VISION AND MISSION OF THE DEPARTMENT: APPLIED SCIENCE AND TECHNOLOGY

Vision of the Department	Provide the knowledge and prosperity through high quality education to next generation of visionaries by illuminating them to perform Engineering & Technologies and to have leadership management role in industry and research institutions.	
	Mission No.	**Mission Statements**
Mission of the Department	M1	To be centre of educational excellence in Petroleum Engineering & Safety programs by the global industries and other Educational institutions.
	M2	To train the students with expertise that would improve the skills and face the challenges in industry.
	M3	To provide the students with multi-disciplinary approach to come up with practical knowledge that would meet global demands.
	M4	To empower the students for advanced study and research in the field of upstream and downstream sectors in Petroleum Industries, Occupational Health and Environmental Management.

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UNIVERSITY DEPARTMENTS

REGULATIONS – 2019

M.TECH. INDUSTRIAL SAFETY AND HAZARDS MANAGEMENT

CHOICE BASED CREDIT SYSTEM

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

1. To provide students with a good understanding of philosophy and integrated approach to managing safety, industrial hygiene and environment.

2. To inculcate the students in hazardous identification techniques, reliability analysis of the process system, event trees & fault trees analysis, hazards and operability analysis (HAZOP).

3. To introduce students to recent developments in analytical techniques, such as computer modeling of risk, reliability and safety problems.

4. To inculcate students in professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to think and act an individual safety consultant.

5. To impart the students with the understanding the professional practice of industrial safety & industrial acts.

2. PROGRAMME OUTCOMES (POs):

On successful completion of the Programme,

PO	Graduate Attribute	Programme Outcome
1.	**Safety knowledge**	Apply knowledge of basics of hazards and its types to assess the risk.
2.	**Problem Analysis**	Identify, formulate and solve the current problems related to industrial safety
3.	**Design / Development of solutions**	Evaluate existing system / design safety models identify the problems, evaluate and implement the remedial measures in the industries.
4.	**Conduct investigations of complex problems**	Conduct detailed audit, collect data and analyze accident investigation report.
5.	**Modern tool usage**	Apply various hazard assessment tools and techniques to identify the hazard estimate riskand reduce the accident occurrence to improve the safety levels.
6.	**The Engineer and Society**	Adequate knowledge about technical aspects with safety legislation to uphold professional and social obligations.
7.	**Environment and sustainability**	Uphold environment legislation and developing sustainable work environment.
8.	**Ethics**	Cultivate and uphold ethical practices in workplace and society.

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9.	**Individual and team work**	Develop documentation individually in an effectively manners and work efficiently in team environment.
10.	**Communication**	Develop communication skills to manage workers and management.
11.	**Project management and finance**	Effective knowledge of safety management aspect helps in efficient project management and reduces budgetary overshoot.
12.	**Life-long learning**	Continue knowledge updating and develop holistically as a learner to become leader of tomorrow.

3. MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVE WITH PROGRAMME OUTCOMES

Programme Educational Objectives	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1.	✓	✓	✓	✓	✓	✓	-	-	✓	-	-	-
2.	-	✓	✓	✓	✓	-	-	-	✓	✓	✓	-
3.	-	-	✓	-	✓	✓	-	1	-	✓	-	✓
4.	-	-	-	-	-	✓	✓	✓	-	✓	✓	✓
5.	-	-	-	✓	✓	-	✓	✓	✓	✓	✓	✓

4. MAPPING OF COURSE OUTCOMES AND PROGRAMME OUTCOMES

			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
YEAR 1	SEMESTER 1	Chemical Process Hazard and Risk Analysis	3	3	1	2	-	–	–	–	–	–	–	3
		Principles of Safety Management	3	2	1	2	2	–	–	–	–	–	–	3
		Standard and Regulation for Health, Safety and Environment	3	2	1	3	-	–	–	–	–	–	–	3
		Occupational Health and Industrial Hygiene	3	2	1	2	3	–	–	–	–	–	–	2
		Programe Elective I(one from list of electives I)												

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		Research Methodology and IPR												
		Audit Course – I (one from list of Audit courses)												
		Mechanical and Thermal Hazard Laboratory	3	1	2	1	3	-	-	-	1	-	-	3
		Industrial Hygiene Laboratory	3	2	3	-	3	2	-	-	1	3	-	-
	SEMESTER 2	Fire Engineering and Explosion Control	3	3	3	2	3	–	3	–	–	–	–	3
		Safety in Construction	3	2	3	2	3	–	–	–	–	–	–	3
		Programe Elective II(one from list of electives II)												
		Programe Elective III(one from list of electives III)												
		Programe Elective IV (one from list of electives IV)												
		Audit Course – II (one from list of Audit courses)												
		Industrial Fire and Safety Laboratory	3	1	2	1	3	-	-	-	-	-	-	3
		Environmental Analysis Laboratory	3	3	2	2	3	-	-	-	-	-	-	3
		Mini Project with Seminar	2	2	2				1		2		2	

			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
YEAR 2	SEMESTER 3	Programe Elective V												
		Programe Elective VI												
		Open Elective (one from list of 6 courses)												
		Internship/ Training	1	2							2	2	2	2
		Project Phase I	2	3	3	3	3	3	2	3	3	3	3	3

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	SEMESTER 4	Project Phase II	2	3	3	3	3	3	2	3	3	3	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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UNIVERSITY DEPARTMENTS

M.TECH. INDUSTRIAL SAFETY AND HAZARDS MANAGEMENT

REGULATIONS – 2019

CHOICE BASED CREDIT SYSTEM CURRICULUM AND

SYLLABI FOR I TO IV SEMESTERS

SEMESTER – I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	IH5101	Chemical Process Hazard and Risk Analysis	PCC	3	0	0	3	3
2.	IH5102	Principles of Safety Management	PCC	3	1	0	4	4
3.	IH5103	Standards and Regulation for Health, Safety and Environment	PCC	3	0	0	3	3
4.	IH5104	Occupational Health and Industrial Hygiene	PCC	3	0	0	3	3
5.		Programe Elective I (one from list of electives I)	PEC	3	0	0	3	3
6.	RM5151	Research Methodology and IPR	RMC	2	0	0	2	2
7.		Audit Course – I* (one from list of Audit courses)	AC	2	0	0	2	0
PRACTICALS								
8.	IH5111	Mechanical and Thermal Hazard Laboratory	EEC	0	0	4	4	2
9.	IH5112	Industrial Hygiene Laboratory	EEC	0	0	4	4	2
			TOTAL	**19**	**1**	**8**	**28**	**22**

*Audit Course is Optional

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SEMESTER – II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	IH5201	Fire Engineering and Explosion Control	PCC	3	0	0	3	3
2.	IH5202	Safety in Construction	PCC	3	0	0	3	3
3.	IH5203	Programme Elective II (one from list of electives II)	PEC	3	0	0	3	3
4.		Programme Elective III (one from list of electives III)	PEC	3	0	0	3	3
5.		Programme Elective IV (one from list of electives IV)	PEC	3	0	0	3	3
6.		Audit Course – II (one from list of Audit courses)	AC	2	0	0	2	0
PRACTICALS								
7.	IH5211	Industrial Fire and Safety Laboratory	EEC	0	0	4	4	2
8.	IH5212	Environmental Analysis Laboratory	EEC	0	0	4	4	2
9.	IH5213	Mini Project with Seminar	EEC	2	0	0	2	2
			TOTAL	**19**	**0**	**8**	**27**	**21**

*Audit Course is Optional

SEMESTER – III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Programme Elective V	PEC	3	0	0	3	3
2.		Programme Elective VI	PEC	3	0	0	3	3
3.		Open Elective (one from list of 6 courses)	OE	3	0	0	3	3
PRACTICALS								
4.	IH5311	Internship / Training	EEC	0	0	4	4	2
5.	IH5312	Project Phase I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**16**	**25**	**17**

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SEMESTER – IV

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	IH5411	Project Phase II	EEC	0	0	24	24	12
			TOTAL					**12**

TOTAL CREDITS: 72

PROGRAME CORE COURSES (PCC)

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	IH5101	Chemical Process Hazard and Risk Analysis	PCC	3	3	0	0	3
2.	IH5102	Principles of Safety Management	PCC	4	3	1	0	4
3.	IH5103	Standards and Regulation for Health, Safety and Environment	PCC	3	3	0	0	3
4.	IH5104	Occupational Health and Industrial Hygiene	PCC	3	0	0	3	3
5.	IH5201	Fire Engineering and Explosion Control	PCC	3	3	0	0	3
6.	IH5202	Safety in Construction	PCC	3	0	0	3	3

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PROGRAME ELECTIVES COURSES (PEC)

S.No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	IH5001	Industrial Noise and Vibration Control	PEC	3	3	0	0	3
2.	IH5002	Safety in Material Handling	PEC	3	3	0	0	3
3.	IH5003	Design of Air Pollution Control System	PEC	3	3	0	0	3
4.	IH5004	Safety in Engineering Industry	PEC	3	3	0	0	3
5.	IH5005	Environmental Pollution and Control	PEC	3	3	0	0	3
6.	IH5006	Human Factors in Process Safety	PEC	3	3	0	0	3
7.	IH5007	International safety Management	PEC	3	3	0	0	3
8.	IH5008	Safety in underground Structures and mines	PEC	3	3	0	0	3
9.	IH5009	Design of Industrial Ventilation	PEC	3	3	0	0	3
10.	IH5010	Safety in Textile Industry	PEC	3	3	0	0	3
11.	IH5011	Dock Safety	PEC	3	3	0	0	3
12.	IH5012	Safety in Chemical Industry	PEC	3	3	0	0	3
13.	IH5013	Reliability Engineering	PEC	3	3	0	0	3
14.	IH5014	Physical and Chemical Treatment of Water and Wastewater	PEC	3	3	0	0	3
15.	IH5015	Safety in Process Industries	PEC	3	3	0	0	3
16.	IH5016	Principles of Technical Analysis	PEC	3	3	0	0	3
17.	IH5017	Transport Safety	PEC	3	3	0	0	3

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18.	IH5018	Safety in Powder Handling	PEC	3	3	0	0	3
19.	IH5019	Electrical Safety	PEC	3	3	0	0	3
20.	IH5020	Fireworks Safety	PEC	3	3	0	0	3
21.	IH5021	Safety in Oil and Gas Industry	PEC	3	3	0	0	3
22.	IH5022	Nuclear Engineering and Safety	PEC	3	3	0	0	3
23.	IH5023	Behaviour Based Safety	PEC	3	3	0	0	3
24	IH5024	Disaster and Incident Management	PEC	3	3	0	0	3
25	IH5025	Hazardous Waste Management	PEC	3	3	0	0	3

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	RM5151	Research Methodology and IPR	RMC	4	2	0	0	2

OPEN ELECTIVE COURSES [OEC]*

*(Out of 6 Courses one Course must be selected)

S.NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	OE5091	Business Data Analytics	3	0	0	3	3
2.	OE5092	Industrial Safety	3	0	0	3	3
3.	OE5093	Operations Research	3	0	0	3	3
4.	OE5094	Cost Management of Engineering Projects	3	0	0	3	3
5.	OE5095	Composite Materials	3	0	0	3	3
6.	OE5096	Waste to Energy	3	0	0	3	3

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AUDIT COURSES (AC)

Registration for any of these courses is optional to students

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lectur	Tutorial	Practical		
1.	AX5091	English for Research Paper Writing	2	0	0	0	1/2
2.	AX5092	Disaster Management	2	0	0	0	
3.	AX5093	Sanskrit for Technical Knowledge	2	0	0	0	
4.	AX5094	Value Education	2	0	0	0	
5.	AX5095	Constitution of India	2	0	0	0	
6.	AX5096	Pedagogy Studies	2	0	0	0	
7.	AX5097	Stress Management by Yoga	2	0	0	0	
8.	AX5098	Personality Development Through Life Enlightenment Skills	2	0	0	0	
9.	AX5099	Unnat Bharat Abhiyan	2	0	0	0	

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	IH5111	Mechanical and Thermal Hazardous Laboratory	EEC	4	0	0	4	2
2.	IH5112	Industrial Hygiene Laboratory	EEC	4	0	0	4	2
3.	IH5211	Industrial Fire and Safety Laboratory	EEC	4	0	0	4	2
4.	IH5212	Environmental Analysis Laboratory	EEC	4	0	0	4	2
5.	IH5213	Mini Project with Seminar	EEC	4	2	0	0	2
6.	IH5311	Internship / Training	EEC	4	0	0	4	2
7.	IH5312	Project (Phase I)	EEC	12	0	0	12	6
8.	IH5411	Project (Phase II)	EEC	24	0	0	24	12

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SUMMARY

CATEGORY/TYPES OF COURSES	SEMESTER WISE CREDITS				TOTAL CREDITS
	Sem I	Sem II	Sem III	Sem IV	
PCC	13	6	---	---	**19**
PEC	3	9	6	---	**18**
RMC	2	---	---	---	**02**
OEC	---	---	3	---	**03**
AC (Non Credit)	✓	✓	---	---	✓
EEC	4	6	8	12	**30**
Total	**22**	**21**	**17**	**12**	**72**

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SYLLABI
SEMESTER I

IH5101	CHEMICAL PROCESS HAZARD AND RISK ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To gain knowledge on PHA, HAZOP studies.
- To learn about BAM testing and thermal analysis.
- To learn about HAZAN, FMEA, FET index.
- To gain knowledge on CPQRA, CAMEO.
- To learn about intermediate, risk on CPQRA.

UNIT I HAZARD, RISK ISSUES AND HAZARD ASSESSMENT 8

Introduction, hazard, hazard monitoring-risk issue - Hazard assessment, procedure, methodology; safety audit, checklist analysis, what-if analysis, safety review, preliminary hazard analysis (PHA), hazard operability studies (HAZOP).

UNIT II THERMAL AND MECHANICAL HAZARD ASSESSMENT 8

Applications of Advanced Equipment's and Instruments, Thermo Calorimetry, Differential Scanning Calorimeter (DSC), Thermo Gravimetric Analyzer (TGA), Accelerated Rate Calorimeter (ARC), 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 QUANTIFICATION AND SOFTWARES 9

Fault Tree Analysis and Event Tree Analysis, Logic symbols, methodology, minimal cut set ranking - fire explosion and Index (FEI)-fire explosion and toxicity index (FETI), various indices - Hazard analysis (HAZAN)- Failure Mode and Effect Analysis (FMEA)

UNIT IV CHEMICAL PROCESS QUANTITATIVE RISK ANALYSIS 10

CPQRA Definitions-components Techniques of CPQRA-Scope of CPQRA- Applications of CPQRA- Utilization of CPQRA results. 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 - Software CAMEO, ALOHA & MARPLOT.

UNIT V APPLICATION OF CPQRA 10

Simple /consequence CPQRA Examples Characterization, application to a new process unit, application to an existing process unit. Intermediate/ Frequency CPQRA characterization-application to existing/new process units. Complex/risk CPQRA Characterization. Application to new or existing process Unit.

Case Studies of Flixborough, Bhopal, Texas, ONGC offshore, HPCL Vizag and Jaipur IOC oil-storage depot incident; Oil, natural gas, chlorine and ammonia storage and transportation hazards.

TOTAL : 45 PERIODS

OUTCOMES:

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

- Understand the basics of hazard and hazard assessment.
- Know about the various advanced equipment and testing.
- Acquire software knowledge on risk analysis.
- Obtain knowledge on application of CPQRA.
- Analyze the risk associated with chemicals process.

REFERENCE BOOKS:

1. Methods in Chemical Process Safety, Volume 1 (1st Edition) - 7th April 2017.
2. Hazop and Hazan, Fourth Edition – IchemE 4th Edition- 2001.
3. Guidelines for Process Hazards Analysis (PHA, HAZOP), Hazards Identification, and Risk Analysis (English, Paperback, Hyatt Nigel).
4. Quantitative Risk Assessment for Environmental and Occupational Health Hardcover – Import, 9 Jun 1993.
5. Lees' Loss Prevention in the Process Industries (3rd Edition) - 27th December 2004.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	Understand the basics of hazard and hazard assessment.	3	1	2	2	-	–	–	–	–	–	–	2	3	–	3	-	1
CO2	Know about the various advanced equipment and testing.	3	2	1	-	3	–	–	–	–	–	–	-	2	–	3	-	1
CO3	Acquire software knowledge on risk analysis.	3	3	1	2	-	-	-	-	-	-	-	-	2	-	2	-	1
CO4	Obtain knowledge on application of CPQRA.	2	2	1	2	-	-	-	-	-	-	-	-	3	-	2	-	1
CO5	Analyze the risk associated with chemicals process.	3	3	1	2	-	–	–	–	–	–	–	3	3	–	3	-	1
Chemical process hazard and risk analysis		3	3	1	2	-	–	–	–	–	–	–	3		3	–	-	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

IH5102	PRINCIPLES OF SAFETY MANAGEMENT	L	T	P	C
		3	1	0	4

OBJECTIVE

- To gain knowledge on hazard identification, risk assessment and safety audit.
- To gain knowledge on concept of accidents and IRT.
- To learn about IS 3786, ANSI (Z16.1) and OSHA regulations.
- To gain knowledge on training methods, decision making process and roles government agencies.
- To learn about sample distribution and correlation methods.

UNIT I SAFETY MANAGEMENT CONCEPTS 10

Definitions - History of Safety movement in India and abroad – Evolution of modern safety concept – Elements of Industrial Safety – ILO Conventions and ratification by Countries - Planning for optimization – productivity, quality and safety - line and staff functions for safety - Role of safety committee - Safety management systems: Safety policy, budgeting for safety, Hazard identification and risk assessment techniques, safety inspection, sampling and survey - performance evaluation of safety - Identification of unsafe acts of workers and unsafe conditions in the shop floor - Disaster control.

