

**ANNA UNIVERSITY- CHENNAI: 600 025
UNIVERSITY DEPARTMENTS**

**DEPARTMENT OF APPLIED SCIENCE AND TECHNOLOGY
VISION AND MISSION OF THE DEPARTMENT**

Vision of the Department	The Department of Applied Science and Technology will achieve worldwide recognition for exceptional academic standards and cutting-edge research in the fields of oil and natural gas exploration, petrochemical production and safety management systems.	
Mission of the Department	Mission No.	Mission Statements
	M1	Foster capable professionals in the upstream, midstream, and downstream sectors of the petroleum industry, as well as in occupational safety, health, and environment management, through quality teaching, research, and service
	M2	Develop core competency by encouraging students to think creatively, identify industry challenges, and construct innovative solutions.
	M3	Cultivate innovative thinking and entrepreneurial skills in the realm of cutting-edge technology.

PROGRESS THROUGH KNOWLEDGE

ANNA UNIVERSITY- CHENNAI: 600 025
UNIVERSITY DEPARTMENTS
REGULATIONS – 2023
M.TECH. INDUSTRIAL SAFETY AND HAZARDS MANAGEMENT
CHOICE BASED CREDIT SYSTEM
CURRICULUM AND SYLLABI FOR I TO IV SEMESTERS

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

The Masters of Industrial Safety and Hazards Management curriculum is designed to prepare postgraduates to

I.	Exhibit a strong technical proficiency in managing safety, hygiene and environment in industry.
II.	Equip with comprehensive understanding of the professional practice of industrial rules and implications on industrial relations.
III.	Foster a culture of continuous learning and training, embracing changes and advancements that would identify hazard, mitigate risk and provide control measures for the safety concerns.
IV.	Take leadership roles and actively engage in multidisciplinary teams, demonstrating professional and ethical attitudes to effectively accomplish objectives.

PROGRAMME OUTCOMES(POs):

On successful completion of the Programme-

PO	Programme Outcomes
1	Independently carry out research/investigation and development work to solve practical problems
2	Write and present a substantial technical report/document
3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
4	To provide an insight to various laws, rules and Acts related to Industrial Safety applicable to the different industry.
5	Application of tools and techniques to identify hazard, estimate risk and reduce accident occurrence to improve safety program through a detailed safety audit.
6	Facilitate healthy work culture, uphold environmental compliance and sustainability development.

MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVE WITH PROGRAMME OUTCOMES:

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)	PROGRAMME OUTCOMES - (POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
I.	✓	✓	✓	✓	✓	✓
II.	✓	✓	✓	✓	-	✓
III.	✓	✓	-	✓	✓	✓
IV.	✓	-	-	✓	✓	✓

MAPPING OF COURSE OUTCOMES AND PROGRAMME OUTCOMES:

YEAR	SEM	COURSE NAME	PO1	PO2	PO3	PO4	PO5	PO6
YEAR 1	SEMESTER I	Artificial Intelligence and Data Analytics	2.2	2	2	2	2	2
		Chemical Process Hazard and Risk Analysis	2.8	2.6	2.6	2	2.8	2.2
		Industrial Safety Management	2.7	2.2	2.2	2	2.4	2
		Legislations In Health, Safety and Environment	1.2	1.2	2	2.8	2	1.8
		Occupational Health and Industrial Hygiene	2	2	2	2	2	2
		Research Methodology and IPR						
		Industrial Safety Laboratory	3	2.3	2.3	2	2	2
	SEMESTER II	Fire Engineering and Explosion Control	2	2	2.6	2	2.8	2
		Safety in Engineering Industry	2.2	2.2	2.2	2.2	2.6	2
		Environmental Pollution and Control	2.3	2.2	2.2	1.8	2.3	2.5
		Plant Layout and Material Handling	2.6	2.2	2.2	2.2	2.6	2.6
		Safety in Construction	2.8	2.6	2.6	2.4	2.4	2
		Electrical Safety	2.8	2.5	2.5	2.3	2.8	2.8
YEAR 2	SEMESTER III	Industrial Safety Simulation Laboratory	3	2.3	2.3	2.3	2.3	2
		Professional Elective I	-	-				
		Environmental and Social governance	2.4	2.2	2.2	2.1	2.4	2.4
		Professional Elective II						
		Professional Elective III						
		Project Phase-I	3	2	3	2	3	2
	Internship/Training **	2	2	3	3	3	3	
SEMESTER IV	First Aid & Fire Fighting Training	3	2	3	3	3	3	
	Project Phase-II	3	2	3	2	3	2	

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CURRICULUM AND SYLLABI FOR I TO IV SEMESTERS
SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	IH3101	Artificial Intelligence and Data Analytics	FC	3	0	0	3	3
2.	IH3102	Chemical Process Hazard and Risk Analysis	PCC	3	0	0	3	3
3.	IH3103	Industrial Safety Management	PCC	3	0	0	3	3
4.	IH3104	Legislations in Health, Safety and Environment	PCC	3	0	0	3	3
5.	IH3105	Occupational Health and Industrial Hygiene	PCC	3	0	2	5	4
6.	RM3151	Research Methodology and IPR	RMC	2	1	0	3	3
PRACTICAL								
7.	IH3111	Industrial Safety Laboratory	PCC	0	0	4	4	2
TOTAL				17	1	6	24	21

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	IH3201	Fire Engineering and Explosion Control	PCC	3	0	0	3	3
2.	IH3202	Safety in Engineering Industry	PCC	3	0	0	3	3
3.	IH3203	Environmental Pollution and Control	PCC	3	0	2	5	4
4.	IH3204	Plant Layout and Material Handling	PCC	3	0	0	3	3
5.	IH3205	Safety in Construction	PCC	3	0	0	3	3
6.	IH3206	Electrical Safety	PCC	3	0	0	3	3
PRACTICAL								
7.	IH3211	Industrial Safety Simulation Laboratory	PCC	0	0	4	4	2
8..	IH3212	Internship/Training **	EEC	-	-	-	-	-
TOTAL				18	0	6	24	21

** Students shall undergo internship training for minimum period of two weeks during second semester and assessment of the same will be done during third semester.

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	IH3301	Environmental and Social Governance	PCC	3	0	0	3	3
2		Professional Elective I	PEC	3	0	0	3	3
3		Professional Elective II	PEC	3	0	0	3	3
4		Professional Elective III	PEC	3	0	0	3	3
PRACTICAL								
5	IH3311	Project Work - I	EEC	0	0	12	12	6
6	IH3312	Internship/Training	EEC	0	0	0	0	1
7	IH3313	First Aid and Fire Fighting Training	EEC	0	0	2	2	1
TOTAL				12	0	14	26	20

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICAL								
1.	IH3411	Project Work II	EEC	0	0	24	24	12
TOTAL				0	0	24	24	12

TOTAL CREDITS:74

FOUNDATION COURSES (FC)

SL.NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			Lecture	Tutorial	Practical	
1.	IH3101	Artificial Intelligence and Data Analytics	3	0	0	3
TOTAL CREDITS						3

PROFESSIONAL CORE COURSES (PCC)

SL.NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			Lecture	Tutorial	Practical	
1.	IH3102	Chemical Process Hazard and Risk Analysis	3	0	0	3
2.	IH3103	Industrial Safety Management	3	0	0	3
3.	IH3104	Legislations in Health, Safety and Environment	3	0	0	3
4.	IH3105	Occupational Health and Industrial Hygiene	3	0	2	4
5.	IH3201	Fire Engineering and Explosion Control	3	0	0	3
6.	IH3202	Safety in Engineering Industry	3	3	0	3
7.	IH3203	Environmental Pollution and Control	3	0	2	4
8.	IH3204	Plant Layout and Material Handling	3	0	0	3
9.	IH3205	Safety in Construction	3	0	0	3
10.	IH3206	Electrical Safety	3	0	0	3

