

**ANNA UNIVERSITY, CHENNAI**  
**UNIVERSITY DEPARTMENTS**  
**REGULATIONS – 2015**  
**CHOICE BASED CREDIT SYSTEM**  
**M.TECH. INDUSTRIAL SAFETY AND HAZARDS MANAGEMENT**

**PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :**

- I. To provide students with a good understanding of philosophy and integrated approach to managing safety, industrial hygiene and environment.
- II. To inculcate the students in hazardous identification techniques, reliability analysis of the process system, event trees & fault trees analysis, hazards and operability analysis (HAZOP).
- III. To introduce students to recent developments in analytical techniques, such as computer modelling of risk, reliability and safety problems.
- IV. To inculcate students in professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to think and act an individual safety consultant.

**PROGRAMME OUTCOMES (POs):**

- a. On successful completion of the programme,
  - I. Graduates will be able to assess the risks that may result from the physical, chemical, biological and psychological hazards.
  - II. Graduates will be able to effectively evaluate the current problems related to industrial safety and implement the remedial measures in the industries.
  - III. Graduates will be able to conduct detailed audit on the environment of existing industries to improve in-plant regimes for the management of hazards.
  - IV. Graduates will be able to design the safety models with regard to plant and machinery.
  - V. Graduates will demonstrate an ability to visualize the environmentally sound hazardous waste handling, storage, transportation, treatment and disposal.
  - VI. Graduates will demonstrate an ability to design of experiments, analyze and interpret data.
  - VII. Graduates will be familiar with the occupational health and safety act (OSHA) that apply to the work being performed in the workplace.
  - VIII. Graduates will demonstrate knowledge of professional and ethical responsibilities.
  - IX. Graduates will be able to communicate effectively to address promptly the concerns of workers in both verbal and written form to ministry of Labour.

Programme Educational Objectives	Programme Outcomes									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	
I	✓	✓	✓	✓						
II				✓	✓	✓				
III				✓		✓	✓			
IV							✓	✓	✓	

			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
YEAR 1	SEM 1	Probability and Statistics	✓					✓			
		Regulation for Health, Safety And Environment							✓	✓	✓
		Computer Aided Hazards Analysis	✓	✓	✓	✓					
		Principles of Safety Management				✓					✓
		Elective II									
		Elective I									
		Seminar							✓	✓	✓
	SEM2	Fundamentals in Environmental Protection	✓	✓	✓		✓				
		Safety in Engineering Industry	✓	✓	✓	✓	✓				
		Safety in Chemical Industry	✓	✓	✓	✓	✓				
		Fire Engineering and Explosion Control	✓	✓	✓	✓	✓				
		Elective III									
		Elective IV									
		Industrial Safety Lab	✓	✓						✓	✓
Industrial Training											✓
YEAR 2	SEM 3	Fundamentals in Occupation health and Industrial Hygiene							✓	✓	✓
		Reliability Engineering	✓					✓			
		Project Work (Phase I)	✓	✓	✓	✓	✓	✓	✓	✓	✓
	SEM 4	Project Work (Phase II)	✓	✓	✓	✓	✓	✓	✓	✓	✓

**ANNA UNIVERSITY, CHENNAI**  
**UNIVERSITY DEPARTMENTS**  
**REGULATIONS – 2015**  
**CHOICE BASED CREDIT SYSTEM**  
**I – IV SEMESTERS CURRICULUM AND SYALLBI**  
**M.TECH. INDUSTRIAL SAFETY AND HAZARDS MANAGEMENT**  
**SEMESTER – I**

SL. NO.	COURSE CODE	COURSE TITLE	Category	Contact Period	L	T	P	C
<b>THEORY</b>								
1.	MA7105	Probability and Statistics	FC	4	3	1	0	4
2.	IH7101	Computer Aided Hazards Analysis	PC	3	3	0	0	3
3.	IH7102	Principles of Safety Management	PC	3	3	0	0	3
4.	IH7103	Regulation for Health, Safety And Environment	FC	3	3	0	0	3
5.		Elective I	PE	3	3	0	0	3
6.		Elective II	PE	3	3	0	0	3
<b>LABORATORY</b>								
7.	IH7111	Seminar	EEC	4	0	0	4	2
<b>TOTAL</b>				<b>23</b>	<b>18</b>	<b>1</b>	<b>4</b>	<b>21</b>

**SEMESTER – II**

SL. NO.	COURSE CODE	COURSE TITLE	Category	Contact Period	L	T	P	C
<b>THEORY</b>								
1.	IH7201	Fire Engineering and Explosion Control	PC	3	3	0	0	3
2.	IH7202	Fundamentals in Environmental Protection	PC	3	3	0	0	3
3.	IH7203	Safety in Chemical Industry	PC	3	3	0	0	3
4.	IH7204	Safety in Engineering Industry	PC	3	3	0	0	3
5.		Elective III	PE	3	3	0	0	3
6.		Elective IV	PE	3	3	0	0	3
<b>LABORATORY</b>								
7.	IH7211	Industrial Safety Lab	EEC	4	0	0	4	2
8.	IH7212	Industrial Training	EEC	4	0	0	4	2
<b>TOTAL</b>				<b>22</b>	<b>18</b>	<b>0</b>	<b>8</b>	<b>22</b>