Components of safety audit: types of audit, audit methodology, non-conformity reporting (NCR), audit checklist and report - Reports from government agencies, consultants, experts - perusal of accident and safety records, formats, implementation of audit recommendations .

UNIT II ACCIDENT INVESTIGATION AND REPORTING 10

Concepts of accident, reportable and non-reportable accidents, reporting to statutory authorities - Principles of accident prevention – Theories of accident causation - accident investigation methodology – Direct and Indirect cost analysis - documentation and reporting –Incident Recall Technique (IRT).

UNIT III SAFETY PERFORMANCE MONITORING 10

Recommended practices for compiling and measuring work injury – 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 - IS 3786, ANSI (Z16.1), OSHA regulations.

UNIT IV SAFETY EDUCATION, TRAINING AND EMPLOYEE PARTICIPATION 15

Importance of training, identification of training needs, training methods, program and training evaluation - Internal and external Training, seminars, conferences, Tool box talks, E-Learning tools - Role of government agencies and Industry forums in safety training - Importance of employee participation - Role of trade unions in Safety, Health and Environment - Integrating SHE in Collective Bargaining - Decision-making process - Organizing suggestions and evaluation of feedback system - Safety competitions - Promotional methods - Performance appraisal - Modern methods of Safety Promotion - awards, competitions, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign. Motivation - Roles of government agencies, management, supervisors, safety department, safety committee, medical officer, trade unions, safety steward and safety circle.

UNIT V DATA ANALYSIS FOR SAFETY 15

Sampling distributions – Testing of hypotheses – t-test, F-test and Chi-square test Curve fitting - Method of least squares - Regression and correlation – Rank correlation– Multiple and partial correlation – Analysis of variance - One way and two way classifications

TOTAL : 60 PERIODS

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OUTCOMES:

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

- Understand the basic concept of safety management.
- Obtain knowledge on investigation and reporting of accident.
- Know about the safety performance indicators.
- Analyze on the impaction of training and employee participation.
- Obtain knowledge on the data analysis.

REFERENCE BOOKS:

1. Chales D. Reese (2017) Occupational Health and Safety management.
2. L M Deshmukh (2007) 'Industrial Safety management'.
3. Krishnan N.V. (1997) 'Safety Management in Industry'. Jaico Publishing House, Bombay.
4. Frank Lees (2012) 'Lees' Loss Prevention in Process Industries'. Butterworth-Heinemann publications, UK, 4th Edition.
5. John Ridley & John Channing (2008) 'Safety at Work'. Routledge, 7th Edition.
   Dan Petersen (2003) 'Techniques of Safety Management: A System Approach'. American
6. Society of Safety Engineers, USA.

ONLINE RESOURCES:

1. https://www.osha.gov/Publications/osha3071.pdf
2. http://www.ilocis.org/documents/chpt18e.htm
3. http://www.hsa.ie/eng/Publications_and_Forms/Publications/Safety_and_Health_Management/ behaviour_based_safety_guide.pdf

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	Understand the basic concept of safety management	3	1	2	3	-	–	–	–	–	–	–	3	3	–	3	-	2
CO2	Obtain knowledge on investigation and reporting of accident.	2	3	2	3	2	–	–	–	–	–	–	-	3	2	3	-	1
CO3	Know about the safety performance indicators.	3	1	1	2	-	-	-	-	-	-	-	-	3	-	2	-	2
CO4	Analyze on the impaction of training and employee participation.	2	3	1	2	-	-	-	-	-	-	-	-	2	-	3	-	1
CO5	Obtain knowledge on the data analysis.	2	3	2	2	-	–	–	–	–	–	–	-	2	–	2	-	2
PRINCIPLES OF SAFETY MANAGEMENT		3	2	1	2	2	–	–	–	–	–	–	3	3	2	2	-	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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IH5103	STANDARDS AND REGULATION FOR HEALTH, SAFETY AND ENVIRONMENT	L	T	P	C
		3	0	0	3

OBJECTIVE

- To gain knowledge on factories act, Tamil Nadu factories rules.
- To learn about Indian Boilers Act and Regulations, Indian Explosive Act.
- To gain knowledge on overview of BOCW Act and rules.
- To learn about Indian Electricity Act.
- To gain knowledge on ISO 14001, ISO 9001, ISD 45001.

UNIT I **10**

Factories Act - Tamil Nadu Factories rules - Tamil Nadu Safety Officers Rules - Welfare officers Rules - Workmen Compensation Act and Rules - ESI Act & Rules.

UNIT II STORAGE AND HANDLING OF PRESSURIZED VESSELS **9**

Indian Boilers Act and Regulations - Indian explosive act and Explosives Rules, Gas cylinder rules, SMPV(U) Rules, Indian petroleum act and rules, Manufacture, Storage and Import of Hazardous Chemical rules 1989.

UNIT III CONSTRUCTION AND ENVIRONMENTAL REGULATIONS **9**

Overview of BOCW Act and Rules, Environmental acts and rules - Overview of Motor Vehicles Act.

UNIT IV ELECTRICITY REGULATIONS **8**

Indian Electricity act 2003 and rules 1956.

UNIT V REGULATIONS IN INDIA AND ABROAD **9**

Overview of Bureau of Indian standards in Safety - Occupational Safety and Health act of USA – Health and Safety Work Act UK - Overview of ISO 45001, ISO 14001 and ISO 9001.

TOTAL : 45 PERIODS

OUTCOMES:

On successful completion of the course, the student will be able to

- Obtain knowledge on welfare compensation and safety of employees in Tamil Nadu and India.
- Know the manufacturing, Storage and impact of chemicals in process industry.
- Understand on air, water acts and Motor Vehicles Act.
- Know about the distribution electricity and process of license.
- Analyze the occupational safety and health is organization.

REFERENCE BOOKS:

1. The Factories Act 1948, Madras Book Agency, Chennai, 2000.
2. Indian Boilers Act and Regulations.
3. Indian Electricity act 2003 and rules 1956.
4. Explosive Act, 1884 and Explosive rules, 2008 (India), Eastern Book company, Lucknow, 10th Edition & www. peso.gov.in
5. The manufacture, storage and import of hazardous chemical rules 1989, Madras Book Agency, Chennai. ISO 9001, ISO 14001, ISO 45001 standards.

ONLINE RESOURCES:

1. https://maitri.mahaonline.gov.in/pdf/factories-act-1948.pdf

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	Obtain knowledge on welfare compensation and safety of employees in Tamil Nadu and India.	3	1	1	3	-	–	–	–	–	–	–	3	3	–	3	3	-
CO2	Know the manufacturing, Storage and impact of chemicals in process industry	3	2	1	3	2	–	–	–	–	–	–	2	3	-	3	3	-
CO3	Understand on air, water acts and Motor Vehicles Act.	3	1	1	3	-	-	-	-	-	-	-	3	3	-	3	3	-
CO4	Know about the distribution electricity and process of license	3	2	1	2	-	-	-	-	-	-	-	2	2	-	3	3	--
CO5	Analyze the occupational safety and health is organization.	3	3	1	2	-	–	–	–	–	–	–	2	2	–	3	3	-
Standards And Regulation For Health, Safety And Environment		3	2	1	3	-	–	–	–	–	–	–	3	3	–	3	3	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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IH5104 OCCUPATIONAL HEALTH AND INDUSTRIAL HYGIENE

L	T	P	C
3	0	0	3

OBJECTIVE

- To learn the anatomy and physiology of human organs, functions and effects of various hazards on organs.
- To gain knowledge about different types of physical hazards.
- To learn the chemical hazards and various air sampling instruments.
- To gain knowledge about various biological hazards agents.
- To learn the various occupational health parameters, work capacity and work organizations.

UNIT I ANATOMY, PHYSIOLOGY, HAZARD AND PATHOLOGY 9

Definition- Anatomy and Physiology of human organs – The lungs, Skin, Ear and Eyes – Functions of organs – Impairment of organs – Effects of various hazards on organs - Cardio pulmonary resuscitation - audiometric tests, eye tests, vital function tests.

UNIT II PHYSICAL HAZARDS 9

Noise, compensation aspects, noise exposure regulation, properties of sound, occupational damage, risk factors, sound measuring instruments, octave band analyzer, noise networks, noise surveys, noise control program, industrial audiometry, hearing conservation programs- Vibration, types, effects, instruments, surveying procedure, permissible exposure limit. Ionizing radiation, types, effects, monitoring instruments, control programs, OSHA standard- non-ionizing radiations, effects, types, radar hazards, microwaves and radio waves, lasers, TLV- cold environments, hypothermia, wind chill index, control measures of hot environments, thermal comfort, heat stress indices, acclimatization, estimation and control.

UNIT III CHEMICAL HAZARDS 9

Recognition of chemical hazards-dust, fumes, mist, vapour, 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 Vapour monitors, dust sample collection devices, personal sampling methods of control - Engineering control, Design maintenance considerations

UNIT IV BIOLOGICAL AND ERGONOMICAL HAZARDS 9

Classification of Bio-hazardous agents – examples, bacterial agents, rickettsial and chlamydial agents, viral agents, fungal, parasitic agents, infectious diseases – Biohazard control program, employee health program-laboratory safety program-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 V OCCUPATIONAL HEALTH, PHYSIOLOGY 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, 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

OUTCOMES:

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

- Obtain knowledge about anatomy and cardio pulmonary resuscitation.
- Know about octave band analyser, noise network and monitoring instruments.
- Understand about gas and vapour monitors, dust sampling collecting devices.
- Obtain knowledge about carpal tunnel syndrome, tendon pain disorders of the neck.
- Know about pre and post-employment medical examinations, categorization of job heaviness and shift works.

REFERENCE BOOKS:

1. Fundamentals of Industrial Hygiene, 6th Edition National Safety Council; 6th Edition (August 10, 2012).
2. Essentials of Industrial Hygiene, 1st Edition National Safety Council (2015).
3. Barbara A.Plog, Patricia J.Quinlan, MPH, CIH and Jennifer Villareal Hand book of "Fundamentals of Industrial Hygiene, 6th edition 2012, National Safety Council, 2012.
4. Occupational Health Safety Management Practical Approach CRC Press Taylor & Francis group second Edition 2008.
5. Danuta Koradecka, Hand book of "Occupational Safety and Health", CRC Press. 2010 Edition.
6. Thomas P. Fuller, Hand book of "Essentials of industrial hygiene" National Safety Council ItascalL, 2015 Edition.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	Obtain knowledge about anatomy and cardio pulmonary resuscitation.	3	1	2	1	-	–	–	–	–	–	–	_	2	–	2	1	-
CO2	Know about octave band analyser, noise network and monitoring instruments	2	1	3	1	3	–	–	–	–	–	–	-	2	-	1	1	-
CO3	Understand about gas and vapour monitors, dust sampling collecting devices.	2	1	2	2	3	-	-	-	-	-	-	-	2	-	1	1	-
CO4	Obtain knowledge about carpal tunnel syndrome, tendon pain disorders neck.	3	2	2	1	-	-	-	-	-	-	-	-	2	-	3	1	-
CO5	Know pre and post-employment, medical examinations of job.	2	2	1	3	-	–	–	–	–	–	–	2	3	–	2	1	-
OCCUPATIONAL HEALTH AND INDUSTRIAL HYGIENE		3	2	1	2	3	–	–	–	–	–	–	2	3	–	2	1	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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RM5151 **RESEARCH METHODOLOGY AND IPR** **LT P C**
2 0 0 2

COURSE OBJECTIVES:

To impart knowledge and skills required for research and IPR:

- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

UNIT I RESEARCH PROBLEM FORMULATION **6**

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT II LITERATURE REVIEW **6**

Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT III TECHNICALWRITING /PRESENTATION **6**

Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) **6**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR) **6**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc.

Traditional knowledge Case Studies, IPR and IITs.

TOTAL: 30 PERIODS

COURCE OUTCOMES:

1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

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

REFERENCES:

1. Asimov, “Introduction to Design”, Prentice Hall, 1962.
2. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
3. Mayall, “Industrial Design”, McGraw Hill, 1992.
4. Niebel, “Product Design”, McGraw Hill, 1974.
5. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners” 2010

IH5111	MECHANICAL AND THERMAL HAZARD LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVE

To provide comprehensive knowledge on various hazards in mechanical and thermal analyzing instrument.

1 Measurement of friction sensitivity using BAM friction tester.
2. Measurement of impact sensitivity using BAM fall hammer.
3. Measurement of sensitivity to sudden compression using Rotter Impact Test.
4. Measurement of earth resistance and ground resistivity using Wenner´s method.
5. Measurement of amount of heat released or absorbed by any chemical process using Bomb Calorimeter.
6. To analyze and assess the material properties and characteristic parameters of shock absorption testing machine.
7. Determine the minimum ignition temperature using Ignition Temperature Apparatus
8. Measurement of reliable index of the strength and performance of materials using Bursting Strength Tester.
9. Measurement and monitoring of Temperature using Infrared Thermometer.
10. Measurement of thermal conductivity using Thermal Conductivity Analyzer.
11. Thermal Analysis using Differential Scanning Calorimeter.
12. Measurement of thermal stability of the material using Thermo Gravimetric Analyzer

TOTAL : 60 PERIODS

OUTCOME:

The students will be able to obtain knowledge on various testing methods associated with mechanical and thermal hazards.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	The students will be able to obtain knowledge on various testing methods associated with mechanical and thermal hazards.	3	1	2	1	3	–	–	–	1	–	–	3	3	1	2	-	2
MECHANICAL AND THERMAL HAZARD LABORATORY		3	1	2	1	3	-	-	-	1	-	-	3	3	1	2	-	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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IH5112	INDUSTRIAL HYGIENE LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVE

To provide comprehensive knowledge on industrial hygiene and safe working environment.

1. Measurement of Noise level using Noise Level Meter.
2. Measurement of intensity of illumination using Lux Meter.
3. Measurement of vibration using Vibration Analyzer.
4. Measurement of ultraviolet radiation.
5. Measurement of fume formation rate using Total fume chamber.
6. Evaluation of Muscle activity using Bio-Mechanical Analysis method.
7. Measurement of Hearing capability using Audiometer.
8. Measurement on strength of electromagnetic radiation in the range from ultraviolet to Infrared and including the visible spectrum using Photo-meter.
9. Measurement of heat stress index using WBGT instrument.
10. Assessment of Ergonomic impact using OWAS software.

TOTAL : 60 PERIODS

OUTCOME:

The students will be able to obtain knowledge and get better exposure to safe industrial hygiene practices, assessing and monitoring work environment.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	The students will be able to obtain knowledge and get better exposure to safe industrial hygiene practices, assessing and monitoring work environment	3	2	3	-	3	2	–	–	1	3	–	-	3	1	2	-	2
INDUSTRIAL HYGIENE LABORATORY		3	2	3	-	3	2	-	-	1	3	-	-	3	1	2	-	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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IH5201	FIRE ENGINEERING AND EXPLOSION CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVE

- To gain knowledge on BLEVE vapour cloud explosion.
- To learn about principles of fire extinguishers.
- To gain knowledge on industrial fire protection systems.
- To learn about the fire protection and fire safety equipment.
- To Gain knowledge on explosive control.

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, Pasedena Texas, Piper Alpha, Bombay Victoria dock ship explosions, Mahul refinery explosion, Nagothane vapour cloud explosion and Vizag refinery disaster.

UNIT II FIRE PREVENTION AND PROTECTION 9

Sources of ignition – fire triangle Fire Tetrahedron – principles of fire extinguishing – active and passive fire protection systems – various classes of fires – A, B, C, D, E-Fire extinguishing agents- Water ,Foam, Dry chemical powder, Carbon-dioxide- Halon alternatives Halocarbon compounds-Inert gases , dry powders – types of fire extinguishers – fire stoppers – hydrant pipes – hoses – monitors – fire watchers – lay out 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, halon system – need for halon replacement – smoke venting. Portable extinguishers – flammable liquids – tank farms – indices of inflammability-firefighting systems.

UNIT IV BUILDING FIRE SAFETY 8

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

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).

TOTAL : 45 PERIODS

OUTCOME

On successful completion of this course, the student will able to

- Obtain knowledge on properties of fire and case studies related to fire
- Know about types, classes and chemicals used in fire extinguishers
- Analysis various fire suppression systems
- Understand the safe building design, fire resistant materials and fire testing
- Know about the principles of explosion and protecting systems

REFERENCE BOOKS:

1. "Fire safety management", 3rd edition – Danial E.Della Giustina – 2014.
2. "Manual of fire safety ", N.Segha prakash – 2011.
3. "A hand book of fire technology", R. S. Gupta – 2010.
4. "Dust explosion and fire prevention handbook", Nicholas P. Cheremisinoff – 2014.
5. "Industrial Fire Protection Handbook", R.Craig Schrool – 2002.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	Obtain knowledge on properties of fire and case studies related to fire	3	2	3	3		–	3	–	–	–	–			-	3	1	-
CO2	Know about types, classes and chemicals used in fire extinguishers	3	1	2	2	3	–	–	–	–	–	–			-	3	2	-
CO3	Analysis various fire suppression systems	3	3	3	2	3	–	–	–	–	–	–	1		-	3	2	-
CO4	Understand the safe building design, fire resistant materials and fire testing		3	3	2	3		-	-	-	-	-	3	3	-	3	1	-
CO5	Know about the principles of explosion and protecting systems	3	2	3	1											3	-	-
FIRE ENGINEERING AND EXPLOSION CONTROL		3	3	3	2	3	–	3	–	–	–	–	3	3	-	3	2	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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IH5202	SAFETY IN CONSTRUCTION	L	T	P	C
		3	0	0	3

OBJECTIVE

- To learn about the accidents related to various construction activities and management system.
- To gain knowledge about the prevention control in excavation and tunneling and housekeeping.
- To gain knowledge using OSHA 3146.
- To learn about safety in dams, bridges, water tanks.
- To learn about safety operation of construction machineries.