11	IH3301	Environmental and Social governance	3	0	0	3
12	IH3111	Industrial Safety Laboratory	0	0	4	2
13	IH3211	Industrial Safety Simulation Laboratory	0	0	4	2
TOTAL CREDITS						39

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

SL.NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			Lecture	Tutorial	Practical	
1.	RM3151	Research Methodology and IPR	2	1	0	3
TOTAL CREDITS						3

LIST OF PROFESSIONAL ELECTIVES

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IH3001	International Safety Management system	PEC	3	0	0	3	3
2.	MI3022	Mine Management, Legislation and Mine Safety	PEC	3	0	0	3	3
3.	IH3002	Emergency Response and Disaster Management	PEC	3	0	0	3	3
4.	IH3003	Safety in Oil and Gas Industry	PEC	3	0	0	3	3
5.	IH3004	Dock Safety	PEC	3	0	0	3	3
6.	IH3005	Asset Integrity and Reliability Engineering	PEC	3	0	0	3	3
7.	IH3006	Transportation Safety	PEC	3	3	0	0	3
8.	IH3007	Behaviour Based Safety	PEC	3	3	0	0	3
9.	IH3008	Safety in Process Industries	PEC	3	0	0	3	3
10.	IH3009	Human Factors Engineering and Ergonomics	PEC	3	0	0	3	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL.NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			Lecture	Tutorial	Practical	
1.	IH3311	Project Work-I	0	0	12	6
2.	IH3312	Internship/Training	0	0	0	1
3.	IH3313	First Aid & Fire Fighting Training	0	0	2	1
4.	IH3411	Project Work II	0	0	24	12

SUMMARY

SL. NO.	SUBJECT AREA	CREDITS PER SEMESTER				TOTAL CREDITS
		SEM-1	SEM-2	SEM-3	SEM-4	
1.	FC	3	0	0	0	3
2.	PCC	15	21	3	0	39
3.	PEC	0	0	9	0	9
4.	RMC	3	0	0	0	3
5.	EEC	0	0	8	12	20
	TOTAL CREDITS	21	21	20	12	74



OBJECTIVE:

- To enable the students to learn about safety measures and practices by leveraging advanced technologies to analyze and interpret safety-related data.

UNIT I DATA SCIENCE AND SAFETY**9**

Introduction -Terminology in data science-. Application of data science- Overview of data science and its applications in safety-risk analysis, anomaly detection and safety optimization -Introduction to safety analysis and risk assessment

UNIT II DATA COLLECTION AND PRE PROCESSING**9**

Data acquisition methods and sources relevant to Safety-Operators - Variables - data types - Conditional statements-Looping - Function -. Data structure - Lists, Dictionary and Tuple -Regular Expression - File Reading (CSV, Excel etc.) - Basics Class and Objects concepts- data cleaning-handling missing values--dealing with outliers- Exploratory data analysis techniques.

UNIT III STATISTICAL**ANALYSIS****9**

Probability theory and statistical concepts relevant to safety analysis-statistical analysis, data visualization, and predictive modelling techniques-Descriptive and inferential statistics -Hypothesis testing and confidence intervals- Safety Program Evaluation, Comparative Analysis, Reliability Analysis, Incident Investigation, Safety Performance Monitoring

UNIT IV MACHINE**LEARNING****9**

Introduction to supervised and unsupervised learning algorithms-Feature engineering and selection -Model evaluation and performance metrics -Regression models --Classification models -Ensemble methods and model optimization -Techniques for identifying anomalies and outlier detection-Time series analysis and forecasting for safety events - Event prediction using machine learning algorithms.

UNIT V VISUALIZATION AND COMMUNICATION OF SAFETY DATA**9**

Data visualization techniques for safety insights-Storytelling with data and effective communication of safety findings-Interactive dashboards and reporting tools for safety analysis-Ethical issues in working with safety data-Privacy and security concerns in data science for safety-Legal and regulatory frameworks related to safety data- Data science to safety problems.

TOTAL: 45 PERIODS**OUTCOMES:**

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

- Understand the benefits for improving safety measures and preventing accidents in various industries.
- Describe about significant impact on the quality and effectiveness of data analysis.
- Illustrate the understanding of safety-related data and drawing meaningful insights from it.
- Identify the trends, patterns, and correlations with experimental data.
- curate data into a form easier to understand, highlighting the trends and outliers

REFERENCE BOOKS:

- "Safety Critical Systems Handbook: A Straightforward Guide to Functional Safety, IEC 61508 (2010 Edition) and Related Standards" by David J. Smith
- "Safety Critical Systems: Problems, Process and Practice" by Tim Kelly
- "System Safety Engineering and Risk Assessment: A Practical Approach" by Nicholas J. Bahr
- "Applied Artificial Intelligence: A Handbook For Business Leaders" by Mariya Yao, Adelyn Zhou, and Marlene Jia

5. "Handbook of Safety and Health for the Service Industry" edited by Charles D. Reese and James P. Nelson
6. "Data Science for Transport: A Self-Study Guide with Computer Exercises" by Jose L. Munoz and Luis F. Miranda-Moreno
7. "Foundations of Data Science" by Avrim Blum, John Hopcroft, and Ravindran Kannan

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	2	2	2	2	2	2
CO3	3	2	2	2	2	2
CO4	2	2	2	2	2	2
CO5	2	2	2	2	2	2
Avg	2.2	2	2	2	2	2

COURSE ARTICULATION MATRIX:

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

IH3102 CHEMICAL PROCESS HAZARD AND RISK ANALYSIS L T P C
3 0 0 3

OBJECTIVES

- To familiarize the students in identifying and assessing the potential hazards and risks associated with chemical processes in order to prevent accidents, protect human health and minimize environmental impacts.

UNIT I HAZARD, RISK ISSUES AND HAZARD ASSESSMENT 9

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 9

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 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 9

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 9

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

1. Understand the basics of hazards and classification of the its assessment
2. Illustrate various advanced equipment and testing
3. Appraise process hazard analysis
4. Obtain the knowledge on application of CPQRA and assessed
5. Assess 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.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	3	2	2	2	3	3
CO3	3	3	3	2	3	2
CO4	3	3	3	2	3	2
CO5	3	3	3	2	3	2
Avg	2.8	2.6	2.6	2	2.8	2.2

COURSE ARTICULATION MATRIX:

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

IH3103

INDUSTRIAL SAFETY MANAGEMENT

**LT P C
3 0 0 3**

OBJECTIVE

- To provide a framework and set of guiding principles for effectively managing safety in various industries and workplaces.

UNIT I SAFETY MANAGEMENT CONCEPTS

9

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

9

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 9

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 9

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 9

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: 45 PERIODS

OUTCOMES:

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

1. Explain about the basic concepts of safety management.
2. Apply the knowledge on investigation and reporting of accident.
3. Identify and illustrate the safety performance indicators.
4. Analyze the impact of training and employee participation.
5. Illustrate the 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.
6. Dan Petersen (2003) 'Techniques of Safety Management: A System Approach'. American Society of Safety Engineers, USA.
7. Society of Safety Engineers, USA.

COURSE ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	3	2	2	2	3	2
CO3	3	2	2	2	2	2
CO4	3	3	3	2	3	2
CO5	2	2	2	2	2	2
Avg	2.6	2.2	2.2	2	2.4	2

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

OBJECTIVE

- To enable the students to establish, follow the standards and regulations developed by government agencies, international bodies and industrial organizations.