**SEMESTER – III**

SL. NO.	COURSE CODE	COURSE TITLE	Category	Contact Period	L	T	P	C
<b>THEORY</b>								
1.	IH7301	Fundamentals in Occupation health and Industrial Hygiene	PC	3	3	0	0	3
2.	IH7302	Reliability Engineering	PC	3	3	0	0	3
<b>LABORATORY</b>								
1.	IH7311	Project Work Phase I	EEC	12	0	0	12	6
<b>TOTAL</b>				<b>18</b>	<b>6</b>	<b>0</b>	<b>12</b>	<b>12</b>

**SEMESTER – IV**

SL. NO.	COURSE CODE	COURSE TITLE	Category	Contact Period	L	T	P	C
<b>LABORATORY</b>								
1.	IH7411	Project Work Phase II	EEC	24	0	0	24	12
<b>TOTAL</b>				<b>24</b>	<b>0</b>	<b>0</b>	<b>24</b>	<b>12</b>

**TOTAL CREDITS : 67**

**Foundation Courses (FC)**

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
<b>THEORY</b>								
1.		Probability and Statistics	FC	4	3	1	0	4
2.		Regulation for Health, Safety And Environment	FC	3	3	0	0	3

**Professional Core (PC)**

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
<b>THEORY</b>								
1.		Computer Aided Hazards Analysis	PC	3	3	0	0	3
2.		Principles of Safety Management	PC	3	3	0	0	3
3.		Fundamentals in Environmental Protection	PC	3	3	0	0	3

4.		Safety in Engineering Industry	PC	3	3	0	0	3
5.		Safety in Chemical Industry	PC	3	3	0	0	3
6.		Fire Engineering and Explosion Control	PC	3	3	0	0	3
7.		Fundamentals in Occupational health Industrial health and Hygiene	PC	3	3	0	0	3
8.		Reliability Engineering	PC	3	3	0	0	3

**Professional Electives (PE)**

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
<b>THEORY</b>								
1.	IH7006	Electrical Safety	PE	3	3	0	0	3
2.	IH7010	Industrial Noise and Vibration Control	PE	3	3	0	0	3
3.	IH7015	Safety in Construction	PE	3	3	0	0	3
4.	IH7016	Safety in Material Handling	PE	3	3	0	0	3
5.	IH7017	Safety in On and Off Shore Drilling	PE	3	3	0	0	3
6.	IH7007	Environmental Pollution And Control	PE	3	3	0	0	3
7.	IH7009	Human Factors in Process Safety	PE	3	3	0	0	3
8.	IH7011	Nuclear Engineering and Safety	PE	3	3	0	0	3
9.	IH7014	Quality Engineering	PE	3	3	0	0	3
10.	IH7012	OHSAS 18000, ISO 14000, ISO 9000	PE	3	3	0	0	3
11.	IH7020	Safety in underground Structures and mines	PE	3	3	0	0	3

12.	IH7004	Disaster and Incident Management	PE	3	3	0	0	3
13.	IH7019	Safety in Textile Industry	PE	3	3	0	0	3
14.	IH7005	Dock Safety	PE	3	3	0	0	3
15.	IH7018	Safety in Powder Handling	PE	3	3	0	0	3
16.	IH7008	Fireworks Safety	PE	3	3	0	0	3
17.	IH7001	Artificial Intelligence and Expert systems	PE	3	3	0	0	3
18.	IH7021	Transport Safety	PE	3	3	0	0	3
19.	IH7003	Design of Industrial Ventillation	PE	3	3	0	0	3
20.	IH7002	Design Of Air Pollution Control System	PE	3	3	0	0	3
21.	IH7013	Principles of Technical Analysis	PE	3	3	0	0	3

**Employability Enhancement Courses (EEC)**

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
<b>THEORY</b>								
1.		Industrial Safety Lab	EEC	4	0	0	4	2
2.		Seminar	EEC	4	0	0	4	2
3.		Industrial Training	EEC	4	0	0	4	2
4.		Project Work (Phase I)	EEC	12	0	0	12	6
5.		Project Work (Phase II)	EEC	24	0	0	24	12

**OBJECTIVE**

To provide basic concepts of Probability and Reliability.

**UNIT I****10**

Random variable – Two dimensional random variables – Standard probability distributions – Binomial, Poisson and Normal distributions - Moment generating function.

**UNIT II****15**

Special distributions – Uniform, Geometric, Exponential, Gamma, Weibull and Beta distributions – Mean, Variance, Raw moments from moment generating functions of respective distributions.

**UNIT III****15**

Sampling distributions – Confidence interval estimation of population parameters – Testing of hypotheses – Large sample tests for mean and proportion – t-test, F-test and Chi-square test.

**UNIT IV****10**

Curve fitting - Method of least squares - Regression and correlation – Rank correlation – Multiple and partial correlation – Analysis of variance - One way and two way classifications – Time series analysis.

**UNIT V****10**

Completely Randomized Design - Randomized Block design - Latin square design - 2 Factorial Design.

**TOTAL : 60 PERIODS****OUTCOME**

Students who successfully complete this course should be able to understanding of numeric and symbolic mathematical computations and use mathematical computation to solve 'real-world' problems .

**REFERENCES**

1. Bowker and Liberman, Engineering Statistics, Prentice-Hall.
2. Spiegel, Murray R., Probability and Statistics, Schaum's series. Statistics, Sultan Chand and Sons.
3. Spiegel, Murray R., Statistics, Schaum's series.
4. Trivedi K.S., Probability and Statistics with Reliability and Queuing and Computer Science Applications, Prentice Hall of India.