UNIT I ACCIDENTS CAUSES AND MANAGEMENT SYSTEMS 10

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 accidents – The Building and other Construction workers (Regulation of Employment and conditions of Service) Central Rules, 1998, Contract document & contractual clauses – Pre contract activities, preconstruction meeting – Project HSE Plan - design aids for safe construction – permits to work – quality assurance in construction - Personal protective equipment – Recording of accidents and safety measures – Education and training.

UNIT II HAZARDS OF CONSTRUCTION AND PREVENTION 8

Excavations, Trenches, shafts – Form work- false work – erection of structural frame work, dismantling – tunneling – blasting, – confined spaces – working on contaminated sites – work over water Safety during Demolition – Cordoning – Dismantling –Clearing debris Housekeeping – accidents due to poor housekeeping.

UNIT III FALL PREVENTION AND FALL PROTECTION 9

Fall prevention and fall protection - Fall protection in construction OSHA 3146 – OSHA requirement for working at heights, Different types of scaffolds – Design, safe erection, use and dismantling, scaffold inspection checklist, requirement for safe work platforms, stairways, gangways and ramps.

Safe access and egress – safe use of ladders- Safety Harnesses, safety nets, fall arrestors, controlled access zones, safety monitoring systems – working on fragile roofs, Height pass – accident case studies.

UNIT IV SAFETY IN HUGE STRUCTURES 8

Safety in typical civil structures – Dams-bridges-water Tanks-Retaining Walls-Critical factors for failure-High rise buildings, Road works, and Power plant constructions.

UNIT V CONSTRUCTION MACHINERY 10

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, Inspection and Maintenance, Hand tools, Manual Material handling.

TOTAL : 45 PERIODS

OUTCOMES:

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

- Know about the onsite construction hazard and safety legislation.
- Analyse the structural framework and safety of various construction activities.
- Obtain knowledge about the fall prevention and fall protection, safe access and egress.
- Know about the safety in high raised structured.
- Obtain knowledge about machinery used in construction.

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REFERENCE BOOKS:

1. Construction Safety Paperback – 1 May 2013 by R.K. Mishra (Author).
2. Construction Safety Manual by Dave Heberle (Author) , McGraw-Hill.
3. Principles of Construction Safety Paperback – April 22, 2005 by Allan St John Holt.
4. Construction Safety Engineering Principles (McGraw-Hill Construction Series): Designing and Managing Safer Job Sites 1st Edition by David V. Mac Collum -McGraw-Hill Education; 1 edition (January 8, 2007).

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	Know about the onsite construction hazard and safety legislation	3	2	3	3		–		–	–	–	–			-	3	2	1
CO2	Analyse the structural framework and safety of various construction activities.	3	2	3	3	3	–	–	–	–	–	–			-	3	3	-
CO3	Obtain knowledge about the fall prevention and fall protection, safe access and egress	3	3	1	2	3	–	–	–	–	–	–	1		-	3	2	-
CO4	Know about the safety in high raised structured.	2	3	3	2	3		-	-	-	-	-	3	3	-	3	2	-
CO5	Obtain knowledge about machinery used in construction.	3	2	3	1											3	2	-
SAFETY IN CONSTRUCTION		3	2	3	2	3	–	–	–	–	–	–	3	3	-	3	3	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

IH5211	INDUSTRIAL FIRE AND SAFETY LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES

To provide comprehensive knowledge on Concept of fire and firefighting equipment

1. Study of basic Personal Protective Equipment used in industries.
2. Study and demonstration of different types of Fire Extinguisher.
3. Study and demonstration of smoke detection, Alarm and Sprinkler System.
4. Study of Fire Hydrant System and it is components.
5. Modeling effects of fire, explosion and estimating safe distance from explosion using PHAST 1 and FLACS Software.
6. Measurement of flash point and fire point using closed cup method.
7. Analysis of fire behaviour using Cone Calorimeter.
8. Study and demonstration of fire mock drill.
9. Performing modeling studies using ALOHA software.
10. Study on Static Electricity hazards, discharging of the same and use of antistatic materials in vulnerable areas.

TOTAL : 60 PERIODS

OUTCOME:

The students shall obtain a complete knowledge about fire properties and behavior, prevention control in various environments.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	The students shall obtain a complete knowledge about fire properties and behavior, prevention control in various environments	3	1	2	1	3	–	–	–	–	–	–	3	3	1	2	2	2
INDUSTRIAL FIRE AND SAFETY LABORATORY		3	1	2	1	3	-	-	-	-	-	-	3	3	1	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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IH5212	ENVIRONMENTAL ANALYSIS LABORATORY	L	T	P	C
		0	0	2	4

OBJECTIVES

To provide comprehensive knowledge about environmental parameter.

1. Measurement of moisture and temperature using Relative Humidity Meter.
2. Measurement of particulate and gaseous pollutants in the ambient air using High Volume Sampler.
3. Measurement of specific gas concentrations like carbon monoxide, chlorine and methane using Multi-Gas detector.
4. Measurement of concentration of dust in breathing zone using personal air sampler.
5. Measurement of speed or velocity of air using Anemometer.
6. Measurement of BTEX emission using VOC sampler.
7. Measurement of Exhaust gas emission using – Exhaust Gas analyzer.
8. Analysis of Effluent concentration using Effluent water analyzer.
9. Analysis of water characteristics using water quality parameter.
10. Performing modeling studies using AERMOD, SCREEN3 Software.

TOTAL : 60 PERIODS

OUTCOME:

The students should be able to get through insight into the various pollutants present and their sources, behavior in environment and workplace.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	The students should be able to get through insight into the various pollutants present and their sources, behavior in environment and workplace.	3	3	2	2	3	–	–	–	–	–	–	3	2	1	2	-	2
ENVIRONMENTAL LABORATORY		3	3	2	2	3	-	-	-	-	-	-	3	2	1	2		2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

IH5001	INDUSTRIAL NOISE AND VIBRATION CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVE

To provide an understanding of sources of noise and industrial vibration control.

- To learn about the wave frequency and mathematical concepts.
- To gain the knowledge in vibration and measurements.
- To learn about sources in industries and noise ratings.
- To gain the knowledge about the noise control and noise control devices.
- To learn about the scope for abatement of industrial noise.

UNIT I INTRODUCTION **10**

Basic definitions and terminology used in Vibrations and acoustics – Mathematical concepts and degrees of freedom in vibratory systems – Natural frequencies and vibration modes – continuous systems and wave theory concept – wave equation and relation to acoustics – theory of sound propagation and terminology involved – Plane wave and spherical waves – Concepts of free field and diffuse field, near field and far field – frequency analysis and vibration and noise spectrum – Signature analysis and condition monitoring.

UNIT II INSTRUMENTATION AND AUDITORY **10**

Sensors used in vibration and measurements – Frequency and spectrum analyzers – Weighting networks – Hearing mechanism – relation between subjective and objective sounds – Auditory effects of noise and audiometric testing – Speech interference levels and its importance.

UNIT III SOURCES OF NOISE AND RATINGS **10**

Mechanism of noise generation and propagation in various machinery and machine components, vehicles etc. – Directivity index – Concept of Leq and estimation – Noise ratings and standards for various sources like industrial, construction, traffic, aircraft community etc. – industrial safety and OSHA regulations – Noise legislations and management

UNIT IV NOISE CONTROL **10**

Energy transferring and dissipating devices Source: Structure borne and flow excited. Vibration isolation and absorption. Spring and damping materials, Dynamic absorbers, Mufflers and silencers, Path: Close filter and loosely covered enclosures – Acoustic treatment and materials– Transmission loss and absorption coefficient of materials and structures and their estimation – Reverberation time and room constant – Design of rooms / industrial halls/ auditorium for minimum noise. Receiver: Measure to control at the receiver end – use of enclosures, ear muffs and other protective devices.

UNIT V ABATEMENT OF NOISE **5**

Active noise attenuators and scope for abatement of industrial noise.

TOTAL : 45 PERIODS

OUTCOMES:

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

- Know about the terminology of noise and vibration.
- Obtain Knowledge about the noise instrumentation.
- Understand the sources of noise generated and various noise legislation and management.
- Know about the control measures for noise.
- Obtain knowledge of reducing industrial noise.

REFERENCE BOOKS:

1. "Engineering Noise Control", David A.Bies, Colin Hansen, Carl Howard – 2017.
2. "Fundamentals of Sound and Vibration", 2nd edition – frank Fahy, David Thompson – 2015.
3. "Vibration engineering and technology of machinery", Springer International Published – 2014.
4. "Mechanical vibration and industrial noise control", Lasithan L.G – 2013.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	Know about the terminology of noise and vibration.	3	1	2	3	-	–	–	–	–	–	–	2	3	–	3	-	-
CO2	Obtain Knowledge about the noise instrumentation	3	2	3	3	2	–	–	–	–	–	–	-	2	2	3	-	-
CO3	Understand the sources of noise generated and various noise legislation and management	3	1	1	3	-	-	-	-	-	-	-	-	3	-	2	1	-
CO4	Know about the control measures for noise	3	2	1	2	-	-	-	-	-	-	-	-	2	-	3	-	-
CO5	Obtain knowledge of reducing industrial noise	2	3	2	2	-	–	–	–	–	–	–	-	2	–	2	1	-
INDUSTRIAL NOISE AND VIBRATION CONTROL		3	2	1	2	-	–	–	–	–	–	–	3	2	–	2	1	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

IH5002	SAFETY IN MATERIAL HANDLING	L	T	P	C
		3	0	0	3

OBJECTIVE

- To learn about the safety handling of ropes, hoops etc.
- To gain the knowledge about the conveying mechanisms.
- To gain the knowledge about hoisting mechanism.
- To learn about the heavy equipment.
- To gain the knowledge about goods and equipment.

UNIT I MATERIAL HANDLING 8

General safety consideration in material handling - Ropes, Chains, Sling, Hoops, Clamps, Arresting gears – Prime movers.

UNIT II ERGONOMICS OF CONVEYING MECHANISMS 10

Ergonomic consideration in material handling, design, installation, operation and maintenance of Conveying equipment, hoisting, traveling and slewing mechanisms.

UNIT III ERGONOMICS OF HOISTING MECHANISMS 8

Ergonomic consideration in material handling, design, installation, operation and maintenance of driving gear for hoisting mechanism – Traveling mechanism.

UNIT IV HANDLING OF HEAVY EQUIPMENTS 9

Selection, operation and maintenance of Industrial Trucks – Mobile Cranes – Tower crane – Checklist - Competent persons.

UNIT V STORAGE OF GOODS AND EQUIPMENTS 10

Storage and Retrieval of common goods of various shapes and sizes in a general store of a big industry. Safety in Manual Material Handling – Ergonomics consideration in manual material handling -OSHA Lifting Equation.

TOTAL : 45 PERIODS

OUTCOMES:

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

- Know about the general safety in material handling.
- Obtain knowledge about the ergonomic hazards due to conveyer machines.
- Obtain knowledge about the ergonomic hazards due to hoisting.
- Understand the operations of handling equipment.
- Know about the storage and safe handling of goods.

REFERENCE BOOKS:

1. "Handbook of industrial and system engineering", 2nd edition, Adedeji B. Badiru – 2017.
2. Material Handling Handbook, volume 1 – Raymond - 2009.
3. Accident Prevention Manual for Industrial Operations, NSC, Chicago.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	Know about the general safety in material handling	3	2	1	3	-	–	–	–	–	–	–	3	3	–	3	3	-
CO2	Obtain knowledge about the ergonomic hazards due to conveyer machines	3	3	1	2	2	–	–	–	–	–	–	2	3	-	3	2	-
CO3	Obtain knowledge about the ergonomic hazards due to hoisting	3	1	1	3	-	-	-	-	-	-	-	3	3	-	3	1	-
CO4	Understand the operations of handling equipment	3	2	3	2	-	-	-	-	-	-	-	2	3	-	3	3	-
CO5	Know about the storage and safe handling of goods	3	2	1	2	-	–	–	–	–	–	–	3	2	–	3	2	-
SAFETY IN MATERIAL HANDLING		3	2	1	2	-	–	–	–	–	–	–	3	3	–	3	3	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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IH5003	DESIGN OF AIR POLLUTION CONTROL SYSTEM	L	T	P	C
		3	0	0	3

OBJECTIVE

- To gain the knowledge about emission, regulation, control of air pollution.
- To learn about the control of particulate pollutant.
- To gain the knowledge about gaseous pollutant.
- To gain the knowledge about the removal of HCs or VOCs or NOx.
- To learn about the integrated air pollution control system.

UNIT I AIR POLLUTION **10**

Industrial sources of Air Pollution – Emission factors – Regulations – Control Strategies – Policies.

UNIT II PARTICULATE POLLUTANTS AND CONTROL **12**

Particulate pollutant control: Settling chambers – Laminar and Turbulent flow - Filtration – Interception – Impaction – Convective diffusion – Collection of particles by fibers and Granular beds – Electrostatic precipitation – Cyclones – Wet Collectors.

UNIT III GASEOUS POLLUTANTS AND CONTROL **8**

Gaseous Pollutant control: Gas absorption in tray and packed towers – Absorption with /Without chemical reaction – Removal of SO2 – Absorption in fixed blades- Breakthrough.

UNIT IV TOXIC POLLUTANTS REMOVAL **8**

Removal of HCs / VOCs – NOx removal – Wet scrubbers.

UNIT V AIR POLLUTION CONTROL **7**

Integrated Air pollution control systems.

TOTAL : 45 PERIODS

OUTCOMES:

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

- Acquire the knowledge about the industrial air pollution.
- Obtain knowledge about sources and removal of particulate pollutants.
- Obtain knowledge about gaseous pollutants controls.
- Understand about the toxic pollutants and VOCs.
- Obtain knowledge about air pollution control system.

REFERENCE BOOKS:

1. "Air pollution control technology handbook", 2nd edition, karl B. Schnelle, Jr. Russell – CRC press – 2017.
2. "Air pollution control equipment selection guide", 2nd edition – Kenneth C. Schifftner – 2017.
3. Air pollution control engineering environmental engineering, CRC press - 2018.
4. Air quality: Monitoring, Measuring and modeling environmental Hazards – Marco Ragazzi – 2016.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	Acquire the knowledge about the industrial air pollution.	3	1	2	2	1	–	–	–	–	–	–	2	3	–	2	1	-
CO2	Obtain knowledge about sources and removal of particulate pollutants.	2	3	2	1	2	2	–	–	–	–	–	-	2	–	2	1	-
CO3	Obtain knowledge about gaseous pollutants controls.	3	3	2	1	2	-	2	-	-	-	-	-	2	-	2	1	-
CO4	Understand about the toxic pollutants and VOCs.	2	2	1	2	1	-	-	-	-	-	-	2	2	-	3	1	-
CO5	Obtain knowledge about air pollution control system.	3	3	2	2	2	2	–	–	–	–	–	3	3	–	3	1	-
DESIGN OF AIR POLLUTION CONTROL SYSTEM		2	3	2	2	1	2	1	–	–	–	–	2	3	–	2	1	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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IH5004	SAFETY IN ENGINEERING INDUSTRY	L	T	P	C
		3	0	0	3

OBJECTIVE

- To gain knowledge about metal and wood working machineries.
- To learn about zero mechanical state and other guarding mechanisms.
- To gain knowledge about welding and gas cutting.
- To learn about cold forming and hot working.
- To gain knowledge about engineering devices in industries.

UNIT I SAFETY IN METAL WORKING MACHINERY AND WOOD WORKING MACHINES 5

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 PRINCIPLES OF MACHINE GUARDING 10

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 chain pulleys and belts-authorized entry to hazardous installations-benefits of good guarding systems.

UNIT III SAFETY IN WELDING AND GAS CUTTING 8

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 FORMING AND HOT WORKING OF METALS 12

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 sheers-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 10

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

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OUTCOMES:

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

- Know about the safety rules, principles, maintenance of machineries.
- Understanding the principles of machine guarding.
- Obtain knowledge of handling of flammable material for machining purposes.
- To know about the safety in forging operations.
- To know about the relief valve in various pressure vessels.

REFERENCE BOOKS:

1. Accident Prevention Manual: Engineering & Technology 14th Edition National Safety Council; 14th Edition (August 2015).
2. Occupational Health & Safety, 3rd Edition National Safety Council; 3rd Ed. (2000).
3. Safeguarding Concepts, 7th Edition National Safety Council; 7th Ed. (June 2002).

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	Know about the safety rules, principles, maintenance of machineries.	3	1	1	2	3	–	–	–	–	–	–	2	3	–	2	3	-
CO2	Understanding the principles of machine guarding.	3	2	3	1	3	-	–	–	–	–	–	-	3	–	2	2	-
CO3	Obtain knowledge of handling of flammable material for machining purposes.	3	2	2	1	3	-	-	-	-	-	-	-	2	-	2	3	-
CO4	To know about the safety in forging operations.	2	3	2	1	3	-	-	-	-	-	-	-	3	-	2	1	-
CO5	To know about the relief valve in various pressure vessels.	3	3	2	2	3	-	–	–	–	–	–	3	3	–	2	-	-
SAFETY IN ENGINEERING INDUSTRY		3	2	2	1	3	–	–	–	–	–	–	2	3	–	2	3	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

IH5005	ENVIRONMENTAL POLLUTION AND CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVE

- To learn about various sources of air and water pollutions.
- To gain knowledge about the solid waste management.
- To gain knowledge on environment measurement control.
- To learn about various environmental legislations.
- To gain knowledge on pollution control in process industries.

UNIT I AIR AND WATER POLLUTION 14

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- stack emissions-CFC, Ambient air quality standards Classification of water pollutants-health hazards-sampling and analysis of water-water treatment - different industrial effluents and their treatment and disposal –advanced wastewater treatment - common treatment- Marine pollution-Under water pollution.