UNIT I FACTORIES ACT AND RULES 9

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 9

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

- Provide a list of welfare compensation and safety acts.
- Understand about manufacturing, storage and impact of chemicals in process industry.
- Describe about environmental acts and motor vehicles act.
- Review about distribution of electricity and process of license.
- List out the occupational safety and health act and ISO regulations

REFERENCE BOOKS:

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

COURSE ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	2	3	2	1
CO2	2	2	2	2	2	2
CO3	1	1	2	3	2	2
CO4	1	1	2	3	2	2
CO5	1	1	2	3	2	2
Avg	1.2	1.2	2	2.8	2	1.8

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

OBJECTIVE

To evaluate and mitigate the hazards in order to maintain the health, safety and well-being of workers in workplaces.

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, rickettsia and chlamydial agents, viral agents, fungal, parasitic agents, infectious diseases – Covid SARS- 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 – Industrial toxicology, local, systemic and chronic effects, temporary and cumulative effects, carcinogens entry into human systems -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.

LIST OF EXPERIMENTS:

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 Hearing capability using Audiometer.
5. Measurement of heat stress index using WBGT instrument.
6. Measurement of specific gas concentrations like carbon monoxide, chlorine and methane using Multi Gas detector

TOTAL: 75 PERIODS

OUTCOMES:

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

1. Explain about the anatomy, cardio pulmonary resuscitation.
2. Illustrate about octave band analyzer, noise network and monitoring instruments.
3. Discuss about gas and vapor monitors, dust sampling collecting devices.
4. Explain about carpal tunnel syndrome, tendon pain disorders of the neck.
5. Describe and assess about pre- and post-employment medical examinations, categorization of job heaviness and shift works.
6. Evaluate the various workplace hazards and overcome its effects

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.
7. Interim guidance "COVID-19: Occupational health and safety for health workers", WHO

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

COURSE ARTICULATION MATRIX:

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

PROGRESS THROUGH KNOWLEDGE

RM3151

RESEARCH METHODOLOGY AND IPR

L T P C
2 1 0 3

OBJECTIVES:

To impart knowledge on

- Formulation of research problems, design of experiment, collection of data, interpretation and presentation of result
- Intellectual property rights, patenting and licensing

UNIT I RESEARCH PROBLEM FORMULATION

9

Objectives of research, types of research, research process, approaches to research; conducting literature review- information sources, information retrieval, tools for identifying literature, Indexing and abstracting services, Citation indexes, summarizing the review, critical review, identifying research gap, conceptualizing and hypothesizing the research gap

UNIT II RESEARCH DESIGN AND DATA COLLECTION

9

Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools

UNIT III DATA ANALYSIS, INTERPRETATION AND REPORTING 9

Sampling, sampling error, measures of central tendency and variation,; test of hypothesis- concepts; data presentation- types of tables and illustrations; guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript; guidelines for writing thesis, research proposal; References – Styles and methods, Citation and listing system of documents; plagiarism, ethical considerations in research

UNIT IV INTELLECTUAL PROPERTY RIGHTS 9

Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical indications, Copy rights, applicability of these IPR; , IPR & biodiversity; IPR development process, role of WIPO and WTO in IPR establishments, common rules of IPR practices, types and features of IPR agreement, functions of UNESCO in IPR maintenance.

UNIT V PATENTS 9

Patents – objectives and benefits of patent, concept, features of patent, inventive steps, specifications, types of patent application; patenting process - patent filling, examination of patent, grant of patent, revocation; equitable assignments; Licenses, licensing of patents; patent agents, registration of patent agents.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of the course, the student can

CO1: Describe different types of research; identify, review and define the research problem

CO2: Select suitable design of experiment s; describe types of data and the tools for collection of data

CO3: Explain the process of data analysis; interpret and present the result in suitable form

CO4: Explain about Intellectual property rights, types and procedures

CO5: Execute patent filing and licensing

REFERENCES:

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Soumitro Banerjee, “Research methodology for natural sciences”, IISc Press, Kolkata, 2022,
3. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
4. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
5. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

IH3111

INDUSTRIAL SAFETY LABORATORY

L T P C

0 0 4 2

OBJECTIVE

- To explore the knowledge on mechanical, thermal hazards and the usage of firefighting equipment.

LIST OF EXPERIMENTS

1. Measurement of friction sensitivity using BAM friction tester.
2. Measurement of impact sensitivity using BAM fall hammer.
3. Measurement of earth resistance and ground resistivity using Wenner’s method.
4. Measurement of amount of heat released or absorbed by any chemical process using Bomb Calorimeter.
5. Study of basic Personal Protective Equipment used in industries.
6. Study and demonstration of different types of Fire Extinguisher.

7. Study and demonstration of smoke detection, Alarm and Sprinkler System.
8. Study of Fire Hydrant System and its components.
9. Measurement of flash point and fire point using closed cup method.
10. Study and demonstration of fire mock drill.

TOTAL: 60 PERIODS

OUTCOME:

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

1. Practice testing methods associated with mechanical & thermal hazards.
2. Use fire extinguisher at the time of emergency
3. Evaluate the fire chemistry, prevention and control in various environments

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	2	2
CO2	3	2	2	2	2	2
CO3	3	3	3	2	2	2
Avg	3	2.33	2.33	2	2	2

COURSE ARTICULATION MATRIX:

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

IH3201

FIRE ENGINEERING AND EXPLOSION CONTROL

**L T P C
3 0 0 3**

OBJECTIVE

- To enable the students in applying various techniques to minimize the likelihood and severity of fire-related incidents and explosions.

UNIT I PHYSICS AND CHEMISTRY OF FIRE

9

Fire properties of solid, liquid and gases - fire spread - toxicity of products of combustion - theory of combustion and explosion – vapour clouds – flash fire – jet fires – pool fires – unconfined vapour cloud explosion, shock waves - auto-ignition – boiling liquid expanding vapour explosion – case studies – Flixborough, Mexico disaster, Pasadena Texas, Piper Alpha, 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: CO₂ 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

9

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 (CO₂) and halons-hazards in LPG, ammonia (NH₃) etc.

TOTAL: 45 PERIODS

OUTCOME

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

1. Familiarize the fire chemistry and kinetics of combustion.
2. Classify the types, classes and chemicals used in fire extinguishers.
3. Analyze the various fire suppression systems.
4. Understand and construct a safe building design, fire resistant materials and fire testing.
5. Implement the explosion protecting systems in industries

REFERENCE BOOKS:

1. "Fire safety management", 3rd edition – Danial E.DellaGiustina – 2014.
2. "Manual of fire safety", N.Seghaprakash – 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.CraigSchrool – 2002.
6. "Accident Prevention manual for industrial operations" N.S.C., Chicago, 1982.
7. "Davis Daniel et al, "Hand Book of fire technology"
8. "Fire Prevention and firefighting", Loss prevention Association, India
9. Derek, James, "Fire Prevention Hand Book", Butter Worths and Company, London, 1986.
10. DinkoTuhtar, "Fire and explosion protection"
11. Fire fighters hazardous materials reference book "Fire Prevention in Factories", an Nostrand
12. Rein Hold, New York, 1991.
13. Relevant Indian Acts and rules, Government of India.
14. Purandare D.D & AbhayD.Purandare, "Hand book on Industrial Fire Safety" P & A publications, New Delhi, 2006.
15. Jain V K "Fire Safety in Building" New Age International 1996.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	3	2
CO2	2	2	2	2	2	2
CO3	2	2	3	2	3	2
CO4	2	2	3	2	3	2
CO5	2	2	3	2	3	2
Avg	2	2	2.6	2	2.8	2

COURSE ARTICULATION MATRIX:

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

OBJECTIVE

- To protect the well-being and lives of workers, as well as to prevent accidents, injuries, and damage to property and the environment

UNIT I SAFETY IN METAL WORKING MACHINERY AND WOOD WORKING MACHINES**9**

General safety rules, principles, maintenance, Inspections of turning machines, boring machines, milling machine, planing 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**9**

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**9**

Gas welding and oxygen cutting, resistances welding, arc welding and cutting, common hazards, personal protective equipment, training, safety precautions in brazing, soldering and metalizing – explosive welding, selection, care and maintenance of the associated equipment and instruments – safety in generation, distribution and handling of industrial gases-color 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**9**

Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot-operated presses, power press electric controls, power press set up and die removal, inspection and maintenance-metal 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**9**

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

TOTAL: 45 PERIODS**OUTCOMES:**

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

1. Implement the safety rules in maintenance of machineries.
2. Illustrate the principles of machine guarding.
3. Explain the handling of flammable material in welding and gas cutting operations.
4. Assess about the safety in forging operations.
5. Minimize the risk of accidents and injuries by inspection and testing.