**OBJECTIVE**

To provide comprehensive knowledge on PHA, HAZOP, Thermal analysis and BAM testing.

**UNIT I****HAZARD, RISK ISSUES AND HAZARD ASSESSMENT****8**

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

**UNIT II INSTRUMENTATION AND TESTING 8**

Applications of Advanced Equipments 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 ANALYSIS QUANTIFICATION AND SOFTWARES 9**

Fault Tree Analysis and Event Tree Analysis, Logic symbols, methodology, minimal cut set ranking - fire explosion and Index(FEI)-fire explosion and toxicity index(FETI), various indices - Hazard analysis(HAZAN)- Failure Mode and Effect Analysis(FMEA)- Basic concepts of Reliability- Software on Risk analysis, CISCON, FETI, HANGARS modules on Heat radiation, Pool fire, Jet, Explosion. Reliability software on FMEA for mechanical and electrical systems..

**UNIT IV CONSEQUENCES ANALYSIS 10**

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

**UNIT V DISPERSION MODEL ANALYSIS AND CASE STUDY 10**

Spill and leakage of liquids, vapors, gases and their mixture from storage tanks and equipment; Estimation of leakage/spill rate through hole, pipes and vessel burst; Isothermal and adiabatic flows of gases, spillage and leakage of flashing liquids, pool evaporation and boiling; Release of toxics and dispersion. Naturally buoyant and dense gas dispersion models; Effects of momentum and buoyancy; Mitigation measures for leaks and releases. 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**

**OUTCOME**

Students who successfully complete this course should be able to understanding of Hazard, Risk issues and Hazard assessment. It also be able to develop the air dispersion modeling

**REFERENCES**

1. Loss Prevention in Process Industries-Frank P. Less Butterworth-Hein UK 1990 (Vol.I, II & III).
2. Methodologies for Risk and Safety Assessment in Chemical Process Industries, Commonwealth Science Council, UK
3. Hazop and Hazon, by Trevor A Klett, Institute of Chemical Engineering.
4. Quantitative Risk assessment in Chemical Industries, Institute of Chemical Industries, Centre for Chemical process safety.
5. Guidelines for Hazard Evaluation Procedures, Centre for Chemical Process safety, AIChE 1992.



**OBJECTIVE**

To ensure that potential hazards are identified and mitigation measures are in place to prevent accidents. Also to know how to monitor the safety performance importance of training.

**UNIT I CONCEPTS****5**

Evolution of modern safety concept- Safety policy - Safety Organization - line and staff functions for safety- Safety Committee- budgeting for safety.

**UNIT II TECHNIQUES****8**

Incident Recall Technique (IRT), disaster control, Job Safety Analysis (JSA), safety survey, safety inspection, safety sampling, Safety Audit. Pareto Analysis

**UNIT III ACCIDENT INVESTIGATION AND REPORTING****12**

Concept of an accident, reportable and non-reportable accidents, Accident Frequency Rate, Accident Severity Rate, unsafe act and condition – principles of accident prevention, Supervisory role- Role of safety committee – Accident causation models - Cost of accident. Overall accident investigation process - Response to accidents, India reporting requirement, Planning document, Planning matrix, Investigators Kit, functions of investigator, four types of evidences, Records of accidents, accident reports-Class exercise with case study. Cause and Effect Analysis.

**UNIT IV SAFETY PERFORMANCE MONITORING****10**

permanent total disabilities, permanent partial disabilities, temporary total disabilities - Calculation of accident indices, frequency rate, severity rate, frequency severity incidence, incident rate, accident rate, safety “t” score, safety activity rate – problems.

**UNIT V SAFETY EDUCATION AND TRAINING****10**

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

**TOTAL : 45 PERIODS****OUTCOME**

This course should be to able to know how to monitor the safety performance importance of training.

**REFERENCES**

1. Accident Prevention Manual for Industrial Operations”, N.S.C.Chicago, 1982
2. Heinrich H.W. “Industrial Accident Prevention” McGraw-Hill Company, New York, 1980.
3. Krishnan N.V. “Safety Management in Industry” Jaico Publishing House, Bombay, 1997.
4. John Ridley, “Safety at Work”, Butterworth & Co., London, 1983.
5. Blake R.B., “Industrial Safety” Prentice Hall, Inc., New Jersey, 1973.

<b>IH7103</b>	<b>REGULATION FOR HEALTH, SAFETY AND ENVIRONMENT</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVE**

To impart knowledge about regulations for health, safety and environment.

<b>UNIT I</b>	<b>8</b>
Factories act and rules; Workmen compensation act.	

<b>UNIT II</b>	<b>9</b>
Indian explosive act – Explosives Rules, 2008 - Gas cylinder rules, 2004 – SMPV(U) -Rules, 1981 - Indian petroleum act, 1934 and rules, 2002, Environment Protection Act, 1986	

<b>UNIT III</b>	<b>9</b>
Manufacture, Storage and Import of Hazardous Chemical rules 1989.	

<b>UNIT IV</b>	<b>10</b>
Indian Electricity act 2003 and rules 1956. The Building and other Construction Workers (Regulation of Employment and Condition of Service) Act, 1996, The Building and other Construction workers (Regulation of Employment and conditions of Service) Central Rules, 1998	
	<b>9</b>

<b>UNIT V</b>	
Overview of OHSAS 18000 and ISO 14000. ISO9000	

**TOTAL : 45 PERIODS**

**OUTCOME**

Students who successfully complete this course, explains common hazards, how workers are protected, and precautions taken to ensure a safe workplace and environment.