UNIT II SOLID WASTE MANAGEMENT 6

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 – Filtration - 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.

UNIT III ENVIRONMENTAL MEASUREMENT AND CONTROL 7

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.

UNIT IV ENVIRONMENTAL ACTS AND RULES 9

The Environment (Protection) Act 1986 and Rules - The Water (Preventions Control of Pollution) Act and Rules - The Air (Prevention & Control of Pollution) Act 1981 - The Hazardous and Other Wastes (Management and Trans boundary Movement) Rules 2016 - The Bio-Medical Waste Management Rules, 2016 - The Ozone Depleting Substances (Regulation & Control) Rules 2000 - The Batteries (Management & Handling) Rules, The Noise Pollution (Regulation & Control) Rules, 2000, The E-Waste (Management) Rules, 2016, The Public Liability Insurance Act, 1991, The Environmental Impact Assessment Notification 2006.

UNIT V POLLUTION CONTROL IN PROCESS INDUSTRIES 9

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

TOTAL : 45 PERIODS

OUTCOMES:

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

- Understand the various pollutions sources for air and water pollution and their effects.
- Know about the methods and disposal of solid waste in effective manner.
- Obtain knowledge about different instrument used to measure pollutant levels.
- Know about rules and regulation derived for pollutant and E-waste control.
- Analyze pollution control in cement, paper and petroleum industries.

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REFERENCE BOOKS:

1. “Handbook of environmental pollution and control”, Raven Breman – 2017.
2. “Environmental Microbiology”, Lan T. Paulsen – 2014.
3. “Environmental Law Handbook”, Christopher I. Bell – 2013.
4. “Life Cycle Assessment Hand book”, Mary Ann Curran - 2012

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	Understand the various pollutions sources for air and water pollution and their effects.	3	2	1	2	-	–	2	–	–	–	–	2	3	–	2	-	-
CO2	Know about the methods and disposal of solid waste in effective manner.	2	3	1	2	2	-	–	–	–	–	–	-	2	–	2	-	-
CO3	Obtain knowledge about different instrument used to measure pollutant levels.	2	2	2	1	3	-	-	-	-	-	-	-	2	-	2	1	-
CO4	Know about rules and regulation derived for pollutant and E-waste control.	3	1	1	3	-	-	-	-	-	-	-	2	3	-	2	-	-
CO5	Analyze pollution control in cement, paper and petroleum industries.	3	3	3	1	2	2	–	–	–	–	–	3	3	–	3	-	-
ENVIRONMENTAL POLLUTION CONTROL		3	3	2	2	1	1	1	–	–	–	–	2	3	–	2	-	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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IH5006	HUMAN FACTORS IN PROCESS SAFETY	L	T	P	C
		3	0	0	3

OBJECTIVES

- To learn about man-machine system concept.
- To gain knowledge on various human behavior and their attitudes.
- To learn about ergonomics application in work system.
- To gain knowledge on various safety factors.
- To learn about personal protective equipment's standards and their testing procedure.

UNIT I INTRODUCTION **9**

Man-machine system Concept – Human factors Engineering and its Applications - Man as Information processor, Sensor, Controller.

UNIT II BASIC BEHAVIOURAL CONCEPT **9**

Human Behavior – Individual difference –Motivation –Frustration and Conflicts – Attitudes - Learning concepts.

UNIT III ERGONOMICS **9**

Ergonomic Principles – ergonomics Application in a work system – motion economy Principle – environmental effects.

UNIT IV SAFETY FACTORS **9**

Impending safety factors – Technological factor –Physiological factor –Legal factor – Administrative factors.

UNIT V PERSONAL PROTECTIVE EQUIPMENTS **9**

Personal protective equipment's (different types, specifications, standards, testing procedures, and maintenance).

TOTAL : 45 PERIODS

OUTCOMES:

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

- Obtain knowledge about human factor engineering and its applications.
- Know about motivations frustration and conflicts.
- Obtain knowledge about ergonomic principles.
- Understand about physiological and legal factors.
- Know about personal productive equipment.

REFERENCES:

1. "The human factor of process safety ", 2018.
2. "Human factor methods for improving performance in the process industries", Center for chemical process Safety – 2006.
3. "Guidelines for human preventing human error in process safety", Center for chemical process Safety – 2004.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	Obtain knowledge about human factor engineering and its applications.	3	2	2	1	-	–	–	–	–	–	–		3	–	3	1	-
CO2	Know about motivations frustration and conflicts.	2	2	-	2	-	–	–	2	–	–	–	-	2	–	3	1	-
CO3	Obtain knowledge about ergonomic principles	3	3	2	2	-	-	-	-	-	-	-	-	2	-	2	1	-
CO4	Understand about physiological and legal factors	2	2	1	2	-	-	-	-	-	-	-	1	3	-	2	1	-
CO5	Know about personal productive equipment.	3	2	1	2	-	–	–	–	–	–	–	2	3	–	3	2	-
HUMAN FACTORS IN PROCESS SAFETY		3	2	2	2	-	–	–	2	–	–	–	2	3	–	3	1	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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IH5007	INTERNATIONAL SAFETY MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES

- To learn about structures and features of OSHAS 1800.
- To gain knowledge on general requirements in operational health and safety 18001 policy.
- To learn about control of records, internal audit and management review.
- To gain knowledge about legal aspect of ISO 14001 and ISO 9000.
- To learn about different methods of environmental impact Assessment.

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 18001:2007, ISO 14001:2004 and ISO 9001:2000- Correspondence between OHSAS 18001, OHSAS 18002, and the ILO-OSH:2001.

UNIT II OHSAS 18001 POLICY & PLANNING, IMPLEMENTATION AND OPERATION 9

General requirements, OH & S policy , Planning- Hazard identification, risk assessment and determining controls - Legal and other requirements-Objectives and programme(s), Implementation and operation-Resources, roles, responsibility, accountability and authority-Competence, training and awareness -Communication, participation and consultation – Documentation - Control of documents - Operational control-Emergency preparedness and response.

UNIT III CHECKING AND REVIEW GUIDELINES 9

Checking- Performance measurement and monitoring-Evaluation of compliance-Incident investigation, nonconformity, corrective action and preventive action-Control of records-Internal audit-Management review - guidelines for implementation of 18001:2007 -Examples of items for hazard identification checklist – Comparison of risk assessment tool and methodologies.

UNIT IV ISO 14001 AND ISO 9000 9

ISO 14001 - Environmental management systems - Requirements with guidance for use - Environmental policy- Environmental aspects - Legal and other requirements - Objectives, targets and programme(s)- Implementation and operation – Checking - Management review-Guidance for use - Principles (ISO 14004), clauses 4.1 to 4.5. Documentation requirements, 3 levels of documentation for ISO 14000 based EMS, steps in ISO 14001.Implementation plan, Registration, Importance of ISO 14000 to the Management. Guidelines for environmental management systems auditing -General principles, Managing audit programme - Audit activities, steps in audit, Audit plan. Competence of auditors.

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

OUTCOMES:

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

- Obtain knowledge about OSHAS 18001: 2007, ISO 14001: 2004, ISO 9001: 2000 and ILO – OSH: 2001.
- Know about on OHSAS 18001 policy and planning.
- Understand about performance measurement and monitoring of 18001: 2007.
- Obtain knowledge about ISO 14001 thoroughly.
- Know about ISO 14040 (LCA), ISO 14020 (Eco labelling), ISO 14024 and EIA in EMS.

REFERENCES:

1. "Occupational Health and Safety Assessment Series BS (OHSAS) 18001:2007" BSI, UK, 2007.
2. "OHSAS 18002, Occupational Health and Safety Management Systems – Guidelines for the implementation of OHSAS 18001", OHSAS project group, 2008.
3. "ISO 14001:2004, Environmental Management Systems - Requirements with guidance for use", ISO, 2004.
4. Dr. Arora K.C. "ISO 9000 to OHSAS 18001", S. K. Kataria & Sons, 2012.
5. "Guidelines on Occupational Health and Safety Management Systems (OSH-MS)" International Labour Organization: 2001.
6. "BS 8800: 2004 Occupational Health and Safety Management.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	Obtain knowledge about OSHAS 18001: 2007, ISO 14001: 2004, ISO 9001: 2000 and ILO – OSH: 2001.	3	2	2	3	-	–	–	–	–	–	–	2	3	–	3	3	2
CO2	Know about on OHSAS 18001 policy and planning.	2	2	2	3	-	–	–	–	–	–	–	-	3	-	3	3	3
CO3	Obtain knowledge about ISO 14001 thoroughly.	3	1	1	2	-	-	-	-	-	-	-	-	2	-	2	3	1
CO4	Analyze on the impaction of training and employee participation.	2	2	1	2	-	-	-	-	-	-	-	-	2	-	3	-	3
CO5	Know about ISO 14040 (LCA), ISO 14020 (Eco labelling),ISO 14024 and EIA in EMS.	3	3	2	3	-	2	–	–	–	–	–	2	3	–	2	3	1
INTERNATIONAL SAFETY MANAGEMENT		3	2	2	3	-	2	–	–	–	–	–	2	3	–	2	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

IH5008 SAFETY IN UNDERGROUND STRUCTURES AND MINES

L	T	P	C
3	0	0	3

OBJECTIVES

- To gain the knowledge on prevention of accident & accident reporting system in opencast mines.
- To learn about warning sensor, gas detectors and evacuation from confined space.
- To gain the knowledge on hazards due to collapse and atmospheric pollutions.
- To learn about fault tree analysis and failure mode and effect analysis.
- To gain the knowledge on cost of accident emergency preparedness.

UNIT I OPENCAST 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. – Confined space classifications – Safe entry, working and evacuation from confined space.

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

OUTCOMES:

On successful completion of this course, the student will be able to

- Know about prevention of accident and safe transportation of explosives.
- Understand the effect of gases, occupation hazard and working condition.
- Analyze the ventilation and lighting and PPE'S during tunneling.
- Knowledge on risk assessment using advance techniques.
- Knowledge about accident analysis and measure for improving safety in mines.

REFERENCES:

1. "Hard rock miner's handbook", – Jack de la verge - 2014.
2. "Occupational Safety and health in mining", Kaj elgstrand Eva Vingard – 2013.
3. "Safety and health in underground coal mine", - International Labour Organisation, Geneva – 2009.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	Know about prevention of accident and safe transportation of explosives.	3	2	2	3	-	–	–	–	–	–	–	-	3	–	3	1	-
CO2	Understand the effect of gases, occupation hazard and working condition	3	1	2	2	2	–	–	–	–	–	–	-	3	-	3	1	-
CO3	Analyze the ventilation and lighting and PPE'S during tunneling.	3	1	1	3	-	-	-	-	-	-	-	-	3	-	3	1	-
CO4	Knowledge on risk assessment using advance techniques.	3	2	1	2	-	-	-	-	-	-	-	-	2	-	3	1	-
CO5	Knowledge about accident analysis and measure for improving safety in mines.	3	2	2	2	-	–	–	–	–	–	–	-	2	–	3	1	-
SAFETY IN UNDERGROUND STRUCTURES AND MINES		3	2	2	2	2	–	–	–	–	–	–	-	3	–	3	1	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

IH5009	DESIGN OF INDUSTRIAL VENTILLATION	L	T	P	C
		3	0	0	3

OBJECTIVE

- To gain knowledge about the concept and principles of ventilation systems.
- To learn about the dilution ventilation system and acclimatization.
- To gain knowledge about air contamination characteristic and hood design and air cleaning system.
- To learn about design and testing of local exhaust ventilation system.
- To gain knowledge about ventilation to specific operation areas.

UNIT I GENERAL PRINCIPLES OF VENTILATION 9

Introduction - supply and exhaust systems - Basic definitions - Principles of air flow-Acceleration of air and Hood entry losses - Duct losses - Multiple hood exhaust system.

UNIT II GENERAL INDUSTRIAL VENTILATION 9

Dilution Ventilation Principles- Dilution Ventilation for health- Dilution Ventilation for fire and explosion-Heat Control-Heat balance and Exchange-Adaptive mechanisms of the body-Acclimatization-Acute heat disorders-Assessment of heat stress and strain-Ventilation control-and ventilation system - Radiant heat control – Enclosures and Insulation– Personal Protective equipments-Protective suits and refrigerated suits.

UNIT III LOCAL EXHAUST HOODS AND AIR CLEANING DEVICES 9

Air contamination Characteristics –Hood types-Hood design factors-Hood losses-Minimum Duct velocity-Special hood requirements-Push –pull ventilation-Hot processes-Air cleaning devices-selection –types –Explosion venting.

UNIT IV DESIGN AND TESTING OF INDUSTRIAL VENTILATION 9

Exhaust system design procedure-steps-duct segment calculations –Distribution of air flow-Plenum Exhaust system-Fan Pressure calculations-Corrections for velocity changes-Duct material –friction losses- Construction guidelines for local Exhaust system – Fan selection – Replacement and recirculated air-Distribution –Flow rate-Air conservation-Ventilation aspects of indoor air quality-Testing of ventilation system-Measurement of volumetric flow rate-Calibration of air measuring instrument- pressure measurement –Check out procedure.

UNIT V VENTILATION SYSTEM FOR SPECIFIC OPERATIONS 9

Cleaner rooms- Filling operations-foundry operations-Gas treatment-Laboratory Ventilation-Machining-Metal melting furnaces-Mixing operations- Movable exhaust hoods-open surface tanks-painting operations- Mechanical surface cleaning and finishing –Welding and cutting – wood working.

TOTAL : 45 PERIODS

OUTCOMES:

- Get insight into general principle and basics of industrial ventilation
- Obtain knowledge about effects of ventilation on human health and their preventive measures
- Analyze the design and characteristic of various ventilation systems
- Knowledge about various construction guidelines and design aspects of ventilation system
- Understand the ventilation system for specific operation

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REFERENCES:

1. ACGIH Industrial Ventilation “A manual of Recommended Practice for Design”, 28th edition 2013.
2. “Accident Prevention manual for industrial operations” N.S.C., Chicago.
3. Jeanne Mager Stellman “Encyclopaedia of Occupational Health and Safety”, Vol. I and II, 4th edition, published by International Labour office, Geneva.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	Get insight into general principle and basics of industrial ventilation	3	2	2	2	3	–	–	–	–	–	–	3	3	-	2	1	-
CO2	Obtain knowledge about effects of ventilation on human health and their preventive measures	3	2	2	2	3	–	–	–	–	–	–	3	3	-	2	-	-
CO3	Analyze the design and characteristic of various ventilation systems	3	2	2	2	3	–	–	–	–	–	–	3	3	-	2	-	-
CO4	Knowledge about various construction guidelines and design aspects of ventilation system	3	2	2	2	3	–	–	–	–	–	–	3	3	-	2	-	-

CO5	Understand the ventilation system for specific operation	3	2	2	2	3	–	–	–	–	–	–	3	3	-	2	-	-
DESIGN OF INDUSTRIAL VENTILLATION		3	2	2	2	3	-	-	-	-	-	-	3	3	-	2	1	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

IH5010	SAFETY IN TEXTILE INDUSTRY	L	T	P	C
		3	0	0	3

OBJECTIVE

- Understand the concept of spinning and safety precautions.
- Know about hazards in basic textile operations.
- Know about hazards in finishing process and its effluents.
- Understand the welfare measures for textile workers.
- Learn about the regulation of the textile industry.

UNIT I INTRODUCTION **9**

Process flow charts of i) short staple spinning, ii) long staple spinning, iii) viscose rayon and synthetic fibre, manufacturer, iv) spun and filament yarn to fabric manufacture, v) jute spinning and jute fabric manufacture-accident hazard, guarding of machinery and safety precautions in opening, carding, combing, drawing, flyer frames and ring frames, doubles, rotor spinning, winding, warping, softening/spinning specific to jute.

UNIT II TEXTILE HAZARDS I **9**

Accident hazards i)sizing processes- cooking vessels, transports of size, hazards due to steam ii) Loom shed – shuttle looms and shuttles looms iii) knitting machines iv) nonwovens.

UNIT III TEXTILE HAZARDS II **9**

Scouring, bleaching, dyeing, punting, mechanical finishing operations and effluents in textile processes.

UNIT IV HEALTH AND WELFARE **9**

Health hazards in textile industry related to dust, fly and noise generated-control measures-relevant occupational diseases, protective equipment-health and welfare measures specific to textile industry, Special precautions for specific hazardous work environments.

UNIT V SAFETY STATUS **9**

Relevant provision of factories act and rules and other statues applicable to textile industry – effluent treatment and waste disposal in textile industry.

TOTAL : 45 PERIODS

OUTCOME

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

- Understand the process flow of various manufacturing process for different materials and safety precautions for the process.
- Obtain knowledge about hazards present in various textile processes.
- Know about the effluent discharge of the textile process.
- Understand the various preventive methods and precautions available for the textile processes.
- Analyze the statuses and norms for textile industry and its effluents.