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).
4. "Occupational safety Manual" BHEL, Trichy, 1988.
5. "Safety Management by John V. Grimaldi and Rollin H. Simonds, All India Travelers Book seller, New Delhi, 1989.
6. "Safety in Industry" N.V. Krishnan Jaico Publishery House, 1996.
7. Indian Boiler acts and Regulations, Government of India.
8. Safety in the use of wood working machines, HMSO, UK 1992.
9. Health and Safety in welding and Allied processes, welding Institute, UK, High Tech. Publishing Ltd., London, 1989.

COURSE ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	2	2	2	2	3	2
CO3	2	2	2	2	2	2
CO4	2	3	3	3	3	2
CO5	3	2	2	2	3	2
Avg	2.2	2.2	2.2	2.2	2.6	2

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

IH3203

ENVIRONMENTAL POLLUTION AND CONTROL

L T P C
3 0 2 4

OBJECTIVE

- To evaluate and minimize the effects of human activities on the environment and mitigate the health and well-being of both ecosystems and human populations.

UNIT I AIR AND WATER POLLUTION

9

Classification and properties of air pollutants – Pollution sources – Effects of air pollutants on human beings, Animals, Plants and Materials - automobile pollution hazards of air pollution-concept of clean coal combustion technology - ultra violet radiation, infrared radiation, radiation from sun-hazards due to depletion of ozone – deforestation- 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

9

Methods of collection and disposal of solid wastes-health hazards-toxic and radioactive wastes incineration and verification - 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

9

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

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.

LIST OF EXPERIMENTS:

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 speed or velocity of air using Anemometer.
4. Measurement of Exhaust gas emission using – Exhaust Gas analyzer.
5. Gaseous pollutants sampler for indoor/outdoor air quality monitoring

TOTAL: 75 PERIODS

OUTCOMES:

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

1. Identify the various sources for pollution and their effects.
2. Select the method for disposal of solid waste.
3. Evaluate the pollutant levels by various instruments.
4. Implement the rules and regulations for e-waste disposal.
5. Examine pollution control in cement, paper and petroleum industries.
6. Analyze and assess the pollutants in the environment.

REFERENCE BOOKS:

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

COURSE ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	3	2	2	2	3	3
CO3	3	3	3	2	3	3
CO4	1	1	1	1	1	2
CO5	3	3	3	2	3	3
CO6	2	2	2	2	2	2
Avg	2.3	2.2	2.2	1.8	2.3	2.5

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

OBJECTIVES:

- To educate the students about the plant layout with safety systems and material handling equipment in workplace.

UNIT I PLANT LOCATION 9

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

UNIT II PLANT LAYOUT 9

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

UNIT III WORKING CONDITIONS 9

Principles of good ventilation, purpose, physiological and comfort level types, local and exhaust ventilation, hood and duct design, air conditioning, ventilation standards, application. Purpose of lighting, types, advantages of good illumination, glare and its effect, lighting requirements for various work, standards- Housekeeping, principles of 5S.

UNIT IV MANUAL MATERIAL HANDLING AND LIFTING TACKLES 9

Preventing common injuries: lifting by hand, team lifting and carrying, and other heavy objects – accessories for manual handling, hand tools, hand trucks, – storage of specific materials - problems with hazardous materials, liquids, solids – storage and handling of cryogenic liquids - shipping and receiving, stock picking, dock boards, machine and tools– personal protection – ergonomic considerations-types, strength and working load inspection, wire rope, construction, design factors, deterioration causes, sheaves and drums, lubrication, overloading, rope fitting, inspection and replacement – slings, types, method of attachment, rated capacities, alloy chain slings, inspection

UNIT V MECHANICAL MATERIAL HANDLING 9

Hoisting apparatus, types - cranes, types, design and construction, guards and limit devices, signals, operating rules, maintenance safety rules, inspection – conveyors, precautions, types, applications- Powered industrial trucks, operators selection and training and performance test, inspection and maintenance, electric trucks, gasoline operated trucks, LPG trucks - machine room emergency procedure - Escalator, safety devices and brakes, moving walks – man lifts, construction, brakes, inspection.

TOTAL: 45 PERIODS**OUTCOMES:**

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

1. Identify the equipment requirements for a specific process and its working conditions.
2. Plan an efficient material handling system.
3. Understand the difficulties during the design and implementation of the plant layout.
4. Familiarize the material handling equipment.
5. Understand the inspection and maintenance techniques.

REFERENCES:

1. "Accident prevention manual for industrial operations" N.S.C., Chicago, 1982.
2. Alexandrov. M.P." Material handling equipment" Mir Publishers, Moscow, 1981
3. Apple M. James "Plant layout and material handling", 3rd edition, John Wiley and sons.
4. "Encyclopedia of occupational safety and health", ILO Publication, 1985

COURSE ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	3	3
CO2	3	3	3	3	3	3
CO3	3	2	2	2	3	3
CO4	2	2	2	2	2	2
CO5	2	2	2	2	2	2
Avg	2.6	2.2	2.2	2.2	2.6	2.6

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

IH3205

SAFETY IN CONSTRUCTION

L T P C

3 0 0 3

OBJECTIVE

- To ensure the health, well-being, and physical integrity of workers, to prevent accidents, injuries, and fatalities in construction sites.

UNIT I ACCIDENTS CAUSES AND MANAGEMENT SYSTEMS

9

Problems impeding safety in construction industry- causes of fatal accidents, types and causes of accidents related to various construction activities, human factors associated with these accidents – The Building and other Construction workers (Regulation of Employment and conditions of Service) Central Rules, 1998, Contract document & contractual clauses - compensation- 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

9

Excavations, Trenches, shafts – Form work- false work – erection of structural frame work, dismantling – tunneling – blasting, pre blast and post blast inspection – confined spaces – working on contaminated sites – work over water. 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, work permit systems – accident case studies.

UNIT IV SAFETY IN HUGE STRUCTURES

9

Safety in typical civil structures – Dams-bridges-water Tanks-Retaining Walls-Critical factors for failure-High rise buildings, Road works, and Power plant constructions. Safety in demolition work, manual, mechanical, using explosive - keys to safe demolition, pre survey inspection, method statement, site supervision, safe clearance zone, health hazards from demolition- first aid– fire hazards and preventing methods – interesting experiences at the construction site against the fire accidents-Refuge area.

UNIT V CONSTRUCTION MACHINERY

9

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

grinding tools, manual handling scaffolding, hoisting cranes – use of conveyors and mobile cranes- Inspection and Maintenance, Hand tools, Manual Material handling.

TOTAL: 45 PERIODS

OUTCOMES:

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

1. Identify the onsite construction hazards and safety legislation.
2. Analyze the structural framework and safety of various construction activities.
3. Illustrate about the fall prevention and fall protection, safe access and egress design
4. Plan the safety measures in high rise buildings.
5. Assess the safety aspects of machineries in construction site.