**REFERENCES**

1. The Factories Act 1948, Madras Book Agency, Chennai, 2000
2. The Environment Act (Protection) 1986, Commercial Law Publishers (India) Pvt.Ltd., New Delhi.
3. Water (Prevention and control of pollution) act 1974, Commercial Law publishers (India) Pvt.Ltd., New Delhi.
4. Air (Prevention and control of pollution) act 1981, Commercial Law Publishers (India) Pvt.Ltd., New Delhi.
5. Explosive Act, 1884 and Explosive rules, 2008 (India), Eastern Book company, Lucknow, 10th Edition & www. peso.gov.in
6. The manufacture, storage and import of hazardous chemical rules 1989, Madras Book Agency, Chennai.
7. ISO 9000 to OHSAS 18001, Dr. K.C. Arora, S.K. Kataria & Sons, Delhi.

<b>IH7201</b>	<b>FIRE ENGINEERING AND EXPLOSION CONTROL</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVE**

To provide basic concepts of fire engineering and explosion control.

<b>UNIT I</b>	<b>PHYSICS AND CHEMISTRY OF FIRE</b>	<b>9</b>
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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 – CO<sub>2</sub> 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-fire fighting 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 (CO<sub>2</sub>) and halons-hazards in LPG, ammonia (NH<sub>3</sub>).

**TOTAL : 45 PERIODS**

**OUTCOME :**

Students who successfully complete this course should be able to understanding the industrial fire protection systems.

**TEXT BOOKS:**

1. Derek, James, "Fire Prevention Hand Book", Butter Worths and Company, London,1986.
2. Arthur E Cote "Fire protection Handbook" NFPA 2008.
3. Jain V K "Fire Safety in Building" New Age International 1996.
4. Purandare D.D & Abhay D.Purandare, "Hand book on Industrial Fire Safety" P & A publications, New Delhi – 2006.

**REFERENCE BOOKS:**

1. Gupta, R.S., "Hand Book of Fire Technology" Orient Blackswan,2010
2. McElroy, Frank E "Accident Prevention manual for industrial operations" N.S.C., Chicago, 1988.
3. Dinko Tuhtar, "Fire and explosion protection – A System Ap-proach" Ellis Horwood Ltd , Publisher, 1989.
4. "Fire fighters hazardous materials reference book", Van Nostrand

<b>IH7202</b>	<b>FUNDAMENTALS IN ENVIRONMENTAL PROTECTION</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVE**

To provide advanced concepts of EIA and EMS.

**UNIT I** **9**

Evolution of EIA – Concepts – Methodologies – Screening – Scoping – Mitigation – Matrices – Checklist.

**UNIT II** **9**

Rapid and Comprehensive EIA – Legislative and Environmental Clearance procedure in India – Prediction tools for EIA.

**UNIT III** **5**

Assesment of Impact – Air – Water – Soil – Noise- Biological.

**UNIT IV** **10**

Socio cultural environment – Public participation – Resettlement and Rehabilitation.

**UNIT V** **12**

Documentation of EIA – Environmental management plan – Waste Management Plan -Post project monitoring – Environmental Audit- Life cycle assessment – EMS – case studies in EIA.

**TOTAL : 45 PERIODS**

**OUTCOME**

Students who successfully complete this course should be able to frame the EIA documentation

**REFERENCES**

1. Canter. R. L., Environmental Impact Assessment, McGraw Hill.
2. John G. Rau and David. C. Wooten (Ed)., Environmental Impact analysis hand book, McGraw Hill

<b>IH7203</b>	<b>SAFETY IN CHEMICAL INDUSTRY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVE**

To provide comprehensive knowledge on safety in process equipment

**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, Effects Estimation of hazard assessment.

**UNIT II PLANT COMMISSIONING AND INSPECTION 9**

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

**UNIT III PLANT MAINTENANCE, MODIFICATION AND EMERGENCY PLANNING 9**

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

**UNIT IV STORAGEES AND TRANSPORTATION 9**

General consideration, petroleum product storagees, storage tanks and vessel- storagees layout- segregation, separating distance, secondary containment- venting and relief, atmospheric vent, pressure, vacuum valves, flame (NOT arrest) arrestors, Spark Arrestor, fire relief- fire prevention and protection- LPG storagees, pressure storagees, layout, instrumentation, vapourizer, refrigerated storagees, Cryogenic Storage- LNG storagees, hydrogen storagees, toxic storagees, toxic release & control methodologies, chlorine storagees, ammonia storagees, other chemical storagees- underground storagees- loading and unloading facilities- drum and cylinder and Pressure Vessel storage – Importance of Ullage - ware house, storage hazard assessment of LPG and LNG Hazards during transportation-pipeline transport.

**UNIT V PLANT OPERATIONS 9**

Operating discipline, operating procedure and inspection, format, emergency procedures hand over and permit system- start up and shut down operation, refinery units- operation of fired heaters, driers, storage- operating activities and hazards- trip systems- exposure of personnel. Specific safety consideration of cement, Paper, pharmaceutical, petroleum, petrochemical, rubber, fertilizer and distilleries.

**TOTAL : 45 PERIODS**

**OUTCOME**

Gain the comprehensive knowledge on safety in process equipment, storage vessels and Gas transportation pipelines.

**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, 1984.
4. McElroy, Frank E., "Accident Prevention Manual for Industrial Operations", NSC, Chicago, 1988.
5. Green, A.E., "High Risk Safety Technology", John Wiley and Sons, 1984.