REFERENCES:

1. “Safety in Textile Industry”, Thane Belapur Industries Association, Mumbai.
1. 100 Textile fires – analysis, findings and recommendations LPA.
2. Elliot B. Grover and Hamby D.S, “Hand book of textile testing and quality control” Textile Book Publishers (Interscience), New York,
3. “Quality tolerances for water for textile industry”, BIS.
4. Shenai, V.A. “A technology of textile processing”, Vol. I, Evak Publications.
5. Little, A.H., “Water supplies and the treatment and disposal of effluent” the textile institute, Manchester.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	Understand the process flow of various manufacturing process for different materials and safety precautions for the process.	3	1	2	2	-	–	–	–	–	–	–	_	2	–	2	2	-
CO2	Obtain knowledge about hazards present in various textile processes	3	2	3	1	-	–	–	–	–	–	–	-	2	-	1	1	-
CO3	Know about the effluent discharge of the textile process.	2	1	2	2	-	-	-	-	-	-	-	-	2	-	1	-	2
CO4	Understand the various preventive methods and precautions available for the textile processes	3	2	2	2	-	-	-	-	-	-	-	-	2	-	3	1	-

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CO5	Analyze the statuses and norms for textile industry and its effluents	2	2	1	3	-	–	–	–	–	–	–	2	3	–	2	1	1
SAFETY IN TEXTILE INDUSTRY		3	2	2	2	-	–	–	–	–	–	–	2	2	–	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

IH5011	DOCK SAFETY	L	T	P	C
		3	0	0	3

OBJECTIVE

- To learn about the history and verity of dock safety legislation and regulation.
- To learn about the process, hazards present in cargo ships and safety measures.
- To understand the safety for lifting appliances.
- To understand the safety measures for transportations.
- To learn about emergency response and welfare of workers.

UNIT I HISTORY OF SAFETY LEGISLATION 9

History of dock safety status 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.

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 – Storage – types, hazardous cargo – Oil, Chemicals and Flammable Liquids Tankers – Man Entry, Dock Entry & Hot work of hazardous cargo ships

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 unstacking both on board the ship and ashore.

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

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OUTCOMES:

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

- Know about history of dock safety legislation, welfare acts for workers and environment protection.
- Understand the types of cargo ships, deck illumination and safety measures for combustible fuels present in cargo ships.
- Know about various types of lifting appliances.
- Learn about transportation devices for containers and handling methods.
- Know about how to respond to various emergency situation, dock workers rules and regulations.

REFERENCES:

1. International Labour Organization, “Safety and Health in Dock work”, 2nd ed. 1997.
2. “Indian Dock Labourers Act 1934 with rules 1948”, Law Publishers (India) Pvt. Ltd., Allahabad.
3. Taylor D.A., “”Introduction to Marine Engineering”, 2nd ed., Butterworth-Heinemann, 1996.
4. Srinivasan “Harbour, Dock and Tunnel Engineering”, Charotar Publishing House Pvt. Limited, 2011.
5. Bindra SR “Course in Dock and Harbor Engineering”, Dhanpat Rai Publications (P) Ltd., New Delhi, 2013.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	Know about history of dock safety legislation, welfare acts for workers and environment protection	3	2	2	1	-	–	–	–	–	–	–	_	2	–	2	-	-
CO2	Understand the types of cargo ships, deck illumination and safety measures for combustible fuels present in cargo ships.	2	1	3	2	2	–	–	–	–	–	–	-	2	-	1	1	-
CO3	Know about various types of lifting appliances	2	1	2	2	3	-	-	-	-	-	-	-	2	-	1	2	-
CO4	Learn about transportation devices for containers and handling methods	3	2	2	1	-	-	-	-	-	-	-	-	2	-	3	1	-
CO5	Know about how to respond to various emergency, dockworkers rules and regulations.	3	2	1	2	-	-	-	-	-	-	-	-	2	-	2	2	-
DOCK SAFETY		3	2	1	2	3	–	–	–	–	–	–	-	2	–	2	2	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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IH5012	SAFETY IN CHEMICAL INDUSTRY	L	T	P	C
		3	0	0	3

OBJECTIVE

- To gain knowledge on hazard assessment, pressure system, and process machinery.
- To learn more about various testing methods, monitoring and inspection.
- To learn about protective devices modification of planned, permit system emergency planning.
- To gain knowledge on arrestors, LPG and LNG storages, renting and relief.
- To gain knowledge on over all planned operation, start up and shut down operations.

UNIT I SAFETY IN PROCESS DESIGN AND PRESSURE SYSTEM DESIGN 10

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 equipment, 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, disposal- flare and vent systems- failures in pressure system, Effects Estimation of hazard assessment.

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 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 IV STORAGES AND TRANSPORTATION 8

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 (NOT arrest)arrestors, Spark Arrestor, fire relief- fire prevention and protection- LPG storages, pressure storages, layout, instrumentation, vaporizer, refrigerated storages, Cryogenic Storage- LNG storages, hydrogen storages, toxic storages, toxic release & control methodologies, chlorine storages, ammonia storages, other chemical storages- underground storages- loading and unloading facilities- drum and cylinder and Pressure Vessel storage – Importance of Ullage - ware house, storage hazard assessment of LPG and LNG Hazards during transportation-pipeline transport.

UNIT V 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. Specific safety consideration of cement, Paper, pharmaceutical, petroleum, petro-chemical, rubber, fertilizer and distilleries.

TOTAL : 45 PERIODS

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OUTCOMES:

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

- Understand the basic safety in process design and pressure system design.
- Know about planned commissioning and inspection.
- Obtain knowledge on equipment maintenance and several emergency plans.
- Know about hazardous gases transportation and storages.
- Obtain knowledge on specific safety considerations.

REFERENCES:

1. Safety In Chemical Plants/Industry And Its Management" by RaoBk – 2010.
2. Safety and Hazards Management in Chemical Industries – 1 Dec 2013.
3. Safety and Accident Prevention in Chemical Operations, Second Edition (Fawcett, Howard H.; Wood, William S.) April 1984.
4. Normal Accidents: Living with High Risk Technologies - Updated Edition Revised ed. Edition, Kindle Edition.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	Understand the basic safety in process design and pressure system design	3	2	2	1	-	–	–	–	–	–	–	_	2	–	2	3	2
CO2	Know about planned commissioning and inspection.	2	1	3	1	-	–	–	–	–	–	–	-	2	-	1	1	-
CO3	Obtain knowledge on equipment maintenance and several emergency plans	3	1	2	2	-	-	-	-	-	-	-	-	2	-	1	3	-
CO4	Know about hazardous gases transportation and storages	3	2	2	1	-	-	-	-	-	-	-	-	2	-	3	2	-
CO5	Obtain knowledge on specific safety considerations	2	2	3	2	-	-	-	-	-	-	-	-	2	-	2	2	-
SAFETY IN CHEMICAL INDUSTRY		3	2	1	1	-	–	–	–	–	–	–	-	2	–	2	3	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

IH5013	RELIABILITY ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVE

- To learn about the concept of maintenance, TPM features and its implementation and Tero technology.
- To learn about the safe inventory management and its control, maintenance, Five Zero concept, Root Cause analysis, FMECA.
- To understand the concept of reliability prediction models, RBD approach, application of Baye's theorem and Markov analysis.
- To know about reliability concepts and failure models, MTBF, MTTF, mortality curve, hazard plotting.
- To know how to assess the reliability of systems, non-parametric methods and replacement models.

UNIT I MAINTENANCE CONCEPTS 9

Definition – Need for maintenance – Maintenance objectives and challenges – Types of Maintenance - Preventive maintenance vs. break down maintenance – Maintenance costs - Role of maintenance department - TPM features – Chronic and sporadic losses – Equipment defects – Six major losses – Overall equipment effectiveness – TPM pillars – Autonomous maintenance – TPM implementation– Tero technology.

UNIT II MAINTENANCE MANAGEMENT AND INVENTORY CONTROL 10

Policies - Preventive maintenance schedule – Equipment and components criticality – Inspection and testing - Optimizing profit and downtime – Replacement decisions – Spare parts planning – Inventory Control. Human factors – Maintenance staffing, Learning curves, training Methods – Maintenance resource requirements, Optimization – Maintenance planning and scheduling.

Maintenance excellence - System effectiveness – Design for maintainability – Reliability Centered Maintenance – Five Zero concept – Root cause analysis – FMECA.

UNIT III RELIABILITY CONCEPTS AND FAILURE DATA ANALYSIS 10

Reliability function – failure rate – mean time between failures (MTBF) – mean time to failure (MTTF) – priory and posteriori concept - mortality curve - Life cycle assessment, useful life, availability, maintainability, system effectiveness - Time to failure distributions – Exponential, normal, Gamma, Weibull, ranking of data – probability plotting techniques – Hazard plotting

UNIT IV RELIABILITY PREDICTION MODELS 8

Series and parallel systems – RBD approach – Standby systems – m/n configuration – Application of Bayes' theorem – cut and tie set method – Markov analysis – Fault Tree Analysis – limitations.

UNIT V RELIABILITY ASSESSMENT 8

Reliability testing – Reliability growth monitoring – Non-parametric methods – Reliability and life cycle costs – Reliability allocation – Replacement model.

TOTAL : 45 PERIODS

OUTCOMES:

On successful completion of the course, the student will be able to

- Understand the necessity, objective, challenges, methods and cost involved in maintenance.
- Understand various techniques of maintenance management, optimization and reliability maintenance.
- Learn about various tools of reliability functions and various failure distributions.
- Gain knowledge about various systems and analysis of reliability prediction models.
- Learn about the testing, monitoring, allocation and cost analysis of reliability.

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REFERENCE BOOKS:

1. Charles E Ebeling, " An Introduction to Reliability and Maintainability Engineering", Tata McGraw Hill, 2009
2. Andrew K.S.Jardine and Albert H.C. Tsang (2017) 'Maintenance, Replacement and Reliability' CRC Press, 2nd Edition.
3. Bikas Badhury and S.K.Basu (2003) 'Tero Technology: Reliability Engineering and Maintenance Management' Asian Books.
4. Seiichi Nakajima (1995) 'Introduction to Total Productive Maintenance'. Productivity Press.
5. Srinath (2011) 'Reliability Engineering'. Affiliated East-West Press Pvt Ltd, New Delhi.
6. Mohammed Modarres (2009) 'Reliability Engineering and Risk Analysis: A Practical Guide' CRC Press, 2nd Edition.
7. John Davidson (1994) 'The Reliability of Mechanical system' Wiley – Blackwell publisher Smith C.O. (1976) 'Introduction to Reliability in Design' McGraw Hill Inc., US.

ONLINE SOURCES:

1. http://www.weibull.com/knowledge/links.htm
2. https://www.camcode.com/asset-tags/top-reliability-blogs/

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	Understand the necessity, objective, challenges, methods and cost involved in maintenance.	3	1	2	1	-	–	–	–	–	–	–	_	2	–	2	-	-
CO2	Understand various techniques of maintenance management, optimization and reliability maintenance.	2	2	3	1	3	–	–	–	–	–	–	-	2	-	1	1	-
CO3	Learn about various tools of reliability functions and various failure distributions	2	2	2	2	3	-	-	-	-	-	-	-	2	-	1	-	-
CO4	Gain knowledge about various systems and analysis of reliability prediction models.	3	2	2	1	-	-	-	-	-	-	-	-	2	-	3	-	-
CO5	Learn about the testing, monitoring, allocation and cost analysis of reliability.	3	2	2	2	-	-	-	-	-	-	-	1	3	-	2	1	1
RELIABILITY ENGINEERING		3	2	1	2	-	–	–	–	–	–	–	1	2	–	2	1	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

IH5014	PHYSICAL AND CHEMICAL TREATMENT OF WATER AND WASTE WATER	L	T	P	C
		3	0	0	3

OBJECTIVES

- To study the pollutants and characteristics in water and waste water.
- To know the physical treatment principles, mass transfer isotherms and mass transfer coefficient.
- To know chemical treatment principles, solvent extraction, advance oxidation.
- To provide knowledge on design of conventional treatment plants and their O & M aspects.
- To design the industrial water treatment process, demineralizers and residue arrangement.

UNIT I INTRODUCTION **3**

Pollutants in water and wastewater – Characteristics – Standards for performance –Significance and need for physico-chemical treatment.

UNIT II PHYSICAL TREATMENT PRINCIPLES **10**

Principles of Screening – Mixing, equalization – Sedimentation – Filtration – Modelling – Back washing – Evaporation – Incineration – Gas transfer – Mass transfer coefficients – Adsorption – Isotherms – Principles, equilibria and kinetics, reactors, regeneration, membrane separation, Reverse Osmosis, Nano filtration, ultra filtration and hyper filtration – Electro dialysis, distillation – Stripping and crystallization – Recent Advances.

UNIT III CHEMICAL TREATMENT PRINCIPLES **9**

Principles of Chemical treatment – Coagulation flocculation – Precipitation – flotation, solidification and stabilization – Disinfection – Ion exchange, Electrolytic methods, Solvent extraction – advance Oxidation /reduction – Recent Advances.

UNIT IV DESIGN OF CONVENTIONAL TREATMENT PLANTS **15**

Selection of unit operations and processes – Design of conventional water treatment plant units – Aerators – chemical feeding – Flocculation – clarifier – filters – Rapid sand filter, slow sand filter, pressure filter – Chlorinators – Displacement and gaseous type. Layouts – flow charts – Hydraulic Profile – O and M aspects – Case studies – Residue management – Up gradation of existing plants – Recent Advances.

UNIT V DESIGN OF INDUSTRIAL WATER TREATMENT AND RECLAMATION **8**

Selection of process – Design of softeners – Demineralisers – Wastewater reclamation – Reverse osmosis plants – Residue management – O and M aspects – Recent Advances – Case studies.

TOTAL : 45 PERIODS

OUTCOMES:

On successful completion of the course, the student will be able to

- Understand the characteristics & level of the pollutants in water and waste water.
- Know about the principles of the physical treatment process.
- Obtain knowledge about chemical treatment process and recent advancements in the field.
- Understand about the design of conventional treatment plants, filters and recent advancements.
- Analyze the knowledge of water treatment, reverse osmosis and reclamation process in the industry.

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REFERENCES:

1. Metcalf and Eddy, “Wastewater Engineering, Treatment and Reuse”, Tata McGraw-Hill, Fourth Edition, 2009.
2. “Manual on Water Supply and Treatment”, CPHEEO, Ministry of Urban Development, Government of India, 1999.
3. Lee, C.C. and Shun dar Lin, “Handbook of Environmental Engineering Calculations”, McGraw- Hill, Second edition, 2007.
4. Qasim, S.R., Motley, E.M. and Zhu, G., “Water works Engineering – Planning, Design and Operation”, Prentice Hall, 2002.
5. Casey, T.J., “Unit Treatment Processes in Water and Wastewater Engineering”, John Wiley and Sons.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	Understand the characteristics & level of the pollutants in water and waste water	3	3	2	1	-	–	–	–	–	–	–	_	2	–	2	1	-
CO2	Know about the principles of the physical treatment process.	2	2	3	2	-	–	–	–	–	–	–	-	2	-	1	1	-
CO3	Obtain knowledge about chemical treatment process and recent advancements in the field.	2	3	2	2	-	-	-	-	-	-	-	-	2	-	1	1	-
CO4	Understand about the design of conventional treatment plants, filters and recent advancements	3	2	2	1	-	-	-	-	-	-	-	-	2	-	3	1	-
CO5	Analyze the knowledge of water treatment, reverse osmosis	2	2	3	3	-	-	-	-	-	-	-	-	3	-	2	1	-

	and reclamation process in the industry.																	
PHYSICAL AND CHEMICAL TREATMENT OF WATER AND WASTE WATER		3	2	2	2	-	–	–	–	–	–	–	-	2	–	2	1	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

IH5015	SAFETY IN PROCESS INDUSTRIES	L	T	P	C
		3	0	0	3

OBJECTIVES

- To study about safety in process design and pressure system design, batch reactor, flare and vent system.
- To provide the knowledge about plant commissioning and inspection, pre and post commissioning documents.
- To study about plant operation prevailing, trip system.
- To study about maintenance, modification and emergency planning, repair and demolition.
- To provide knowledge about storage condition in process industries.

UNIT I SAFETY IN PROCESS DESIGN AND PRESSURE SYSTEM DESIGN 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 equipment, 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, 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, 69 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-colour coding of pipes and cylinders – Corrosion prevention for underground pipes.

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, vapourizer, 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

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OUTCOMES:

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

- Analyze the different safety aspect in process design and pressure system, heat exchanger, pressure relief valve, flare and vent system.
- Understand the concept of commissioning and inspection.
- Obtain knowledge of operation prevailing in corrosion prevention, underground pipes.
- Know about management of on-site and off-site emergency planning, maintenance, disaster planning
- Analyze about the details of storages in industries, vents, relief valves, storage.

REFERENCES:

1. Lees, F.P., "Loss Prevention in Process Industries" Butterworth publications, London, 3rd Edition, 2005.
2. Sanoy Banerjee, "Industrial hazards and plant safety", Taylor & Francis, London, 2003.
3. Fawcett, H. and Wood, "Safety and Accident Prevention in Chemical Operations" Wiley inters, 2nd Edition.
4. McElroy, Frank E., "Accident Prevention Manual for Industrial Operations", NSC, Chicago.
5. Green, A.E., "High Risk Safety Technology", John Wiley and Sons.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	Analyze the different safety aspect in process design and pressure system, heat exchanger, pressure relief valve, flare and vent system	3	2	2	1	-	–	–	–	–	–	–	_	2	–	2	2	1
CO2	Understand the concept of commissioning and inspection.	2	3	3	1	-	–	–	–	–	–	–	-	2	-	1	-	1
CO3	Obtain knowledge of operation prevailing in corrosion prevention, underground pipes	2	2	2	2	-	-	-	-	-	-	-	-	2	-	1	1	-
CO4	Know about management of on-site and off-site emergency planning, maintenance, disaster planning	3	2	2	1	-	-	-	-	-	-	-	-	2	-	3	3	-

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CO5	Analyze about the details of storages in industries, vents, relief valves, storage	2	1	3	2	-	-	-	-	-	-	-	-	2	-	3	2	-
SAFETY IN PROCESS INDUSTRIES		3	2	1	2	-	–	–	–	–	–	–	-	2	–	2	3	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

IH5016	PRINCIPLES OF TECHNICAL ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To provide comprehensive knowledge on quantitative estimation principle, BERTRAND's method estimation.
- To study about analysis of coal and fertilizers and estimation of nitrogen in ammonia fertilizers.
- To study about rapid methods of analysis of cement and quality assessment of cement.
- To study about purity index of oil, saponification value and iodine value of oils.
- To provide knowledge about quality standards of drinking water and estimation of chemical oxygen demand.