COURSE ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	3	3	3	2	2	2
CO3	3	2	2	2	3	2
CO4	3	3	3	3	3	2
CO5	3	3	3	3	2	2
Avg	2.8	2.6	2.6	2.4	2.4	2

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

IH3206

ELECTRICAL SAFETY

L T P C
3 0 0 3

OBJECTIVES

To provide knowledge to the students on electrical hazards, national electricity safety code, electrical protection and maintenance, discharge rods and earthing device.

UNIT I BASIC ELECTRICAL

9

Review of Electrical concept, Electrostatic – Electro magnetism – Stored energy – Working principle of major electrical equipment – Typical supply situation-- first aid-cardio pulmonary resuscitation (CPR).

UNIT II STANDARDS AND REQUIREMENTS

9

Standards and statutory requirements – Indian electricity acts and rules – statutory requirements from Electrical inspectorate--international standards on electrical safety

UNIT III ELECTRICAL HAZARDS

9

Electrical Hazards – Primary and secondary hazards-shocks, burns, scalds, falls-human safety in the use of electricity- 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- static electricity –definition, sources, hazardous conditions, control, electrical causes of fire and explosion-ionization, spark and arc- ignition energy-national electrical safety code ANSI- Lightning, hazards, lightning arrestor, installation – earthing, specifications, earth resistance, earth pit maintenance.

UNIT IV ELECTRICAL PROTECTION AND MAINTENANCE**9**

Selection of Environment, Protection and Interlock – Discharge rods and earthing device – Safety in the use of portable tools - Preventive maintenance- Fuse, circuit breakers and overload relays – protection against over voltage and under voltage – safe limits of amperage – voltage –safe distance from lines-capacity and protection of conductor-joints-and connections, overload and short circuit protection-no load protection-earth fault protection- FRLS insulation-insulation and continuity test-system grounding-equipment grounding-earth leakage circuit breaker (ELCB)-cable wires-maintenance of ground-ground fault circuit interrupter-use of low voltage-electrical guards- Personal protective equipment – safety in handling hand held electrical appliances tools and medical equipment- lock out and work permit system.

UNIT V CLASSIFICATION OF HAZARDOUS AREAS**9**

Hazardous area classification and classification of electrical equipment's for hazardous areas (IS, NFPA, API and OSHA standards)- increase safe equipment-their selection for different zones-temperature classification-grouping of gases-use of barriers and isolators-equipment certifying agencies.

TOTAL: 45 PERIODS**OUTCOMES:**

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

1. Learn the basic concepts, working principles of electrical equipment and typical supply situations.
2. Apply knowledge about standards and requirements for electrical safety
3. Identify the various electrical hazards and protection measures and PPE requirements.
4. Analyze various electrical protection and preventive maintenance.
5. Assess the classification of hazardous area and the use of suitable electrical equipment.

REFERENCES:

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

COURSE ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	2	2
CO2	3	2	2	2	3	3
CO3	3	2	3	2	3	3
CO4	3	3	2	2	3	3
CO5	3	3	3	3	3	3
Avg	3	2.4	2.4	2.2	2.8	2.8

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

IH3211**INDUSTRIAL SAFETY SIMULATION LABORATORY****L T P C
0 0 4 2****OBJECTIVE**

- To enable the use of commercial simulators to comprehend industrial hazards

LIST OF EXPERIMENTS:

1. Modeling effects of fire, explosion and estimating safe distance from explosion using PHAST1 and FLACS Software.
2. Performing modeling studies using ALOHA software.
3. Assessment of Ergonomic impact using OWAS software.
4. Performing modeling studies using AERMOD, SCREEN3 Software.
5. Analysis of the potential of hazardous incidents that could cause injuries, fatalities, and

damage to assets and the environment using Consequence Analysis (CISCON).

6. Ranking the relative fire and explosion risk associated with a process using Fire, Explosion and Toxicity Index (FETI)
7. Assess the risks of industrial activities and to determine the extent of the risks and casualties caused by accidents – SAFETI Software

TOTAL: 60 PERIODS

OUTCOME:

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

1. Provide a controlled environment for conducting safety-related experiments, simulations, and research in an industrial setting.
2. Handle hazardous situations, emergency response protocols, and use of safety equipment without exposing them to real-world risks
3. Ensure safety measures by designing, testing and optimizing tools to protect workers and minimize the risks.

COURSE ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	2	2
CO2	3	2	2	2	2	2
CO3	3	3	3	3	3	2
Avg	3	2.33	2.33	2.33	2.33	2

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

IH3301

ENVIRONMENTAL AND SOCIAL GOVERNANCE

**L T P C
3 0 0 3**

OBJECTIVES:

- To promote sustainability and responsible business practices that consider the impact of companies on the environment, society, and various stakeholders

UNIT I INTRODUCTION TO ESG INVESTING 9

Define ESG investment-responsible investment, socially responsible investment, sustainable investment, -define sustainability-based concepts in terms of their strengths and limitations: corporate social responsibility and triple bottom line (TBL) accounting –the benefits and challenges of incorporating ESG in decision making, ESG considerations in their investment process.

UNIT II ESG MARKET AND ENVIRONMENTAL FACTORS 9

Size and scope of ESG investing in relation to geography, strategy, investor type, and asset class - key market drivers of ESG integration: investor demand/intergenerational wealth transfer, regulation and policy, public awareness, and data sourcing and processing improvements - key drivers and challenges for ESG integration among key stakeholders, Climate change adaptation, and resilience measures-key concepts related to other environmental issues.

UNIT III SOCIAL FACTORS 9

Systemic relationships and activities between business activities and social issues, including: globalization; automation and artificial intelligence (AI); inequality and wealth creation; digital disruption, social media; changes to work, leisure time, and education; changes to individual rights and responsibilities and family structures; changing demographics; urbanization; and religion-assess key megatrends influencing social change in terms of potential impact on companies and their social practices.

UNIT IV GOVERNANCE FACTORS**9**

Evolution of corporate governance frameworks: -development, roles and responsibility of corporate governance; shareholder engagement; minority shareholder alignment-assess key characteristics of effective corporate governance, and reporting and transparency; business ethics - assess and contrast the main models of corporate governance in major markets and the main variables influencing best practice

UNIT V ESG ANALYSIS, VALUATION, AND INTEGRATION**9**

Objectives of integrating ESG into the investment process - describe different approaches of integrating ESG analysis into the investment process - describe qualitative approaches to ESG analysis across a range of asset classes - describe quantitative approaches to ESG analysis across a range of asset classes.

TOTAL: 45 PERIODS**OUTCOMES:**

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

1. Learn the underlying issues that constitute factors within each of the environmental, social and governance areas.
2. Analyze the ESG market, relevance, size, scope and key drivers.
3. Understand the environmental factors, systemic relationships, material impacts, megatrends and approaches to environmental analysis at country, sector and company levels.
4. Understand the social governance strategy
5. Demonstrate ESG analysis, integration and security valuation across a range of asset classes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	2	2	2	2	2	2
CO3	1	1	1	1	1	1
CO4	2	2	2	2	2	2
CO5	3	2	2	2	3	3
Avg	2.4	2.2	2.2	2.1	2.4	2.4

COURSE ARTICULATION MATRIX:

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

PROGRESS THROUGH KNOWLEDGE

IH3311**PROJECT WORK I****L T P C
0 0 12 6****OBJECTIVES:**

The course aims to enable the students to identify the research problem relevant to their field of interest, search databases to define the problem, design experiment, conduct preliminary study and report the findings.

COURSE CONTENT

Individual students will identify a research problem relevant to his/her field of study with the approval of project review committee. The student will collect, and analyze the literature and design the experiment. The student will carry out preliminary study, collect data, interpret the result, prepare the project report and present before the committee.