<b>IH7204</b>	<b>SAFETY IN ENGINEERING INDUSTRY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

## **OBJECTIVE**

To ensure that safety in Engineering industry.

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

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

### **UNIT II PRINCIPLES OF MACHINE GUARDING 10**

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

### **UNIT III SAFETY IN WELDING AND GAS CUTTING 8**

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

### **UNIT IV SAFETY IN COLD FORMING AND HOT WORKING OF METALS 12**

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

### **UNIT V SAFETY IN FINISHING, INSPECTION AND TESTING 10**

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

**TOTAL : 45 PERIODS**

## **OUTCOME**

Students who successfully complete this course should be able to know the safety in cold forming and hot working of metals , welding and gas cutting .

## **REFERENCES**

1. Accident Prevention Manual” – NSC, Chicago, 1982.
2. Occupational safety Manual” BHEL, Trichy, 1988.
3. Safety Management by John V. Grimaldi and Rollin H. Simonds, All India Travelers Book seller, New Delhi, 1989.
4. Safety in Industry” N.V. Krishnan Jaico Publishery House, 1996.
5. Indian Boiler acts and Regulations, Government of India.
6. Safety in the use of wood working machines, HMSO, UK 1992.
7. Health and Safety in welding and Allied processes, welding Institute, UK, High Tech. Publishing Ltd., London, 1989.
8. Safety and Health for Engineers - Roger L. Brauer, Ph.D & CSP (USA)

**OBJECTIVE**

To provide comprehensive knowledge on analyzing instrument.

**1. NOISE LEVEL MEASUREMENT AND ANALYSIS**

Measurement of noise level for various sources – Impact, continuous and intermittent. Frequency and spectrum analysis of noise: Instrument – precision type of Noise level meter with frequency and spectrum analyzer.

**2. VIBRATION MEASUREMENT AND ANALYSIS**

Measurement of whole body vibration for various acceleration: Instrument – vibration simulator and vibration analyzer.

**3. FRICTION SENSITIVITY TEST**

Measurement of friction sensitivity for unstable materials: Instrument – BAM friction tester

**4. IMPACT SENSITIVITY TEST**

Measurement of impact sensitivity for unstable materials: Instrument – BAM fall hammer

**5. THERMAL REACTIVITY TEST**

Measurement of thermal reactivity for unstable materials: Instrument – DSC/TGA

**6. EXHAUST GAS MEASUREMENT AND ANALYSIS**

Measurement of Exhaust gas measurement of IC engines: Instrument – Gas analyzer

**7. BREATHING ZONE CONCENTRATION**

Measurement of breathing zone concentration of dust and fumes: Instrument – personal air sampler

**8. AMBIENT AIR MONITORING**

Measurement of respirable and non- respirable dust in the ambient air: Instrument – High volume sampler

**9. CONSEQUENCE ANALYSIS**

Soft computing skills on developing effects of fire & explosion and dispersion: Software – PHAST 1 and ALOHA

**10. STUDY OF PERSONAL PROTECTIVE EQUIPMENT**

Safety helmet, belt, hand gloves, goggles, safety shoe, gum boots, ankle shoes, face shield, nose mask, ear plug, ear muff, apron and leg guard.

**11. STUDY OF FIRE EXTINGUISHERS**

Selection and demonstration of first-aid fire extinguishers: soda acid, foam, carbon dioxide (CO<sub>2</sub>), dry chemical powder, halon.

**TOTAL: 60 PERIODS**

**OBJECTIVE**

To provide comprehensive knowledge on physical, chemical and biological hazards and its effects on human health

**UNIT I ANATOMY, PHYSIOLOGY, HAZARD AND PATHOLOGY 9**

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

**UNIT II PHYSICAL HAZARDS 9**

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

**UNIT III CHEMICAL HAZARDS 9**

Recognition of chemical hazards-dust, fumes, mist, vapour, fog, gases, types, concentration, Exposure vs. Dose, TLV - Methods of Evaluation, process or operation description, Field Survey, Sampling methodology, Industrial Hygiene calculations, Comparison with OSHAS Standard. Air Sampling instruments, Types, Measurement Procedures, Instruments Procedures, Gas and Vapour monitors, dust sample collection devices, personal sampling methods of control - Engineering control, Design maintenance considerations

**UNIT IV BIOLOGICAL AND ERGONOMICAL HAZARDS 9**

Classification of Bio-hazardous agents – examples, bacterial agents, rickettsial and chlamydial agents, viral agents, fungal, parasitic agents, infectious diseases – Biohazard control program, employee health program-laboratory safety program-animal care and handling-biological safety cabinets - building design. Work Related Musculoskeletal Disorders –Carpal Tunnel Syndrome CTS- Tendon pain disorders of the neck- back injuries.

**UNIT V OCCUPATIONAL HEALTH, PHYSIOLOGY AND TOXICOLOGY 9**

Concept and spectrum of health - functional units and activities of occupational health services, pre-employment and post-employment medical examinations – occupational related diseases, levels of prevention of diseases, notifiable occupational diseases such as silicosis, asbestosis, pneumoconiosis, siderosis, anthracosis, aluminosis and anthrax, Man as a system component – allocation of functions – efficiency – occupational work capacity – aerobic and anaerobic work – evaluation of physiological requirements of jobs – parameters of measurements – categorization of job heaviness – work organization – stress – strain – fatigue – rest pauses – shift work – personal hygiene.