UNIT I QUANTITATIVE ESTIMATION - PRINCIPLE 8

Types of Analysis- Principles underlying Quantitative estimation- Purity of simple sugars Principle are underlying BERTRAND'S method- Estimation of percentage purity of phenol (By tribromo phenol formation method) - Estimation of percentage purity of glycerol- Principles underlying above estimations.

UNIT II ANALYSIS OF COAL AND FERTILIZER 8

Analysis of Coal- Suitability for thermal power plants- Proximate and ultimate analysis of coal - underlying principles- Correlation between thermal energy and fixed carbon- Estimation of nitrogen in ammonia fertilizers and soil- Principles underlying Kjeldahl's method.

UNIT III STANDARD AND RAPID METHODS OF ANALYSIS OF CEMENT 10

Types of analysis of cement- Standard and rapid methods- Fundamentals generalizations underlying the above estimations- Quality assessment of Cement.

UNIT IV PURITY INDEX OF OIL 9

Estimation of freshness and purity of a vegetable oil- Principles underlying estimation of free acid value, Saponification value and iodine value- Causative factors of rancidity of oil.

UNIT V QUALITY STANDARDS OF DINKING WATER 10

Estimation of Chloride, Sulphate, Total Dissolved Solids and Dissolved Oxygen in the given sample of water- Principles underlying estimation of chemical oxygen demand (COD) - Principles underlying water purification strategies- World Health Organization prescribed standards of drinking water.

TOTAL : 45 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Understand the concepts of quantitative estimation, purity of sugar, phenol and glycerin.
- Analyze the knowledge on the analysis of coal and fertilizer.
- Know about the rapid methods of analysis of cements.
- Obtain knowledge about purity of index of oils.
- Analyze the purity of drinking water to the prescribed standards of the drinking water and WHO standards of water.

REFERENCES:

1. Commercial methods of Analysis by Fosterdee Snell and Frank Moody Bifeen- Chemical Publishing House, Page 11 – 37, 596 – 603 and 654- 662.
2. Technical Analysis Lab Manuals- Volume I and II by Dr.K.Srinivasan and Dr.P.Gnanasundaram, Anna University, Chennai.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	Understand the concepts of quantitative estimation, purity of sugar, phenol and glycerin	2	2	1	2	-	–	–	–	–	–	–	2	3	–	3	-	-
CO2	Analyze the knowledge on the analysis of coal and fertilizer	2	3	2	-	3	–	–	–	–	–	–	-	2	–	3	-	-
CO3	Know about the rapid methods of analysis of cements	2	3	2	1	3	-	-	-	-	-	-	-	2	-	2	-	-
CO4	Obtain knowledge about purity of index of oils	3	2	2	1	2	-	-	-	-	-	-	-	3	-	2	-	-
CO5	Analyze the purity of drinking water to the prescribed standards of the drinking water and WHO standards of water	2	3	2	2	-	–	–	–	–	–	–	3	3	–	3	-	-
PRINCIPLES OF TECHNICAL ANALYSIS		3	2	1	2	2	–	–	–	–	–	–	3	3	–	3	-	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

IH5017	TRANSPORT SAFETY	L	T	P	C
		3	0	0	3

OBJECTIVES

- To obtain knowledge about the safety requirements in transportation of hazardous goods, TREM, IMDG and IATA.
- To learn the road transport, motor vehicle Act, insurance and surveys.
- To gain knowledge on Driver and safety, fleet accident frequency, incentives, slogans, emergency planning and HAZMAT codes.
- To learn about road safety, alignment and gradient, illumination, clearance-tracks-warning.
- To learn about shop floor and repair shop safety, servicing and handling, maintenance equipment and other safety practices.

UNIT I TRANSPORTATION OF HAZARDOUS GOODS 9

Transport emergency card (TREM) – warning symbols – responsibilities of driver – inspection and maintenance of vehicles-check list- loading and decanting procedures – communication – training to driver – selection of drivers – parking of tankers – design of tankers and effects of static electricity- Consensus Standards: IMDG & IATA.

UNIT II ROAD TRANSPORT 8

Introduction – Road safety Improving factors – Accidents Causes due to drivers and pedestrians - design, selection, operation and maintenance of motor trucks preventive maintenance - motor vehicles act – motor vehicle insurance and surveys.

UNIT III DRIVER AND SAFETY 9

Programme on Driver safety – accident reporting and investigation procedures-fleet accident frequency-safe driving incentives-slogans in driver cabin-motor vehicle transport workers act – driver relaxation and rest pauses – speed and fuel conservation – emergency planning and Hazmat codes.

UNIT IV ROAD SAFETY 10

Road alignment and gradient-reconnaissance-ruling gradient-maximum rise per k.m.- factors influencing alignment like tractive resistance, tractive force, direct alignment, vertical curves-breaking characteristics of vehicle-skidding-restriction of speeds- significance of speeds-Pavement conditions – Sight distance – Safety at intersections –Traffic control lines and guide posts-guard rails and barriers – street lighting and illumination overloading-concentration of driver. Plant railway: Clearance-track-warning methods-loading and unloading-moving cars safety practices.

UNIT V SHOP FLOOR AND REPAIR SHOP SAFETY 9

Transport precautions-safety on manual, mechanical handling equipment operations safe driving-movement of cranes-conveyors etc., servicing and maintenance equipment grease rack operation-wash rack operation-battery charging-gasoline handling-other safe practices-off the road motorized equipment.

TOTAL : 45 PERIODS

OUTCOMES:

On successful completion of the course, the student will be able to

- Obtain knowledge about transportation of hazardous goods and procedure involved.
- Know about the road transport, design, selection, operation and maintenance.
- Understand the safety involved in Emergency planning and HAZMAT codes and programs on driver safety.
- Obtain information related to safety such as alignment and gradient.
- Know about the servicing, handling and maintenance of equipment.

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REFERENCES:

1. Popkes, C.A. “Traffic Control and Road Accident Prevention” Chapman and Hall Limited.
2. Babkov, V.F., “Road Conditions and Traffic Safety” MIR Publications, Moscow.
3. Kadiyali, “Traffic Engineering and Transport Planning” Khanna Publishers, New Delhi.
4. Motor Vehicles Act, 1988 (Amendment 2007), Government of India.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	Obtain knowledge about transportation of hazardous goods and procedure involved	3	2	1	2	1	–	–	–	–	–	–	2	3	–	3	3	2
CO2	Know about the road transport, design, selection, operation and maintenance	2	3	1	2	1	–	–	–	–	–	–	-	3	2	3	2	1
CO3	Understand the safety involved in Emergency planning and HAZMAT codes and programs on driver safety	3	2	2	1	-	-	-	-	-	-	-	-	3	-	2	2	1
CO4	Obtain information related to safety such as alignment and gradient	3	2	1	2	-	-	-	-	-	-	-	-	2	-	3	2	1
CO5	Know about the servicing, handling and maintenance of equipment	3	2	1	2	3	–	–	–	–	–	–	-	2	–	2	2	1
TRANSPORT SAFETY		3	2	2	2	2	–	–	–	–	–	–	3	3	–	2	3	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

IH5018	SAFETY IN POWDER HANDLING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To learn the physical, chemical and other properties of powders, synthesis of Nano-powders and charging of powders.
- To know about the metal powders and characterization, SEM, AFM, solid propellants and pyro techniques.
- To learn the dust explosion, Hartmann vertical tube apparatus and hybrid test.
- To know about the dust handling plants and electrostatic hazards and electroplating.
- To learn the dust evaluation and control, environmental protection and NIOSH guidelines.

UNIT I INTRODUCTION **9**

Powder classification-physical, chemical and other properties-metal powders-other non- metallic powders-handling methods-manual, mechanical – synthesis of nano powders - automatic-charges on powders-charge distribution charging of powders.

UNIT II METAL POWDERS AND CHARACTERIZATION **9**

Atomization, types – milling – electro deposition – spray drying, Production of iron powder, aluminium powder, Titanium – screening and cleaning of metals – Explosivity and pyrophoricity – toxicity Particle size and size distribution – measurement, types and significance – particle shape analysis – SEM, AFM, particle size analyser, surface area, density, porosity, flow rate – testing. Metal powders, applications as fuel, solid propellants, explosives, pyrotechnics.

UNIT III DUST EXPLOSION **9**

Industrial dust, dust explosion accidents – explosibility characteristics, minimum explosive concentration, minimum ignition energy, explosion pressure characteristics, maximum permissible oxygen concentration- explosibility tests, Hartmann vertical tube apparatus, horizontal tube apparatus, inflammatory apparatus, Godbert and Greenward furnace. Explosibility classification – Hybrid test – gas mixtures – Dust ignition sources – Dust explosion prevention – Dust explosion protection – Dust explosion venting, vent coefficient, various methods of design – venting of ducts and pipes – dust fire.

UNIT IV DUST HANDLING PLANTS AND ELECTRO STATIC HAZARDS **9**

Grinding mills, conveyors, bucket elevators, dust separators, dust filters, cyclones, driers, spray driers, silos, grain elevators, typical applications, hazards. Electrostatic charges-energy released-type of discharge-spark-carona-insulating powders-propagating brush discharge-discharge in bulk lightning hazards in powder coating-electroplating - handling of nano powders in the presence of flammable gases and vapour.

UNIT V DUST EVALUATION AND CONTROL **9**

Evaluation, methodology, Quantitative, sampling, measurements – control approaches and strategies – control of dust sources, dust transmission – role of workers, PPE and work practice – Housekeeping – storage – labeling – warning sign – restricted areas - Environmental protections. Evaluation procedures and control measures for particulates (Respirable), Asbestos and other fibres, silica in coal mine - NIOSH guide to the selection and use of particulate respirators – case studies

TOTAL : 45 PERIODS

OUTCOMES:

On successful completion of the course, the student will be able to

- Obtain knowledge about various properties of powders, their handling methods and charging of powders.
- Understand the metal powders and their characterization and their measurements, types and significance.
- Know about dust explosion accidents and obtain information on tests carried out, prevention and protection.
- Obtain knowledge about the dust handling plant and electrostatic hazards.
- Understand dust evaluation and control, NIOSH guide.

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REFERENCES:

1. Martin Glor, “Electro Static Hazard in Powder Handling” Research studies Press Ltd., England.
2. International Labour Organization, “Major hazard control”, Geneva.
3. SRMC,“Hazard recognition and prevention in the work place airborne dust” Vol. I & II, Chennai, 2000.
4. ASM, “Metals hand book Powder Metallurgy”, Vol.7, 9th ed.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	Obtain knowledge about various properties of powders, their handling methods and charging of powders.	3	2	1	1	-	–	–	–	–	–	–	3	3	–	3	2	-
CO2	Understand the metal powders and their characterization and their measurements, types and significance	2	1	2	1	2	–	–	–	–	–	–	2	3	-	3	1	-
CO3	Know about dust explosion accidents and obtain information on tests carried out, prevention and protection	2	3	2	2	3	-	-	-	-	-	-	3	3	-	3	-	-
CO4	Obtain knowledge about the dust handling plant and electrostatic hazards	3	1	1	2	3	-	-	-	-	-	-	2	2	-	3	2	-
CO5	Understand dust evaluation and control, NIOSH guide	3	3	2	1	-	–	–	–	–	–	–	2	2	–	3	-	-
SAFETY IN POWDER HANDLING		3	2	2	2	-	–	–	–	–	–	–	3	3	–	3	2	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

IH5019	ELECTRICAL SAFETY	L	T	P	C
		3	0	0	3

OBJECTIVES

- To provide basic electrical concepts and working principles.
- To provide the Standards and requirements, Indian Electrical acts and rules.
- To know about the electrical hazards, National Electricity safety code, protection measures and PPE requirements.
- To learn the electrical protection and maintenance, discharge rods and Earthing device.
- To study the hazard area classification-Electrical equipment (IS NFPA, API and OSHA standards).

UNIT I BASIC ELECTRICAL **12**

Review of Electrical concept, Electrostatic – Electro magnetism – Stored energy – Working principle of major electrical equipment – Typical supply situation.

UNIT II STANDARDS AND REQUIREMENTS **10**

Standards and statutory requirements – Indian electricity acts and rules – statutory requirements from Electrical inspectorate.

UNIT III ELECTRICAL HAZARDS **9**

Electrical Hazards – Energy leakage – Clearance and insulation – Excess energy – Current surges – Electrical causes of fire and explosion – National electrical Safety code. Human interface with electricity – Human resistance to electricity – Protection measures from electrical shock – PPE requirement.

UNIT IV ELECTRICAL PROTECTION AND MAINTENANCE **8**

Selection of Environment, Protection and Interlock – Discharge rods and earthing device – Safety in the use of portable tools - Preventive maintenance.

UNIT V CLASSIFICATION OF HAZARDOUS AREAS **6**

Hazardous area classification and classification of electrical equipment's for hazardous areas (IS, NFPA, API and OSHA standards).

TOTAL : 45 PERIODS

OUTCOMES:

On successful completion of the course, the student will be able to

- Understand the basic concepts and working principles of electrical equipment and typical supply situations.
- Obtain knowledge about standards and requirements.
- Analyze various electrical hazards and protection measure and PPE requirements can be understood.
- Obtain knowledge about electrical protection and preventive maintenance.
- Understand about the classification of hazardous area and the electrical equipment used.

REFERENCES:

1. "Electrician Theory", 2018.
2. "Electrical safety handbook", John Cadick, Mary Capelli-Schellpfeffer – 2012.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	Understand the basic concepts and working principles of electrical equipment and typical supply situations	3	2	2	1	3	–	–	–	–	–	–	_	2	–	2	-	-
CO2	Obtain knowledge about standards and requirements	3	1	3	1	2	–	–	–	–	–	–	-	2	-	1	-	-
CO3	Analyse various electrical hazards and protection measure and PPE requirements can be understood	2	3	2	1	3	-	-	-	-	-	-	-	2	-	1	-	-
CO4	Obtain knowledge about electrical protection and preventive maintenance	3	2	1	1	-	-	-	-	-	-	2	-	2	-	3	-	-
CO5	Understand about the classification of hazardous area and the electrical equipment used	3	2	1	2	3	–	–	–	–	–	–	2	3	–	2	-	-
ELECTRICAL SAFETY		3	2	1	2	1	–	–	–	–	–	1	2	2	–	2	-	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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IH5020	FIREWORKS SAFETY	L	T	P	C
		3	0	0	3

OBJECTIVES

- To gain the knowledge about various chemicals used in fireworks, combustion properties.
- To learn about hazardous pollution prevention, barriers.
- To learn about factories act, explosive act, rules and process safety, fire prevention and control.
- To gain the knowledge about handling and transport.
- To learn about waste control in fireworks, storage and safe disposal.

UNIT I PROPERTIES OF FIREWORKS CHEMICALS 8

Combustion properties – potassium nitrate (KNO3), potassium chlorate (KClO3), barium nitrate (BaNO3), calcium nitrate (CaNO3), Sulphur (S), Phosphorous (P), antimony (Sb), Pyro Aluminum (Ai) powder-Reactions-metal powders, Borax, ammonia (NH3) – Strontium Nitrate, Sodium Nitrate, Potassium per chloride. Fire and explosion, impact and friction sensitivity.

UNIT II STATIC CHARGE AND DUST 9

Concept-prevention - earthing -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 – emergency planning in fireworks – Automation of manual process.

UNIT IV MATERIAL HANDLING 10

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

OUTCOMES:

On successful completion of this course students will able to

- Understand the properties of various chemicals in fireworks.
- Know about the hazards in fire work factories.
- Obtain knowledge on process safety in various stages.
- Analyze the various handling process of materials.
- Know about waste control methods in other countries and role of fire service.

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REFERENCES:

1. Ghosh, K.N. The Principles of Firecrackers, Economic Enterprises, Sivakasi ;
2. Shanmugam, G. et al, Fireworks safety 1999: Proceedings of the National seminar held at MSEC, Sivakasi on July 17 & 18, 1999
1. Pyrotech 2013, Proceedings of the 2nd National Fireworks Conference, Sivakasi; 2013
2. Conkling J., Chemistry of Pyrotechnics: Basic Principles and Theory; Marcel Dekker Inc.: New York.
3. Shimizu, T. Firecrackers: The Art, Science and Technique, Maruzen Co, Tokyo.
4. Brock, H. Pyrotechnics - The history and art of fireworks making, London, D.O'Connor.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	Understand the properties of various chemicals in fireworks	2	2	1	2	-	–	–	–	–	–	–	3	3	1	2	1	-
CO2	Know about the hazards in fire work factories	3	2	1	1	1	-	-	-	-	-	-	3	3	1	2	-	-
CO3	Obtain knowledge on process safety in various stages	3	2	-	1	1	-	-	-	-	-	-	-	3	-	2	-	-
CO4	Analyze the various handling process of materials	2	3	1	-	3	-	–	–	–	–	–	-	2	-	3	2	-
CO5	Know about waste control methods in other countries and role of fire service	3	2	1	3	2	-	–	–	–	–	–	-	2	-	3	1	-
FIREWORKS SAFETY		3	2	1	1	1	-	-	-	-	-	-	-	3	-	3	2	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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IH5021	SAFETY IN OIL & GAS INDUSTRY	L	T	P	C
		3	0	0	3

OBJECTIVE

To ensure knowledge on the safe handling of oil and gas.

UNIT I PETROLEUM PRODUCTS **10**

Flash point - Classification of petroleum products – Class A,B,C & Excluded - LEL – UEL – Static Electricity – Earthing – Bonding – Flameproof Enclosure – ATEX - Case Studies – Jaipur Fire Incident – MB Lal Committee Recommendations - BP Texas incident - Hazira Fire Incident.