TOTAL: 180 PERIODS

OUTCOMES:

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

CO1: Identify the research problem

CO2: Collect, analyze the relevant literature and finalize the research problem

CO3: Design the experiment, conduct preliminary experiment, analyse the data and conclude

CO4: Prepare project report and present

IH3411**PROJECT WORK II****L T P C**
0 0 24 12**I. Continuation of Project Work I (at Institution/Industry)****OBJECTIVES:**

The course aims to enable the students to conduct experiment as per the plan submitted in Project work I to find solution for the research problem identified.

COURSE CONTENT

The student shall continue Project work I as per the formulated methodology and findings of preliminary study. The student shall conduct experiment, collect data, interpret the result and provide solution for the identified research problem. The student shall prepare the project report and present before the committee.

TOTAL: 360 PERIODS**OUTCOMES:**

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

CO1: Conduct the experiment and collect data

CO2: Analyze the data, interpret the results and conclude

CO3: Prepare project report and present

II. Not the continuation of Project Work I (at Industry)**OBJECTIVES:**

The course aims to enable the students to identify the research problem at the company, search databases to define the problem, design experiment, and conduct experiment to find the solution.

COURSE CONTENT

Individual students will identify a research problem relevant to his/her field of study at the company and get approval of project review committee. The student will collect, and analyze the literature and design the experiment. The student will carry out the experiment, collect data, interpret the result, prepare the project report and present before the committee.

TOTAL: 360 PERIODS**OUTCOMES:**

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

CO1: Identify the research problem

CO2: Collect, analyze the relevant literature and finalize the research problem

CO3: Design and conduct the experiment, analyse the data and conclude

CO4: Prepare project report and present

PROFESSIONAL ELECTIVES

IH3001

INTERNATIONAL SAFETY MANAGEMENT SYSTEM

L T P C

3 0 0 3

OBJECTIVES

- To explore a systematic approach in managing safety within an organization, ensuring a safe and healthy work environment for employees and stakeholders.

UNIT I ISO STANDARD

9

Introduction – Development of ISO standard – Structure and features of ISO 45001 – Benefits of certification— OH & S management system element, specification and scope - Correspondence between ISO 45001:2018, ISO 14001:2004 and ISO 9001:2000- Correspondence between ISO 45001, ISO 45002 and the ILO- OSH:2001.

UNIT II ISO 45001 POLICY & PLANNING, IMPLEMENTATION AND OPERATION

9

General requirements, ISO policy, Legal and other requirements-Objectives and programme(s), Implementation and operation-compliance and risk assessment-continuous improvement-communication and reporting – Documentation.

	PO1	PO2	PO3	PO4	PO5	PO6
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UNIT III ISO 50001- Energy management

9

Structured approach in managing- energy & its policies, objectives, target, action plans- continual improvement-legal and regulatory compliances-energy performance indicators –energy review: energy baseline –employee engagement-cost saving-enhanced environment performance-integrations with other management systems

UNIT IV ISO 14001 AND ISO 9000

9

ISO 14001 - Environmental management systems – environmental risk assessment - - Environmental policy- Legal and regulatory requirements – environmental performance monitoring- ISO 14001- quality management- customer satisfactions- process management – continual improvement- risk based thinking.

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

- Learn ISO 45001:2018, ISO 14001: 2004, ISO 9001: 2000 and ILO – OSH: 2001.
- Understand ISO 45001 policy and planning.
- Understand ISO 50001 policy and planning.
- Understand about ISO 14001 thoroughly.
- Implement ISO 14040 (LCA), ISO 14020 (Eco labelling), ISO 14024 and EIA in EMS.

REFERENCES:

- “ISO 14001:2004, Environmental Management Systems - Requirements with guidance for use”, ISO, 2004.
- “Guidelines on Occupational Health and Safety Management Systems (OSH-MS)” International Labour Organization: 2001.
- “BS 8800: 2004 Occupational Health and Safety Management.

COURSE ARTICULATION MATRIX:

CO1	2	2	2	2	2	2
CO2	2	2	2	2	2	2
CO3	2	2	2	2	2	2
CO4	2	2	2	2	2	2
CO5	2	2	2	2	2	2
Avg	2	2	2	2	2	2

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

**MI3022 MINE MANAGEMENT, LEGISLATION AND MINE SAFETY L T P C
3 0 0 3**

OBJECTIVES:

- To enable the students to learn various acts, rules and regulations adopted in the mines.

UNIT I INTRODUCTION TO MINE MANAGEMENT AND LEGISLATION 9

Introduction to Mine Management – Scientific management, Personal management, Production management and Environmental management. General principles of mining laws, development of mining legislation of India. Overview of enactment of various statutes and Bye-laws.

UNIT II ACTS, RULES APPLICABLE TO MINING - I (SAFETY) 9

Mines Act, 1952 and Regulations framed under Mines Act (The Coal Mines Regulations, 1957, The Metalliferous Mines Regulations, 1961, The Oil Mines Regulations, 1984, The Mines Rules, 1955, The Mines Vocational Training Rules, 1966, The Mines Rescue Rules, 1985, Bylaws, DGMS Circulars,

UNIT III ACTS, RULES APPLICABLE TO MINING - II 9

General provisions of Mines and Minerals Regulation and Development Act, Mineral Concession (Other than Hydrocarbon Energy Minerals) Rules, MCDR 2017, Environmental Protection Act 1986, MoEF Notifications & Circulars for the Mining Industry, Explosives Act & Rules.

UNIT IV GENERAL SAFETY IN MINES 9

Safety in Mines: Causes and prevention of accidents and their classification; frequency rate and severity rates; cause-wise analysis; investigations into accidents and accident reports; in-depth study into various causes of accidents; measures for improving safety in mines. Disaster management; rescue and recovery; mine rescue; mine gases and their physiological effects.

UNIT V SAFETY MANAGEMENT SYSTEM IN MINES 9

Risk assessment and risk management; cost of accident; safety management system; human elements in mine safety; workers participation in safety management; ISO and safety audit; safety conferences; tripartite and bipartite committees. Notified and occupational diseases; Sanitation and health in mines.

TOTAL: 45 PERIODS

COURSE OUTCOME:

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

1. Implement the various laws, rules and acts related to mines safety and mining legislation.
2. Prepare the procedures for opening, operation and closure of mines.
3. Analyze the accidents and prepare the accident enquiry reports.
4. Identify the various safety measures for the workers in mines.
5. Assess the risk, safety audit and safety management plan for the mines.

REFERENCES

1. Mines Act 1952, Lovely Prakashan, Dhanbad, 1995.
2. Coal Mines Regulations, 1961, Lovely Prakashan, Dhanbad, 1995.

3. Metal Mines Regulations, 1961, Lovely Prakashan, Dhanbad, 1995.
4. DGMS Circulars, By National Council of Safety in Mines, Dhanbad, 1995.
5. Mines Rules, 1955, Lovely Prakashan, Dhanbad, 1995.
6. The Mines Rescue Rules, 1986, Lovely Prakashan, Dhanbad, 1995.
7. The Indian Electricity Rules, 1995, Lovely Prakashan, Dhanbad, 1995.
8. The Payment of Wages Act, 1936, Ram Narain Lal Beni Prasad, 1995.
9. Vocational Training Rules, Lovely Prakashan, Dhanbad, 1995.
10. The Workmen's compensation Act, 1923, Ram Narain Lal Beni Prasad, Allahabad, 1995.
11. Kejriwal, B.K., Safety in Mines, Gyan Khan Prakashan, Dhanbad, 1994.