**TOTAL : 45 PERIODS**

**OUTCOME:**

Gain the significance knowledge on occupational health, physiology and toxicology.

**TEXTBOOKS:**

1. Danuta Koradecka, Hand book of "Occupational Safety and Health", CRC Press. 2010 edition.
2. Hand book of "Occupational Safety and Health", National Safety Council, Chicago, 1982.



**REFERENCE BOOKS:**

1. Barbara A.Plog, Patricia J.Quinlan, MPH,CIH and Jennifer Villareal “Fundamentals of Industrial Hygiene, 6th edition 2012, National Safety Council, 2012.
2. Jearne Mager Stellman, “Encyclopedia of Occupational Health and Safety”, Vol.I and II, published by International Labour Organi-sation, Geneva, 1998

**IH7302****RELIABILITY ENGINEERING****L T P C  
3 0 0 3****OBJECTIVE**

To provide comprehensive knowledge on Reliability testing and risk analysis techniques

**UNIT I RELIABILITY CONCEPT 9**

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

**UNIT II FAILURE DATA ANALYSIS 9**

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

**UNIT III RELIABILITY PREDICTION MODELS 9**

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

**UNIT IV RELIABILITY MANAGEMENT 9**

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

**UNIT V RISK ASSESSMENT 9**

Definition and measurement of risk – risk analysis techniques – risk reduction resources industrial safety and risk assessment.

**TOTAL : 45 PERIODS****OUTCOME :**

Students who successfully complete this course should be able to analyze the failure data analysis and apply the non parametric models to risk analysis in safety industries.

**TEXT BOOK:**

1. Charles E Ebeling, “An Introduction to Reliability and Maintainability Engineering”, Tata McGraw Hill, 2009.

**REFERENCE BOOKS:**

1. Srinath L.S, “Reliability Engineering”, East West Press, 2005.
2. Modarres, “Reliability Engineering and Risk analysis”, CRC Press, 2009.
3. John Davidson, “The Reliability of Mechanical Systems” Mechanical Engineering Publications Limited, 1994.
4. Smith C.O. “Introduction to Reliability in Design”, McGraw Hill, London, 1976.

IH7006

**ELECTRICAL SAFETY**

L	T	P	C
3	0	0	3

**OBJECTIVE**

To provide electrical protection and maintenance in working environment and ensure that electrical safety.

**UNIT I BASIC ELECTRICAL 12**

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

**UNIT II STANDARDS AND REQUIREMENTS 10**

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

**UNIT III ELECTRICAL HAZARDS 9**

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

**UNIT IV ELECTRICAL PROTECTION AND MAINTENANCE 8**

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

**UNIT V CLASSIFICATION OF HAZARDOUS AREAS 6**

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

**TOTAL : 45 PERIODS**

**OUTCOME**

Gain the knowledge on classification of electrical equipments for hazardous areas and Protection measures from electrical shock.

**REFERENCES**

1. Fordham Cooper W., Electrical Safety Engineering, Butterworths, London, 1986.
2. Accident Prevention Manual for Industrial Operations, NSC, Chicago, 1982.
3. www.osha.gov

IH7010

**INDUSTRIAL NOISE AND VIBRATION  
CONTROL**

L	T	P	C
3	0	0	3

**OBJECTIVE**

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

**UNIT I INTRODUCTION 10**

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

**UNIT II INSTRUMENTATION AND AUDITORY 10**  
Sensors used in vibration and measurements – Frequency and spectrum analysers – Weighting networks – Hearing mechanism – relation between subjective and objective sounds – Auditory effects of noise and audiometric testing – Speech interference levels and its importance.

**UNIT III SOURCES OF NOISE AND RATINGS 10**  
Mechanism of noise generation and propagation in various machinery and machine components, vehicles etc. – Directivity index – Concept of Leq and estimation – Noise ratings and standards for various sources like industrial, construction, traffic, aircraft community etc. – industrial safety and OSHA regulations – Noise legislations and management.

**UNIT IV NOISE CONTROL 10**  
Energy transferring and dissipating devices Source: Structure borne and flow excited. Vibration isolation and absorption. Spring and damping materials, Dynamic absorbers, Mufflers and silencers, Path: Close filter and loosely covered enclosures – Acoustic treatment and materials– Transmission loss and absorption coefficient of materials and structures and their estimation – Reverberation time and room constant – Design of rooms / industrial halls/ auditorium for minimum noise. Receiver: Measure to control at the receiver end – use of enclosures, ear muffs and other protective devices.

**UNIT V ABATEMENT OF NOISE 5**  
Active noise attenuators and scope for abatement of industrial noise.

**TOTAL : 45 PERIODS**

**OUTCOME**

Students gain the knowledge on industrial vibration control in a specific industries.

**REFERENCES**

1. Irwin, J.D and Graf, E. R, Noise and Vibration Control, Prentice Hall Inc. New Jercoy, 1979.
2. Irwing B Crandall, Theory of Vibrating Systems and Sound, D. Vannostrand Company, New Jercoy, 1974.
3. Cyril M. Harris, Hand Book of Noise Control, McGraw Hill Book Company, New York, 1971.
4. White R. G. Walker J. G, “Noise and Vibration”, John Wiley and sons New York, 1982.

**IH7015 SAFETY IN CONSTRUCTION L T P C  
3 0 0 3**

**OBJECTIVE**

To ensure that safety in Construction Industry – Safety when working at height – Underground Excavation and Tunnels- Bridges.