UNIT II UPSTREAM & DOWNSTREAM OPERATION **10**

On and off shore oil operation – Construction of Installation – Pipe line Construction – Maintenance and repair activities – Safety and associated hazards - transportation - Petroleum product storage.

UNIT III SAFETY HANDLING OF HYDROCARBON **9**

Boil over phenomena - Hydro Carbon Detector (HCD) – Remote Operated Shut Off valves (ROSOV) – Firefighting techniques – Foam types – AFFF, ARAFFF, and Rim Seal Fire Protection System - Foam Pourer – Foam monitor – Medium Expansion Foam Generator (MEFG), High Volume Long Range (HVLR) Monitor.

UNIT IV DISASTER MANAGEMENT PLAN **9**

Basic of major DMP - Objective of DMP - Categories of Emergencies – Quantitative Risk Assessment - Element of Disaster Management Plan - Mutual aid - On-site drill - Off-site drill - Disaster Management Act, 2005.

UNIT V RULES & REGULATION **7**

Oil Industry Safety Directorate – OISD-STD-105 - OISD-STD-118 - OISD-STD-144 - Jaipur Fire Incident - OISD-STD-244 - The Petroleum Rules, 2002.

TOTAL : 45 PERIODS

OUTCOMES:

- Understand about the various classes of fuels and case studies of fire accidents
- Know about different aspects of pipeline constructional safety aspects of oil transportation
- Obtain knowledge about various safety techniques of safe handling of hydro carbon
- Analyze different aspects of disaster management plans and safety management drill
- Obtain insight into various oil and natural gas legislation in India

REFERENCE BOOKS:

1. Basic Offshore Safety: Safety induction and emergency training for new entrants to the offshore oil and gas industry Hardcover – 4 Jul 2017.
2. Offshore Safety Management, 2nd Edition, Ian Sutton - 6th December 2013.
3. Safety of offshore oil and gas operations: Lessons from past accident analysis Michalis Christou and Myrto Konstantinidou 2012.
4. Guide to the Offshore Installations (Safety Case) Regulations 2005 (Legal) Paperback – December 1, by HSE (Author).

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	Understand about the various classes of fuels and case studies of fire accidents	3	1	2	1	-	–	–	–	–	–	–	_	2	–	2		
CO2	Know about different aspects of pipeline constructional safety aspects of oil transportation	2	1	3	1	3	–	–	–	–	–	–	-	2	-	1		
CO3	Obtain knowledge about various safety techniques of safe handling of hydro carbon	2	1	2	2	3	-	-	-	-	-	-	-	2	-	1		
CO4	Analyze different aspects of disaster management plans and safety management drill	3	2	2	1	-	-	-	-	-	-	-	-	2	-	3		
CO5	Obtain insight into various oil and natural gas legislation in India	2	2	1	3	-	–	–	–	–	–	–	2	3	–	2		
SAFETY IN OIL & GAS INDUSTRY		3	2	1	2	-	–	–	–	–	–	–	2	2	–	2		

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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IH5022	NUCLEAR ENGINEERING AND SAFETY	L	T	P	C
		3	0	0	3

OBJECTIVES

- To learn about alpha, beta and gamma rays, radioactive decay, neutron modification, fast fission and thermal utilization.
- To gain the knowledge about control means, control and shut-down and problem in the operation.
- To learn about types of nuclear reactors and cycles.
- To gain the knowledge about reactor control and protection systems.
- To gain the knowledge about control of radioactive release.

UNIT I INTRODUCTION **9**

Fission and fusion process – radio activity – alpha, beta and gamma rays, radioactive decay – decay schemes – effects of radiation – neutron interaction – cross section – reaction rate – neutron moderation – multiplication – scattering – collision – fast fission – resonance escape – thermal utilization – criticality.

UNIT II REACTOR CONTROL **9**

Design considerations – Control requirements – control means – control and shut down - rods – their operation – Problems in operations – control instrumentation and monitoring – online central data processing system.

UNIT III REACTOR TYPES **9**

Boiling water reactors – radioactivity of steam system – direct cycle and dual cycle power plants-pressurized water reactors and pressurized heavy water reactors – fast breeder reactors and their role in power generation in the Indian context – conversion and breeding – doubling time – liquid metal coolants – nuclear power plants in India.

UNIT IV SAFETY OF NUCLEAR REACTORS **9**

Principles in design safety – engineered safety features – site related factors – safety related systems – heat transport systems – reactor control and protection system – fire protection system – quality assurance in plant components – operational safety – safety regulation process – public awareness and emergency preparedness. Accident Case studies- Three Mile island and Chernobyl accident.

UNIT V RADIATION CONTROL **9**

Radiation shielding – radiation dose – dose measurements – units of exposure – exposure limits – barriers for control of radioactivity release – control of radiation exposure to plant personnel – health physics surveillance – waste management and disposal practices – environmental releases.

TOTAL : 45 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Understand about fission and fusion process, radioactivity and effect of radiation.
- Know about control requirements, control means, control instrumentation and monitoring.
- Obtain knowledge about various reactors and various power plants in India.
- Analyze various safety related systems, awareness and emergency preparedness.
- Obtain knowledge on radiation, waste management and disposal practices and environmental release.

REFERENCES:

1. Nuclear Energy, Charles D. Ferguson 2011.
2. Nuclear Engineering Fundamentals, Robert E. Masterson, 2017.
3. Introduction to Nuclear Engineering, Jhon R. Lamarsh, Anthony J. Baratta, 3rd Edition-2014.
4. Nuclear reactor Engineering, Dr. G. Vardyanathan-2013.
5. Regulatory control of nuclear power plants Part A, International Atomic Energy Agency, Vienna, 2002

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	Understand about fission and fusion process, radioactivity and effect of radiation	2	3	2	1	2	–	–	–	–	–	–	_	2	–	2	-	-
CO2	Know about control requirements, control means, control instrumentation and monitoring	3	2	2	1	3	–	–	–	–	–	–	-	3	-	1	-	-
CO3	Obtain knowledge about various reactors and various power plants in India	3	2	2	1	1	-	-	-	-	-	-	-	3	-	2	-	-
CO4	Analyze various safety related systems, awareness and emergency preparedness	3	2	2	1	-	-	-	-	-	-	-	-	2	-	3	3	2
CO5	Obtain knowledge on radiation, waste management and disposal practices and environmental release	2	2	1	3	-	–	–	–	–	–	–	2	3	–	2	1	2
NUCLEAR ENGINEERING AND SAFETY		3	2	1	2	-	–	–	–	–	–	–	2	2	–	2	3	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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IH5023	BEHAVIOUR BASED SAFETY	L	T	P	C
		3	0	0	3

OBJECTIVES

- To learn about behavior based safety program, ABC model and BBS - case study.
- To gain the knowledge about psychological aspects of safety and safety culture system.
- To learn about main pillar of process safety management, theories of motivation and their application.
- To gain knowledge on work men compensation act, direct and indirect cost of accidents.
- To learn about element of disaster management plan, aid schemes mineral exploitation.

UNIT I BBS - INTRODUCTION 9

Behaviour based safety – overview – psychology of behaviour based management – focus on behaviour to manage the risk – leadership – behaviour safety programme for employees – measure safety programme – ABC model – BBS – case studies

UNIT II HUMAN BEHAVIOUR CHARACTERS 9

Organizational behaviour – human factors contributing to accident – psychological aspects of safety – safety culture system – individual difference – behaviour function of self and situation – perception of danger and acceptance of risks

UNIT III SAFETY CULTURE 9

PSM and Safety Culture – An Overview – Main Pillar of Process Safety Management – Organization – Monitoring – Reporting – theories of motivations and their application to safety – role of management, supervisors and safety department in motivation – ethical issues.

UNIT IV ACCIDENTS 9

Types and severity of accidents – accident classification – accident – entitlement under workmen's Compensation Act – objectives and methodology of conducting accident investigation – Direct and Indirect costs of accident.

UNIT V DISASTER MANAGEMENT 9

Objectives of Disaster Management Plans – on-site & off-site emergencies' – levels of emergencies – Elements of Disaster Management Plan – Mutual –aid schemes – Mineral exploitation – material Handling Process – Manufacturing plant.

TOTAL : 45 PERIODS

OUTCOMES:

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

- Understand about psychological of behavior based safety and focus on behavior to manage the risk.
- Obtain knowledge about organizational behavior, perception of danger and acceptance of risk.
- Know about PSM, safety culture and ethical issue.
- Understand about the types and severity of accidents and accident investigation.
- Analyze various disasters, on-site and off-site emergencies.

REFERENCES:

1. "Handbook of applied behavior Analysis", wayne W. Fisher, Calhleen C. Piazza, Hentry S. Roane – 2015.
2. "An introduction to production management techniques" (Wickens Christopher, Lee john).
3. Operation forecasting and modeling, CLYDE.B, STROPNG.M.S

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	Understand about psychological of behavior based safety and focus on behavior to manage the risk	3	1	2	1	-	–	–	–	–	–	–	_	2	–	2	-	3
CO2	Obtain knowledge about organizational behavior, perception of danger and acceptance of risk	3	1	2	1	2	–	–	–	–	–	–	-	3	-	2	-	2
CO3	Know about PSM, safety culture and ethical issue	3	2	2	2	-	-	-	-	-	-	-	-	3	-	2	-	2
CO4	Understand about the types and severity of accidents and accident investigation	3	2	3	1	-	-	-	-	-	-	-	-	2	-	3	-	2
CO5	Analyze various disasters, on-site and off-site emergencies	2	3	1	3	-	–	–	–	–	–	–	2	3	–	2	2	2
BEHAVIOUR BASED SAFETY		3	2	2	2	-	–	–	–	–	–	–	2	2	–	2	2	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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IH5024	DISASTER AND INCIDENT MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES

- To gain the knowledge on atmospheric disaster, meteorological phenomena and forest related disaster.
- To learn about APELL, onsite and offsite emergency.
- To gain the knowledge on ODS banking phasing out EL Nino and estimate change.
- To learn about case studies and control measures on marine waste, nuclear waste.
- To gain the knowledge about crisis organization, mutual aid and incident management.

UNIT I INTRODUCTION **10**

Philosophy of Disaster management-Introduction to Disaster mitigation-Hydrological, Coastal and Marine Disasters-Atmospheric disasters-Geological, meteorological phenomena-Mass Movement and Land Disasters-Forest related disasters-Wind and water related disasters-deforestation-Use of space technology for control of geological disasters.

UNIT II TECHNOLOGICAL DISASTERS **10**

Technological Disasters-Case studies of Technology disasters with statistical details-Emergencies and control measures-APELL-Onsite and Offsite emergencies-Crisis management groups-Emergency Centers and their functions throughout the country Software on emergency controls-Monitoring devices for detection of gases in the atmosphere-Right to know act.

UNIT III ENVIRONMENTAL DISASTER MANAGEMENT **8**

Introduction to Sustainable Development- Bio Diversity-Atmospheric pollution- Global warming and Ozone Depletion- ODS banking and phasing out- Sea level rise- El Nino and climate changes- Eco friendly products- Green movements- Green philosophy - Environmental Policies-Environmental Impact Assessment-case studies- Life cycle.

UNIT IV POLLUTION ASPECTS **8**

Offshore and onshore drilling-control of fires-Case studies- Marine pollution and control- Toxic, hazardous and Nuclear wastes-state of India's and Global environmental issues carcinogens-complex emergencies- Earthquake disasters- the nature-extreme event analysis- the immune system- proof and limits.

UNIT V INCIDENT MANAGEMENT **9**

The fundamentals of incident management, essential for effective industrial incident management covering: Incident Command System; Emergency Leadership, Emergency Risk Management; Mutual Aid & Joint Operations; Crisis Organization & Management; Response Functions & Priorities; Media Management; Scene Safety & Security; Damage Assessment; Salvage & Repair; Business Continuity; Employee Assistance; Incident Investigation; Cleanup & Restoration; and Incident Termination.

TOTAL : 45 PERIODS

OUTCOMES:

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

- Understand about the disaster management and spare technology for control of geological disasters.
- Obtain knowledge on technological disaster and case study.
- Analyze environmental disasters and environmental policies
- Know about pollution from various aspects and its analysis.
- Understand the fundamentals of incident management and media management.

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REFERENCES:

1. Gilbert, M. Masters., "Introduction to Environmental Engineering and Science", 3rd edition 2008.
2. Miller, G. Tylor., "Environmental Science",14th edition 2012.
3. G. Tylor, Miller., "Environmental Science sustaining the earth", 2005.
4. Bagad Vilas. "Principles of Environmental Science and Engineering", 2004.
5. Sivakumar.R., "Principles of Environmental Science and Engineering", 2005.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	Understand about the disaster management and spare technology for control of geological disasters	3	2	2	1	-	–	–	–	–	–	–	_	2	–	2	-	-
CO2	Obtain knowledge on technological disaster and case study	2	2	-	3	-	–	–	–	–	–	–	-	2	-	1	-	-
CO3	Analyze environmental disasters and environmental policies	2	3	2	2	-	-	-	-	-	-	-	-	2	-	1	-	-
CO4	Know about pollution from various aspects and its analysis	3	2	2	1	-	-	3	-	-	-	-	-	2	-	3	-	-
CO5	Understand the fundamentals of incident management and media management	2	2	1	3	-	–	–	–	–	–	–	2	3	–	2	-	-
DISASTER AND INCIDENT MANAGEMENT		3	2	1	2	-	–	1	–	–	–	–	2	2	–	2	-	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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IH5025	HAZARDOUS WASTE MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES

- To learn about sources and types of hazardous waste and legislation management in India.
- To gain knowledge about waste characterization, reduction and recycling.
- To learn about different methods of segregation, storage and transport of hazardous waste.
- To gain knowledge about bio and thermal conversion technology.
- To learn about waste disposal management in landfill.

UNIT I WASTE CLASSIFICATION AND REGULATORY REQUIREMENTS 9

Sources and types of hazardous wastes - Need for hazardous waste management –- Salient features of latest Indian legislations on management and handling of hazardous wastes, biomedical wastes, electronic wastes and discarded lead acid batteries – Elements of integrated waste management and roles of stakeholders.

UNIT II WASTE CHARACTERIZATION, SOURCE REDUCTION AND RECYCLING 9

Waste sampling and characterization plan - Waste generation rates and variation – Physical composition, chemical and biological properties – hazardous characteristics – Ignitability, corrosivity and TCLP tests –Source reduction, segregation and onsite storage of wastes –- Waste exchange - Extended producer responsibility - Recycling of hazardous waste.

UNIT III WASTE COLLECTION, TRANSPORT AND MATERIAL RECOVERY 9

Segregation and storage of hazardous wastes - compatibility, storage, labeling and handling of hazardous wastes - hazardous waste transport and manifests - Mechanical processing and material separation technologies – Physico chemical treatment of Hazardous wastes - solidification and stabilization – Case studies on waste collection and material recovery.

UNIT IV BIOLOGICAL AND THERMAL PROCESSING OF WASTES 9

Biological and thermo chemical conversion technologies – hazardous waste incineration – Air pollution control system – residue disposal – pyrolysis - Emerging waste processing technologies.

UNIT V WASTE DISPOSAL 9

Landfills - Components and Configuration– site selection - Liner and Cover systems - Geo synthetic Clay Liners and Geomembranes - design of secure landfills- leachate collection, treatment and landfill gas management – Landfill Construction and Operational Controls - landfill closure and environmental monitoring – landfill bioreactors – Rehabilitation of open dumps and Biomining of Dumpsites-remediation of contaminated sites- Case studies.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Understand the various functional elements of hazardous waste management including legal health, safety and cultural issues.
- Obtain knowledge about science and engineering, fundamentals to characterize different types of hazardous waste.

- Know about the design of system and processes to meet specified need of waste minimization, storage, collection, transportation and recycling.
- Understand the appropriate methods for processing and disposal of hazardous waste.
- Obtain knowledge to conduct research pertinent to hazardous waste management and commicate effectively to different stake-holders.

REFERENCES:

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, “Integrated Solid Waste Management, Mc-Graw Hill India, First edition, 2015.
2. CPHEEO, “Manual on Municipal Solid waste management, Vol I, II and III, Central Public Health and Environmental Engineering Organisation, Government of India, New Delhi, 2016.
3. William A. Worrell, P. Aarne Vesilind, Christian Ludwig, Solid Waste Engineering - A Global Perspective, 3rd Edition, Cengage Learning, 2017.
4. Michael D. LaGrega, Philip L Buckingham, Jeffrey C. E vans and "Environmental Resources Management, Hazardous waste Management", Mc-Graw Hill International edition, New York, 2010.
5. John Pitchtel, Waste Management Practices, CRC Press, Taylor and Francis Group,2014.
6. Gary C. Young, Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons, Wiley, 2010.
7. Cherry P M, Solid and Hazardous Waste Management, CBS publishers and distributors Pvt Ltd, 2018.
8. Rao M.N, Razia Sultana, Sri Harsha Kota, solid and hazardous waste management – Science and Engineering , Butterworth-Heinemann, 2016.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	Understand the various functional elements of hazardous waste management including legal health, safety and cultural issues	3	2	1	1	-	1	–	–	–	–	–	_	2	–	2	1	-
CO2	Obtain knowledge about science and engineering, fundamentals to characterize different types of hazardous waste	3	2	-	2	-	–	–	–	–	–	–	-	3	-	2	1	-
CO3	Know about the design of system and processes to meet specified need of waste minimization, storage, collection, transportation and recycling	3	2	3	1	1	-	-	-	-	-	-	-	2	-	2	1	-
CO4	Understand the appropriate methods for processing and disposal of hazardous waste	3	2	2	1	2	-	-	-	-	-	-	-	2	-	3	1	-
CO5	Obtain knowledge to conduct research pertinent to hazardous	2	2	3	2	-	–	–	–	–	–	–	2	3	–	2	1	-

	waste management and commicate effectively to different stake-holders																	
HAZARDOUS WASTE MANAGEMENT		3	2	3	2	-	1	–	–	–	–	–	2	2	–	2	1	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

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IH5312	PROJECT PHASE I	L	T	P	C
		0	0	12	6

OBJECTIVE

- Offer the opportunity to apply in principle, concepts of industrial safety learned throughout the program.
- Introduce the concept of project and workload management into the graduate programme to ensure efficient completion of course in the semester.
- Updation of theory, safety legislation and accident case studies happening in real time in India.
- Facilitate the student in effective project management and improve his communication skills through presentation reviews.