COURSE ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3	2	2
CO2	3	2	2	2	3	3
CO3	3	3	3	2	3	3
CO4	2	2	2	2	2	2
CO5	3	3	3	3	3	3
Avg	2.6	2.4	2.4	2.4	2.6	2.6

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

IH3002

EMERGENCY RESPONSE AND DISASTER MANAGEMENT

**L T P C
3 0 0 3**

OBJECTIVES

- To make the students effective and efficient while responding to emergencies, disasters, and crises to protect lives, minimize damage, and facilitate recovery.

UNIT I INTRODUCTION

9

Philosophy of Disaster management-Introduction to Disaster mitigation-Hydrological, Natural and Man-made disasters, earthquakes, floods drought, landside, land subsidence, cyclones, volcanoes, tsunami, avalanches, global climate extremes- Man-made disasters: Terrorism, gas and radiations leaks, toxic waste disposal, oil spills, forest fires.

UNIT II TECHNOLOGICAL & ENVIRONMENTAL DISASTERS

9

Technological Disasters - Case studies of Technology disasters with statistical details- Emergencies and control measures- APELL- Onsite and Offsite emergencies- Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts- Biodiversity-. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches.

UNIT III POLLUTION ASPECTS

9

Products of fires - 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-Atmospheric pollution- Global warming and Ozone Depletion Destruction of Ecosystem-Eco-friendly products- Green movements- Green philosophy - Environmental Policies- Environmental Impact Assessment- Life cycle.

UNIT IV REPERCUSSIONS OF DISASTERS AND HAZARDS

9

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

UNIT V INCIDENT MANAGEMENT

9

Basic principles of disaster management-Disaster Management cycle- Disaster management

policy, National and State Bodies for Disaster Management-Early Warning Systems-Building design and construction in highly seismic zones-The fundamentals of incident management-Incident Command System; Emergency Leadership-Mutual Aid & Joint Operations; Crisis Organization & Management; Response Functions & Priorities- Cleanup & Restoration; and Incident Termination- Training and drills for disaster preparedness-Awareness generation program- Usages of GIS and Remote sensing techniques in disaster management

TOTAL: 45 PERIODS

OUTCOMES:

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

1. Understand the basic conceptual understanding of disasters.
2. Learn about the Onsite/ Offsite disaster & environmental disasters
3. Describe pollution from various aspects and its effects
4. Analyze effects of disaster in economically, environmentally and society.
5. design incident management to prevent and mitigate disaster.

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:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	2	2	2	2	2	2
CO3	3	3	3	2	3	3
CO4	2	2	2	2	2	2
CO5	3	3	3	3	3	3
Avg	2.4	2.4	2.4	2.2	2.4	2.4

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

IH3003

SAFETY IN OIL AND GAS INDUSTRY

**L T P C
3 0 0 3**

OBJECTIVES

- To prevent accidents, injuries, and occupational illnesses and ensure the well-being of workers, protect the environment, and maintain the integrity of operations in oil & gas industries.

UNIT I PETROLEUM PRODUCTS

9

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

9

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 (HVLN) 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 9

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:

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

1. Understand the chemistry of petrochemical products and analyze the fire accidents
2. Design and evaluate the pipeline constructional safety in oil transportation
3. Learn the various safety techniques in handling of hydrocarbons.
4. Analyze the different aspects of disaster management and safety management in drilling operations
5. Understand 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)

COURSE ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	2	2	2	2	2	2
CO3	2	2	2	2	2	2
CO4	3	3	3	2	3	3
CO5	2	2	2	2	2	2
Avg	2.2	2.2	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

IH3004

DOCK SAFETY

**L T P C
3 0 0 3**

OBJECTIVE

- To ensure the safety of individuals, equipment, and goods during loading, unloading, and other activities at docks and waterfront areas.

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 forklift trucks and 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

OUTCOMES:

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

1. Know about dock safety legislation, welfare acts for workers and environment protection.
2. Learn the types of cargo ships, deck illumination and safety measures for combustible fuels present in cargo ships.
3. Identify the various types of lifting appliances.
4. Analyze the transportation safety in material handling.
5. Understand the dock worker's legislations and prepare to respond for various emergency situation.

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:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3	2	2
CO2	2	2	2	2	2	2
CO3	2	2	2	2	2	2
CO4	2	2	2	2	2	2
CO5	3	3	3	3	3	2
Avg	2.2	2.2	2.2	2.4	2.2	2

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

IH3005 ASSET INTEGRITY AND RELIABILITY ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To explore the integrity and reliability of industrial assets, which directly impacts the safety of workers, environment and communities.

UNIT I INTRODUCTION TO ASSET INTEGRITY 9

Introduction to Asset Integrity Management - Advanced Inspection techniques -the interpretation of inspection results --equipment criticality, optimization of maintenance schedules and cost-effective maintenance planning- Asset Performance Optimization -performance metrics, data-driven decision-making, and improvement methodologies. - Integrity Management of Aging Assets

UNIT II ASSET MANAGEMENT 9

Merging the concepts of asset with: Risk assessment –asset inspection & maintenance- safety standards and compliance- safety performance monitoring-incident investigation analysis-emergency preparedness plan-safety culture and training

UNIT III RELIABILITY CONCEPTS AND FAILURE DATA ANALYSIS 9

Reliability function – failure rate – mean time between failures (MTBF) – mean time to failure (MTTF) – priori 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 9

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

UNIT V RELIABILITY ASSESSMENT 9

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

TOTAL: 45 PERIODS

REFERENCES:

- Safety, Health, and Asset Protection: Management Essentials, Second Edition 2nd Edition by Richard Lack
- Guidelines for Asset Integrity Management By CCPS (Center for Chemical Process Safety) · 2017
- Charles E. Ebeling, “An introduction to Reliability and Maintainability engineering”, TMH, 2000.
- Roy Billington and Ronald N. Allan, “Reliability Evaluation of Engineering Systems”, Springer, 2007.

5. Srinath (2011) 'Reliability Engineering'. Affiliated East-West Press Pvt Ltd, New Delhi.

OUTCOME:

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

1. Ensure the assets are maintained in a manner that minimizes risks, prevents failures, and maximizes their lifespan.
2. Manage an organization's assets to achieve optimal performance, efficiency, and value throughout their lifecycle.
3. Assess the value of assets.
4. Understand the methodologies to analyze the failure data and the reliability concepts.
5. Design a systematic approach to estimating the reliability of systems or components

COURSE ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	2	2	2	2	2	3
CO3	3	3	3	3	3	3
CO4	2	2	2	2	2	2
CO5	3	3	3	3	3	3
Avg	2.6	2.6	2.6	2.6	2.6	2.8

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

IH3006

TRANSPORTATION SAFETY

L T P C
3 0 0 3

OBJECTIVE:

- To provide the safe and secure movement of people, goods and vehicles across railway, road, water and air transportation.

UNIT I RAILWAY ENGINEERING

9

Introduction of Railway Engineering: Permanent way. Curves, super-elevation, negative super elevation, transition curve, grade compensation on curves. Railway operation & control – points and crossings turn-out. Signalling and interlocking. Centralized traffic control. Railway accidents & safety. Rapid transit railways - types, merits & demerits.

UNIT II HIGHWAY ENGINEERING

9

Introduction of Highway Engineering: Classification of highways and urban road patterns. Typical cross section of roads. Factors controlling the alignment of roads. Basic geometric design - stopping and overtaking sight distances.

UNIT III TRAFFIC ENGINEERING

9

Introduction of Traffic Engineering: Traffic characteristics. Various traffic studies and their applications. Traffic signals. Carriage-way markings. Traffic islands. Highway intersections. Principles of highway lighting. Road Accidents - prevention, investigation and reduction

UNIT IV HARBOUR AND DOCK ENGINEERING

9

Introduction of Harbor & Dock Engineering: Water transportation, classification of harbors, accessibility and size, ports, Indian ports. Layout of ports, breakwater, facilities (in brief) for docking, repair, approach, loading and unloading, storing and guiding

UNIT V AIR TRANSPORTATION ENGINEERING

9

Classification of air transportation, Types of air craft engines – Propellants-feeding systems – Ignition and combustion – Theory of rocket propulsion -Applications –Air way accidents & safety.