**UNIT I INTRODUCTION 10**

General safety consideration – analyzing construction jobs for safety – Contract document – Safety certificate for statutory authorities for old building and construction. The Building and other Construction workers (Regulation of Employment and conditions of Service) Central Rules, 1998

**UNIT II SAFETY IN EXCAVATION AND DEMOLITION**

Excavation for foundation and basement identification of utilities and protection– Safety in deep excavation - Safety during Demolition – Cordoning – Dismantling –Clearing debris

**UNIT III FORMWORK AND SCAFFOLD SAFETY 8**

Different types of formwork – Design, Erection, Loading and Dismantling – Different types of scaffolds – Design, safe erection, use and dismantling.

**UNIT IV INSPECTION IN HUGE STRUCTURES 10**

Safety in typical civil structures – Dams-bridges-water Tanks-Retaining walls-Critical factors for failure-Regular Inspection and monitoring.

**UNIT V PLANT AND MACHINERY INSPECTION AND MAINTENANCE 9**

Plant and Machinery regular inspection and Maintenance –Training, appointment of qualified for operators-Scheduling-Preventive maintenance-Lock out Tag out of Mechanical and Electrical equipment during maintenance-ground maintenance-hand tools-Gasoline operating equipment.

**TOTAL : 45 PERIODS**

**OUTCOME**

Gain the safety in Construction Industry – Safety when working at height – Underground Excavation and Tunnels- Bridges.

**REFERENCES**

1. Accident Prevention Manual for Industrial Operations, NSC, Chicago, 1982.
2. Fulman, J.B., Construction Safety, Security, and Loss Prevention, John Wiley and Sons, 1979.

<b>IH7016</b>	<b>SAFETY IN MATERIAL HANDLING</b>	<b>L T P C 3 0 0 3</b>
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**OBJECTIVE**

To ensure that safety in ergonomics of conveying and hoisting mechanisms and handling of heavy equipment.

**UNIT I MATERIAL HANDLING 8**

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

**UNIT II ERGONOMICS OF CONVEYING MECHANISMS 10**

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

**UNIT III ERGONOMICS OF HOISTING MECHANISMS 8**

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

**UNIT IV HANDLING OF HEAVY EQUIPMENTS 9**

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

**UNIT V STORAGE OF GOODS AND EQUIPMENTS 10**

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

**TOTAL : 45 PERIODS**

**OUTCOME**

To ensure that General safety consideration in material handling

**REFERENCES**

1. Accident Prevention Manual for Industrial Operations, NSC, Chicago, 1982.
2. Alexandrov, M.P., Material Handling Equipment, Mir Publishers, Moscow, 1981.
3. Rudenko N., Material Handling Equipments, Mir Publishers, Moscow, 1981.

<b>IH7017</b>	<b>SAFETY IN ON AND OFF SHORE DRILLING</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVE**

To ensure that knowledge on safety measures in textile industries., extraction and transportation.

**UNIT I PETROLEUM PRODUCTS 10**

Petroleum and Petroleum products – Fuels- Petroleum solvents – Lubricating oils – Petroleum wax, greases – Miscellaneous product.

**UNIT II ON AND OFF SHORE OPERATION 10**

On and off shore oil operation – Construction of Installation – Pipe line Construction – Maintenance and repair activities – Safety and associated hazards.

**UNIT III DRILLING 9**

Drilling oil – Technique and equipment- Work position –Working condition – safety and associated hazards- lighting and its effects.

**UNIT IV EXTRACTION AND TRANSPORTATION 9**

Petroleum Extraction and transport by sea – Oil field products – Operation – Transport of crude by sea – Crude oil hazards.

**UNIT V STORAGE AND CLEANING 7**

Petroleum product storage and transport –Storage equipment –Precaution –Tank cleaning

**TOTAL : 45 PERIODS**

**OUTCOME**

Gain the knowledge on safety measures in On and Off shore Drilling

**REFERENCES**

1. Encyclopedia of Occupational Health and Safety, Vol. II, International Labour Organisation, Geneva, 1985.

<b>IH7007</b>	<b>ENVIRONMENTAL POLLUTION CONTROL</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVE**

To train in computer programming and use of software tools for solving chemical engineering problems.

**UNIT I AIR POLLUTION 9**

Classification and properties of air pollutants – Pollution sources – Effects of air pollutants on human beings, Animals, Plants and Materials - automobile pollution hazards of air pollution-concept of clean coal combustion technology - ultra violet radiation, infrared radiation, radiation from sun-hazards due to depletion of ozone - deforestation-ozone holes-automobile exhausts-chemical factory stack emissions-CFC. Guide lines on Air (prevention and control of pollution) act, 1981 and rules 1982.

**UNIT II WATER POLLUTION 9**

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

**UNIT III HAZARDOUS WASTE MANAGEMENT 9**

Hazardous waste management in India-waste identification, characterization and classification-technological options for collection, treatment and disposal of hazardous waste-selection charts for the treatment of different hazardous wastes-methods of collection and disposal of solid wastes-health hazards-toxic and radioactive wastes incineration and vitrification - hazards due to bio-process-dilution-standards and restrictions – recycling and reuse. Environmental impact assessment (EIA)-scope, guidelines, activities and methodologies.

