eye, positional control guard, fixed guard fencing - guard construction - guard opening. Selection and suitability: lathe - drilling-boring - milling - grinding - shaping sawing - shearing - presses - forge hammer – flywheels - shafts - couplings - gears - sprockets wheels and chains - Pulleys and belts-authorized entry to hazardous installations - benefits of good guarding systems – introduction to sensors, instrumentation - types and measurement.

UNIT - III	SAFETY IN WELDING AND GAS CUTTING	(9)

Gas welding and oxygen cutting, resistances welding, arc welding and cutting, common hazards, personal protective equipment, training, safety precautions in brazing, soldering and metalizing - explosive welding, selection, care and maintenance of the associated equipment and instruments - safety in generation, distribution and handling of industrial gases - colour coding - flashback arrestor - leak detection - pipe line safety - storage and handling of gas cylinders.

UNIT - IV	SAFETY IN COLD FARMING AND HOT WORKING OF METALS	(9)

Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot - operated presses, power press electric controls, power press set up and die removal, inspection and maintenance - metal shears-press brakes. Hot working safety in forging, hot rolling mill operation, safe guards in hot rolling mills - hot bending of pipes, hazards and control measures. Safety in gas furnace operation, cupola, crucibles, ovens, foundry health hazards, work environment, material handling in foundries, foundry production cleaning and finishing foundry processes

UNIT - V	SAFETY IN FINISHING, INSPECTION AND TESTING	(9)

Heat treatment operations, electro plating, paint shops, sand and shot blasting, safety in inspection and testing, dynamic balancing, hydro testing, valves, boiler drums and headers, pressure vessels, air leak test, steam testing, safety in radiography, personal monitoring devices, radiation hazards, engineering and administrative controls, Indian Boilers Regulation. Health and welfare measures in engineering industry - pollution control in engineering industry - industrial waste disposal.

TOTAL: 45 PERIODS

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

COs	Course Outcome	Cognitive Level
CO1	Determine the General safety rules, principles, maintenance, Inspections of metal and wood working machinery	. Understand
CO2	Apply the concepts of safety in design, use and maintenance of machines.	Apply
CO3	Recall about welding, common hazards in welding, personal protective equipment and safety precautions in welding.	Understand
CO4	Analyze the safety in cold working and hot working of metals.	.Analyze
CO5	Acquire knowledge on safety in finishing, inspection and testing of machines.	. Understand

TEXT BOOKS:

1. Occupational Safety Manual, BHEL, Trichy, Second Edition, 1988.
2. Accident Prevention Manual, NSC, Chicago, Third Edition, 2008.

REFERENCES:

1. Krishnan, N.V., Safety in Industry, Jaico Publishers House, London, Fourth Edition, 1996.
2. Safety in the use of wood working machines, HSE, UK, Second Edition, 2005
3. Health and Safety in Welding and Allied Processes, Welding Institute, UK, High Tech. Publishing Ltd., London, Fifth Edition, 1989

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO2	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO3	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO4	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
CO5	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**
Avg.	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**

1-low, 2-medium, 3-high

IS24E20	MATERIALS TESTING AND CHARACTERIZATION TECHNIQUES	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

Background in engineering principles relevant to testing and characterization.

OBJECTIVES:

- To Know in microstructure evaluation & crystal structure analysis.
- To get knowledge in electron microscopy.
- To learn the Chemical and Thermal Analysis.
- To inspect the static mechanical testing methods.
- To check the dynamic mechanical testing methods.

UNIT - I	MICRO AND CRYSTAL STRUCTURE ANALYSIS	(9)

Principles of Optical Microscopy – Specimen Preparation Techniques – Polishing and Etching – Polarization Techniques – Quantitative Metallography – Estimation of grain size – ASTM grain size numbers – Microstructure of Engineering Materials - Elements of Crystallography – X- ray Diffraction – Bragg's law – Techniques of X-ray Crystallography – Debye – Scherer camera – Geiger Diffractometer – analysis of Diffraction patterns – Inter planer spacing – Identification of Crystal Structure, Elements of Electron Diffraction.

UNIT - II	ELECTRON MICROSCOPY	(9)

Interaction of Electron Beam with Materials – Transmission Electron Microscopy – Specimen Preparation – Imaging Techniques – BF & DF – SAD – Electron Probe Microanalysis – Scanning Electron Microscopy – Construction & working of SEM – various Imaging Techniques – Applications-Atomic Force Microscopy-Construction & working of AFM - Applications

UNIT - III	CHEMICAL AND THERMAL ANALYSIS	(9)

Basic Principles, Practice and Applications of X-Ray Spectrometry, Wave Dispersive X-Ray Spectrometry, Auger Spectroscopy, Secondary Ion Mass Spectroscopy, Fourier Transform Infra Red Spectroscopy (FTIR)-Proton Induced X-Ray Emission Spectroscopy, Differential Thermal Analysis, Differential Scanning Calorimetry (DSC) And Thermo Gravitymetric Analysis (TGA).

UNIT - IV	MECHANICAL TESTING – STATIC TESTS	(9)

Hardness – Brinell, Vickers, Rockwell and Micro Hardness Test – Tensile Test – Stress – Strain plot – Proof Stress – Torsion Test - Ductility Measurement – Impact Test – Charpy & Izod – DWTT - Fracture Toughness Test, Codes and standards for testing metallic and composite materials.

UNIT - V	MECHANICAL TESTING – DYNAMIC TESTS	(9)

Fatigue – Low & High Cycle Fatigues – Rotating Beam & Plate Bending HCF tests – S-N curve – LCF tests – Crack Growth studies – Creep Tests – LM parameters – AE Tests-modal analysis - Applications of Dynamic Tests.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Knowledgeable in microstructure evaluation & crystal structure analysis.	*Understand*
CO2	Gain knowledge in electron microscopy.	*Understand*
CO3	Discover the Chemical and Thermal Analysis.	*Analyze*

CO4	Examine the static mechanical testing methods.	*Analyze*
CO5	Inspect the dynamic mechanical testing methods.	*Analyze*

TEXT BOOKS:

1. Culity B.D., Stock S.R& Stock S., Elements of X ray Diffraction, (3rd Edition). Prentice Hall, 2001.
2. Davis J. R., Tensile Testing, 2nd Edition, ASM International, 2004.

REFERENCES:

1. ASM Hand book-Materials characterization, Vol – 10, 2004.
2. Davis, H.E., Hauck G. & Troxell G.E., The Testing of engineering Materials, (4th Edition), McGraw Hill, College Divn., 1982.
3. Grundy P.J. and Jones G.A., Electron Microscopy in the Study of Materials, Edward Arnold Limited, 1976.
4. Morita.S, Wiesendanger.R, and Meyer.E, "Non-contact Atomic Force Microscopy" Springer, 2002.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO2	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO3	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO4	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO5	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
Avg.	**1**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**

1-low, 2-medium, 3-high