This course will able to conduct largely as an individual project under the direct supervision of a member of academic staff. The specific project topic undertaken will reflect the common interests and expertise of the student and supervisor. The project work may carried out in collaboration with an Industry or a Research Organization. The project work will evaluated in three reviews.

Students will be required to:

1) Select a real time problem in industrial safety aspect in one of industrial fields
2) Perform extensive literature reviews to review current knowledge and recent technical advancements and developments in the industrial safety methodologies
3) Undertake detailed survey and practical work in the chosen industry
4) Produce progress reports to establish work completed; schedule further work within the period specified for the technical work in industrial safety.
5) Prepare a complete report describing the work undertaken and results obtained so far
6) Deliver detailed presentation on technical area of work being undertaken and outline the specific contributions of the work undertaken to that field
7) Present the work in an international/national conference involving poster presentations and demonstrations.

OUTCOMES:

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

- Demonstrate a sound technical knowledge and base of their selected project area.
- Undertake problem identification, assessment of risks, and suggest solutions in form of control measures to the industry, which shall bring down the prevalent risks to acceptable levels.
- Conduct project work which involves applying all the concepts of safety engineering
- Design feasible safety solutions to problems faced in complex processes utilizing a systems approach.
- Demonstrate the knowledge depth, management skills and attitude of a professional safety engineer.

Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	Demonstrate a sound technical knowledge and base of their selected project area	2	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO2	Undertake problem identification, assessment of risks, and suggest solutions in form of control measures to the industry, which shall bring down the prevalent risks to acceptable levels	2	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO3	Conduct project work which involves applying all the concepts of safety engineering	2	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO4	Design feasible safety solutions to problems faced in complex processes utilizing a systems approach	2	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO5	Demonstrate the knowledge depth, management skills and attitude of a professional safety engineer	2	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
PROJECT WORK (PHASE I & II)		2	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

IH5411	PROJECT PHASE II	L	T	P	C
		0	0	24	2

OBJECTIVE

- Offer the opportunity to apply in principle, concepts of industrial safety learned throughout the program.
- Introduce the concept of project and workload management into the graduate programme to ensure efficient completion of course in the semester.
- Updation of theory, safety legislation and accident case studies happening in real time in India.
- Facilitate the student in effective project management and improve his communication skills through presentation reviews.

This course will able to conduct largely as an individual project under the direct supervision of a member of academic staff. The specific project topic undertaken will reflect the common interests and expertise of the student and supervisor. The project work may carried out in collaboration with an Industry or a Research Organization. The project work will evaluated in three reviews.

Students will be required to:

8) Select a real time problem in industrial safety aspect in one of industrial fields
9) Perform extensive literature reviews to review current knowledge and recent technical advancements and developments in the industrial safety methodologies
10) Undertake detailed survey and practical work in the chosen industry
11) Produce progress reports to establish work completed; schedule further work within the period specified for the technical work in industrial safety.
12) Prepare a complete report describing the work undertaken and results obtained so far
13) Deliver detailed presentation on technical area of work being undertaken and outline the specific contributions of the work undertaken to that field
14) Present the work in an international/national conference involving poster presentations and demonstrations.

OUTCOMES:

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

- Demonstrate a sound technical knowledge and base of their selected project area.
- Undertake problem identification, assessment of risks, and suggest solutions in form of control measures to the industry, which shall bring down the prevalent risks to acceptable levels.
- Conduct project work which involves applying all the concepts of safety engineering
- Design feasible safety solutions to problems faced in complex processes utilizing a systems approach.
- Demonstrate the knowledge depth, management skills and attitude of a professional safety engineer.

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Course Articulation Matrix:

Course Outcomes	Statement	Program Outcome																
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	Demonstrate a sound technical knowledge and base of their selected project area	2	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO2	Undertake problem identification, assessment of risks, and suggest solutions in form of control measures to the industry, which shall bring down the prevalent risks to acceptable levels	2	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO3	Conduct project work which involves applying all the concepts of safety engineering	2	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO4	Design feasible safety solutions to problems faced in complex processes utilizing a systems approach	2	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO5	Demonstrate the knowledge depth, management skills and attitude of a professional safety engineer	2	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
PROJECT WORK (PHASE I & II)		2	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

OPEN ELECTIVE COURSES (OEC)

OE5091 BUSINESS DATA ANALYTICS L T P C
3 0 0 3

OBJECTIVES:

- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I OVERVIEW OF BUSINESS ANALYTICS 9

Introduction – Drivers for Business Analytics – Applications of Business Analytics: Marketing and Sales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support – Skills Required for a Business Analyst – Framework for Business Analytics Life Cycle for Business Analytics Process.

Suggested Activities:

- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

Suggested Evaluation Methods:

- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT II ESSENTIALS OF BUSINESS ANALYTICS 9

Descriptive Statistics – Using Data – Types of Data – Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, z-Score, Covariance, Correlation – Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map – Data Dashboards.

Suggested Activities:

- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:

- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT III MODELING UNCERTAINTY AND STATISTICAL INFERENCE 9

Modeling Uncertainty: Events and Probabilities – Conditional Probability – Random Variables – Discrete Probability Distributions – Continuous Probability Distribution – Statistical Inference: Data Sampling – Selecting a Sample – Point Estimation – Sampling Distributions – Interval Estimation – Hypothesis Testing.

Suggested Activities:

- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

Suggested Evaluation Methods:

- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability.

UNIT IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK 9

Introducing Hadoop– RDBMS versus Hadoop–Hadoop Overview – HDFS (Hadoop Distributed File System) – Processing Data with Hadoop– Introduction to MapReduce – Features of MapReduce – Algorithms Using Map-Reduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation – Extensions to MapReduce.

Suggested Activities:

- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:

- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT V OTHER DATA ANALYTICAL FRAMEWORKS 9

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

Suggested Activities:

- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

Suggested Evaluation Methods:

- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student will be able to:

- Identify the real world business problems and model with analytical solutions.
- Solve analytical problem with relevant mathematics background knowledge.
- Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
- Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce
- Use open source frameworks for modeling and storing data.
- Apply suitable visualization technique using R for visualizing voluminous data.

REFERENCES:

1. VigneshPrajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
2. Umesh R Hodeghatta, UmeshaNayak, “Business Analytics Using R – A Practical Approach”, Apress, 2017.
3. AnandRajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2012.
4. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, “Essentials of Business Analytics”, Cengage Learning, second Edition, 2016.
5. U. Dinesh Kumar, “Business Analytics: The Science of Data-Driven Decision Making”, Wiley, 2017.
6. A. Ohri, “R for Business Analytics”, Springer, 2012
7. Rui Miguel Forte, “Mastering Predictive Analytics with R”, Packt Publication, 2015.

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	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	3	1
CO2	2	1	1	2	1	1
CO3	1	1	2	3	3	1
CO4	2	2	1	2	1	1
CO5	1	1	2	2	1	1
CO6	1	1	1	3	2	1

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OE5092 **INDUSTRIAL SAFETY** **LT P C**
3 0 0 3

OBJECTIVES:

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT I INTRODUCTION 9

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING 9

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III WEAR AND CORROSION AND THEIR PREVENTION 9

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT IV FAULT TRACING 9

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE 9

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Ability to summarize basics of industrial safety
CO2: Ability to describe fundamentals of maintenance engineering
CO3: Ability to explain wear and corrosion
CO4: Ability to illustrate fault tracing
CO5: Ability to identify preventive and periodic maintenance

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

REFERENCES:

1. Audels, Pump-hydraulic Compressors, Mcgrew Hill Publication, 1978.
2. Garg H P,Maintenance Engineering, S. Chand and Company,1987.
3. Hans F. Winterkorn ,Foundation Engineering Handbook, Chapman & Hall London,2013.
4. Higgins & Morrow , Maintenance Engineering Handbook,Eighth Edition,2008

OE5093 OPERATIONS RESEARCH LT P C
3 0 0 3

OBJECTIVES:

- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation , assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I LINEAR PROGRAMMING 9

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II ADVANCES IN LINEAR PROGRAMMING 9

Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT III NETWORK ANALYSIS – I 9

Transportation problems -Northwest corner rule, least cost method,Voges's approximation method - Assignment problem -Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II 9

Shortest path problem: Dijkstra' s algorithms, Floyds algorithm, systematic method -CPM/PERT

UNIT V NETWORK ANALYSIS – III 9

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

TOTAL: 45 PERIODS

OUTCOMES:

CO1: To formulate linear programming problem and solve using graphical method.
CO2: To solve LPP using simplex method
CO3: To formulate and solve transportation, assignment problems
CO4: To solve project management problems
CO5: To solve scheduling problems

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

REFERENCES:

1. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010
2. Hitler Libermann, Operations Research: McGraw Hill Pub. 2009
3. Pant J C, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Pannerselvam, Operations Research: Prentice Hall of India 2010
5. Taha H A, Operations Research, An Introduction, PHI, 2008

OE5094 COST MANAGEMENTOF ENGINEERING PROJECTS L T P C
3 0 0 3

OBJECTIVES:

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I INTRODUCTION TO COSTING CONCEPTS 9

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II INTRODUCTION TO PROJECT MANAGEMENT 9

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member,Importance Project site: Data required with significance, Project contracts.

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS 9

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

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OUTCOMES:

CO1 – Understand the costing concepts and their role in decision making CO2– Understand the project management concepts and their various aspects in selection
CO3–Interpret costing concepts with project execution
CO4–Gain knowledge of costing techniques in service sector and various budgetary control techniques
CO5 - Become familiar with quantitative techniques in cost management

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

REFERENCES:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988
3. Charles T. Horngren et al Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2011
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007

OE5095 COMPOSITE MATERIALS L T P C
3 0 0 3

OBJECTIVES:

- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identifythe various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT I INTRODUCTION 9

Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCEMENTS 9

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES 9

Casting – Solid State diffusion technique - Cladding – Hot isostatic pressing - Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving - Properties and applications.

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UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES 9

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method –Filament winding method – Compression moulding – Reaction injection moulding - Properties and applications.

UNIT V STRENGTH 9

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL: 45 PERIODS

OUTCOMES:

- CO1 - Know the characteristics of composite materials and effect of reinforcement in composite materials.
- CO2 – Know the various reinforcements used in composite materials.
- CO3 – Understand the manufacturing processes of metal matrix composites.
- CO4 – Understand the manufacturing processes of polymer matrix composites.
- CO5 – Analyze the strength of composite materials.

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

REFERENCES:

1. Cahn R.W. - Material Science and Technology – Vol 13 – Composites, VCH, WestGermany.
2. Callister, W.D Jr., Adapted by Balasubramaniam R, Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian edition, 2007.
3. Chawla K.K., Composite Materials, 2013.
4. Lubin.G, Hand Book of Composite Materials, 2013.

OE5096 **WASTE TO ENERGY** **L T P C**
3 0 0 3

OBJECTIVES:

- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNITI INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNITIIBIOMASS PYROLYSIS 9

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNITIII BIOMASS GASIFICATION 9

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNITIV BIOMASS COMBUSTION 9

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNITV BIO ENERGY 9

Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

OUTCOMES:

CO1 – Understand the various types of wastes from which energy can be generated
CO2 – Gain knowledge on biomass pyrolysis process and its applications
CO3 – Develop knowledge on various types of biomass gasifiers and their operations
CO4 – Gain knowledge on biomass combustors and its applications on generating energy
CO5 – Understand the principles of bio-energy systems and their features

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

REFERENCES:

1. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

AUDIT COURSES (AC)

AX5091 ENGLISHFOR RESEARCHPAPERWRITING L T P C
2 0 0 0

OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNITI INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

TOTAL: 30 PERIODS

OUTCOMES:

CO1 –Understand that how to improve your writing skills and level of readability
CO2 –Learn about what to write in each section
CO3 –Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

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

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1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

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AX5092 **DISASTER MANAGEMENT** **L T P C**
2 0 0 0

OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION **6**

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS **6**

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA **6**

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT **6**

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT **6**

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

OUTCOMES:

CO1: Ability to summarize basics of disaster
CO2: Ability to explain critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

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

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REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. Nishitha Rai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company,2007.
3. Sahni, Pardeep Et.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi,2001.

AX5093 SANSKRIT FOR TECHNICAL KNOWLEDGE L T P C
2 0 0 0

OBJECTIVES

- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

UNIT I ALPHABETS 6

Alphabets in Sanskrit

UNIT II TENSES AND SENTENCES 6

Past/Present/Future Tense - Simple Sentences

UNIT III ORDER AND ROOTS 6

Order - Introduction of roots

UNIT IV SANSKRIT LITERATURE 6

Technical information about Sanskrit Literature

UNIT V TECHNICAL CONCEPTS OF ENGINEERING 6

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL: 30 PERIODS

OUTCOMES:

- CO1 - Understanding basic Sanskrit language.
- CO2 - Write sentences.
- CO3 - Know the order and roots of Sanskrit.
- CO4 - Know about technical information about Sanskrit literature.
- CO5 - Understand the technical concepts of Engineering.

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

REFERENCES

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

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AX5094	VALUE EDUCATION	L T P C
		2 0 0 0

OBJECTIVES

Students will be able to

- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I

Values and self-development–Social values and individual attitudes. Workethics,Indianvisionofhumanism.Moralandnon-moralvaluation.Standards and principles. Value judgements

UNIT II

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love fornature, Discipline

UNIT III

Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV

Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

TOTAL: 30 PERIODS

OUTCOMES:

Students will be able to

- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the over all personality.

Suggested reading

1. Chakroborty, S.K."Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

AX5095	CONSTITUTION OF INDIA	L T P C 2 0 0 0

OBJECTIVES

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION:

History, Drafting Committee, (Composition &Working)

UNIT II PHILOSOPHYOFTHE INDIANCONSTITUTION:

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE:

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION:

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION:

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES:

Students will be able to:

- DiscussthegrowthofthedemandforcivilrightsinIndiaforthebulkofIndiansbeforethe arrival of Gandhi in Indian politics.
- Discusstheintellectualoriginsoftheframeworkofargumentthatinformedtheconceptualization
- of social reform sliding to revolution in India.
- DiscussthecircumstancessurroundingthefoundationoftheCongressSocialistParty[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- DiscussthepassageoftheHinduCodeBillof1956.

Suggested reading

1. TheConstitutionofIndia,1950(BareAct), Government Publication.
2. Dr. S. N. Busi, Dr. B. R.AmbedkarframingofIndianConstitution,1st Edition,2015.
3. M.P. Jain,IndianConstitutionLaw,7th Edn.,Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis,2015.

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AX5096	PEDAGOGY STUDIES	L T P C 2 0 0 0

OBJECTIVES

Students will be able to:

- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT I INTRODUCTION AND METHODOLOGY:

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III EVIDENCE ON THE EFFECTIVENESS OFPEDAGOGICALPRACTICES

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT IV PROFESSIONAL DEVELOPMENT

Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

OUTCOMES:

Students will be able to understand:

- Whatpedagogicalpracticesarebeingusedbyteachersinformalandinformalclassrooms in developing countries?
- What is the evidence on the effectiveness soft he sepedagogical practices, in what conditions, and with what population of learners?
- How can teacher education(curriculum and practicum)and the school curriculum and guidance materials best support effective pedagogy?

Suggested reading

1. Ackers, HardmanF(2001)ClassroominteractioninKenyanprimaryschools,Compare,31(2): 245-261.
2. AgrawalM (2004)Curricular reform in schools: The importance of evaluation, JournalofCurriculumStudies,36(3):361-379.
3. AkyeampongK(2003)TeachertraininginGhana-doesitcount?Multi-siteteachereducationresearchproject(MUSTER) country report 1.London:DFID.
4. Akyeampong K,LussierK, PryorJ, WestbrookJ (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.
5. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. ChavanM (2003) Read India: Amass scale, rapid, 'learningtoread 'campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf

AX5097 **STRESS MANAGEMENT BY YOGA** **L T P C**
2 0 0 0

OBJECTIVES

- To achieve overall health of body and mind
- To overcome stress

UNIT I

Definitions of Eight parts of yoga.(Ashtanga)

UNIT II

Yam and Niyam - Do`s and Don't'sin life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III

Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

TOTAL: 30 PERIODS

OUTCOMES:

Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

SUGGESTEDREADING

1. 'YogicAsanasforGroupTarining-Part-I":JanardanSwamiYogabhyasiMandal, Nagpur
2. "Rajayogaorconquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department),Kolkata

AX5098	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L T P C 2 0 0 0

OBJECTIVES

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To a waken wisdom in students

UNIT I

Neetishatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses- 71,73,75,78 (do's)

UNIT II

Approach to day to day work and duties - Shrimad BhagwadGeeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III

Statements of basic knowledge - Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68 Chapter 12 - Verses 13, 14, 15, 16,17, 18 -Personality of role model - shrimadbhagwadgeeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

OUTCOMES:

Students will be able to

- Study of Shrimad- Bhagwad- Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and man kind to peace and prosperity
- Study of Neetishatakam will help in developing versatile personality of students.

Suggested reading

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.

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