OUTCOMES

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

1. Apply the knowledge of railway track components, materials and fixtures and fastenings
2. Understand elements of highway safety and approaches to accident Studies
3. know about traffic causes, critical points and its factors
4. Explain the significance of ports and harbors as a mode of transport.
5. Identify hazards and preventive measures in air transportation.

REFERENCES:

1. John Khisty C, Kent Lall B, "Transportation Engineering – An Introduction, 3rd Edition, Prentice Hall of India, New Delhi, 2002
2. B.S.Dhillon, "Transportation systems, reliability and safety" CRC Press
3. Chandra, S. & Agarwal, M. M. "Railway Engineering". Oxford University Press, New Delhi, 2007
4. 3 Khanna, S. K. and Justo, C. E. G., "Highway Engineering" (9th ed). Nem Chand & Brothers, New Delhi, 2001.
5. Geetham Tiwari & Dinesh Mohan, "Transport Planning & Traffic safety"
6. 5. Srinivasan, R., "Harbour, Dock and Tunnel Engineering". Charotar Publishing House Pvt. Ltd, Anand, 2013.
7. Kadiyali, L. R., "Traffic Engineering and Transport Planning", Khanna Publishers, New Delhi, 2004

COURSE ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	2	2	1
CO2	2	2	1	2	3	1
CO3	3	2	1	2	3	1
CO4	2	2	1	2	2	1
CO5	3	2	1	2	3	1
Avg	2.4	2	1	2	2.6	1

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

IH3007

BEHAVIOUR BASED SAFETYL T P C
3 0 0 3**OBJECTIVES**

- To promote the workplace safety by focusing on human behavior and encouraging safe practices among employees.

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

UNIT III SAFETY CULTURE**9**

Safety Culture- Safety Climate – An Overview – Main Pillar of Process Safety Management – Organization – Monitoring – Reporting – theories of motivations and their application to safety – the

role of management, supervisors, and safety department in motivation – ethical issues.

UNIT IV MODELS & THEORIES 9

ABC models- Iceberg theory-leading & lagging indicators – Bradley Curve –hierarchy of controls in understanding BBS- parameters affect BBS: fatigue, frustration, rush & complacency – sustainability in BBS.

UNIT V PSYCHOLOGY IN BBS 9

Neuroscience- human psychology- concern – commitment- skill matrix in understanding the strength of safety-safety emotions-mistakes & improvement – safety leadership.

TOTAL: 45 PERIODS

OUTCOMES:

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

1. Learn about the behavior based safety and focus on behavior to manage the risk.
2. Analyze about organizational behavior, solve perception of danger and acceptance of risk.
3. Understand about PSM, safety culture and ethical issue.
4. Understanding the ideology of BBS.
5. Analyze the impact of Safety on the psychological factors of Employees

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

COURSE ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	2	2	2	2	2	2
CO3	2	2	2	2	2	2
CO4	2	2	2	2	2	2
CO5	3	3	3	2	3	2
Avg	2.2	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

IH3008 SAFETY IN PROCESS INDUSTRIES L T P C 3 0 0 3

OBJECTIVES

- To protect the workers, public and the environmental hazards associated with the handling, processing, and storage of hazardous materials in complex industrial processes.

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 STORAGEES**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**OUTCOMES:**

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

1. Analyze the different safety aspect in process design and pressure system, heat exchanger, pressure relief valve, flare and vent system.
2. Understand the concept of commissioning and inspection.
3. Learn about operation prevailing in corrosion prevention of underground pipes.
4. Evaluate the management of on-site and off-site emergency planning, maintenance and disaster planning.
5. Analyze the details of vents, relief valves and storage in the industry

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:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	3	2
CO2	2	2	2	2	2	2
CO3	2	2	2	2	2	2
CO4	3	3	3	2	3	2
CO5	3	3	3	2	3	2
Avg	2.6	2.6	2.6	2	2.6	2

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

OBJECTIVES:

- To enable the students to design systems, products, and environments that consider human capabilities, limitations, and characteristics, with the goal of optimizing performance, safety, and user experience.

UNIT I ERGONOMICS AND ANATOMY

Introduction to ergonomics: The focus of ergonomics, ergonomics and its areas of application in the work system, a brief history of ergonomics, attempts to humanize work, modern ergonomics, and future directions for ergonomics. Anatomy, Posture and Body Mechanics: Some basic body mechanics, anatomy of the spine and pelvis related to posture, posture stability and posture adaptation, low back pain, risk factors for musculoskeletal disorders in the workplace, behavioral aspects of posture, effectiveness and cost effectiveness, research directions

9

UNIT II HUMAN BEHAVIOR

Individual differences, Factors contributing to personality, fitting the man to the job, Influence of difference on safety, Method of measuring characteristics, Accident Proneness. Motivation, Complexity of Motivation, Job satisfaction. Management theories of motivation, Job enrichment theory. Frustration and Conflicts, Reaction to frustration, Emotion and Frustration. Attitudes-Determination of attitudes, Changing attitudes Learning, Principles of Learning, Forgetting, Motivational requirements.

9

UNIT III ANTHROPOMETRY AND WORK DESIGN FOR STANDING AND SEATED WORKS

Designing for a population of users, percentile, sources of human variability, anthropometry and its uses in ergonomics, principals of applied anthropometry in ergonomics, application of anthropometry in design, design for everyone, anthropometry and personal space, effectiveness and cost effectiveness. Fundamental aspects of standing and sitting, an ergonomics approach to work station design, design for standing workers, design for seated workers, work surface design, visual display units, guidelines for design of static work, effectiveness and cost effectiveness, research directions

9

UNIT IV MAN-MACHINE SYSTEM AND REPETITIVE WORKS AND MANUAL HANDLING TASK

Applications of human factors engineering, man as a sensor, man as information processor, man as controller – Man vs Machine. Ergonomics interventions in Repetitive works, handle design, key board design- measures for preventing in work related musculoskeletal disorders (WMSDs), reduction and controlling, training Anatomy and biomechanics of manual handling, prevention of manual handling injuries in the work place, design of manual handling tasks, carrying, postural stability

9

UNIT V HUMAN SKILL AND PERFORMANCE AND DISPLAY,CONTROLS AND VIRTUAL ENVIRONMENTS

A general information-processing model of the users, cognitive system, problem solving, effectiveness-Principles for the design of visual displays- auditory displays- design of controls-combining displays and controls- virtual (synthetic) environments, research issues.

9

TOTAL: 45 PERIODS**OUTCOMES:**

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

- Learn the work procedure and its applications in hazardous workplaces.
- Design their own safety devices and equipment to reduce accidents.
- Apply human factors in design of Personal protective equipment.
- Understand the risk factors, guide lines for safe design of man machine systems considering human factors.
- Learn the principles for the design of visual displays- auditory displays

REFERENCES:

1. Ergonomic design for organizational effectiveness, Michael O'Neill 1st Edition 1998.
2. Human factors in engineering and design, MARK S.SANDERS 1992.
3. Introduction to Ergonomics, R.S. Bridger, Taylor and Francis 3rd Edition 2008.
4. The Ergonomics manual, Dan Mc Leod, Philip Jacobs and Nancy Larson

COURSE ARTICULATION MATRIX:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	1	1
CO2	3	3	3	3	3	3
CO3	3	2	2	2	2	3
CO4	2	2	2	2	2	2
CO5	1	1	1	1	1	1
Avg	2.4	2.2	2.2	2.1	2.3	2.4

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