**UNIT IV ENVIRONMENTAL MEASUREMENT AND CONTROL 9**

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

**UNIT V POLLUTION CONTROL IN PROCESS INDUSTRIES 9**

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

**TOTAL : 45 PERIODS**

**OUTCOME**

Students gain the knowledge on pollution control in Process industries

**REFERENCES**

1. Varma and Braner, "Air pollution equipment", Springer Publishers, Second Edition.
2. "Guidelines for EIA of Industrial and other Projects" Ministry of Environment and Forests, Government of India. 2009
3. Pollution Control Law Series: Pollution Control Acts, Rules and Notification Issued There under, Central Pollution Control Board, Ministry of Environment and Forest, Government of India. 2006
4. Cheremisinoff N.P. and Graffia M.L., "Environmental Health and Safety Management. A Guide to Compliance", Pressure safety design practices for refinery and chemical operations", Jaico Publication. 2003
5. Canter L.W., "Environmental Impact Assessment", McGraw Hill. 1996.

<b>IH7009</b>	<b>HUMAN FACTORS IN PROCESS SAFETY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVE**

To provide comprehensive knowledge on application of ergonomics in a work system.

**UNIT I** **9**

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

**UNIT II** **9**

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

**UNIT III** **9**

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

**UNIT IV** **9**

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

**UNIT V** **9**

Personal protective equipments (different types, specifications, standards, testing procedures, and maintenance).

**TOTAL : 45 PERIODS**

**OUTCOME**

Students who successfully complete this course should be able know the Personal protective equipments in industries

**REFERENCES**

1. McCornick, E.J., Human Factors in Engineering and Design, Tata McGraw-Hill, 1982.
2. Accident Prevention Manual for Industrial Operations, NSC, Chicago, 1982.

<b>IH7011</b>	<b>NUCLEAR ENGINEERING AND SAFETY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVE**

To provide basic concepts on safety of nuclear reactors and radiation control

**UNIT I INTRODUCTION** **9**

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

**UNIT II REACTOR CONTROL** **9**

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

**UNIT III REACTOR TYPES** **9**

Boiling water reactors – radioactivity of steam system – direct cycle and dual cycle power

plants-pressurized water reactors and pressurized heavy water reactors – fast breeder reactors and their role in power generation in the Indian context – conversion and breeding – doubling time – liquid metal coolants – nuclear power plants in India.

**UNIT IV SAFETY OF NUCLEAR REACTORS 9**

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

**UNIT V RADIATION CONTROL 9**

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

**TOTAL : 45 PERIODS**

**OUTCOME**

Students who successfully complete this course should be able understanding the safety of nuclear reactors and radiation control.

**TEXT BOOKS:**

1. Wakil M.M.E.L, “Nuclear Power Engineering”, International Text Book Co, 1962.
2. Sterman L.S. ”Thermal and Nuclear Power Stations”, MIR Publica-tions, Moscow, 1986.

**REFERENCE BOOKS:**

1. “Loss prevention in the process Industries” Frank P.Lees Butter-worth-Hein-UK, 1990.
2. Wakil M.M.E.L, “Nuclear Energy Conversion”, International Text Book Co,1978
3. Murray R.L, “Introduction to Nuclear Engineering”, Prentice Hall,1961
4. Sri Ram K, “Basic Nuclear Engineering” Wiley Eastern Ltd., New Delhi, 1990.
5. Loffness R.L., “Nuclear Power Plant” Van Nostrand Publications, 1979.
6. “Loss prevention in the process Industries” M. Sam Mannan But-terworth-Heinemann; 4th edition, 2012.

<b>IH7014</b>	<b>QUALITY ENGINEERING</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVE**

To provide knowledge on quality engineering and on-line quality control

**UNIT I INTRODUCTION TO QUALITY ENGINEERING AND LOSS FUNCTION 9**

Engineering and quality value and - quality system overview- product design using quality engineering - designing production processes based on quality engineering - quality engineering used in production - service provided with quality engineering. Loss function Derivation – use-loss function for products/system- justification of improvements-loss function and inspection- quality evaluations and tolerances-N type, S type, L type.

**UNIT II ON-LINE QUALITY CONTROL 9**

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



**UNIT III ON-LINE QUALITY CONTROL ATTRIBUTES AND METHODS FOR PROCESS IMPROVEMENTS 9**  
 Checking intervals- frequency of process diagnosis. Production process improvement method- process diagnosis improvement method- process adjustment and recovery improvement methods.

**UNIT IV QUALITY ENGINEERING AND TPM 9**  
 Preventive maintenance schedules- PM schedules for functional characteristics- PM schedules for large scale systems. Quality tools–fault tree analysis, event tree analysis, failure mode and effect analysis. ISO quality systems

**UNIT V SIX SIGMA AND ITS IMPLEMENTATION 9**  
 Introduction- definition-methodology- impact of implementation of six sigma-DMAIC method-roles and responsibilities –leaders, champion, black belt, green belts. Do’s and don’ts - readiness of organization – planning-management role- six sigma tools – sustaining six sigma.- Introduction to Quality Control Circle (QCC)

**TOTAL : 45 PERIODS**

**OUTCOMES**

Gain the knowledge on implementation of six sigma and Quality Control Circle.

**TEXT BOOKS:**

1. Taguchi G, Elsayed E A and Hsiang, T.C., "Quality Engineering in Production Systems", Mc-Graw-Hill Book company, Singapore, In-ternational Edition, 1989.
2. Brue G, "Six Sigma for Managers", Tata-McGraw Hill, New Delhi, Second reprint, 2002.

**REFERENCE BOOKS:**

1. De Feo J A and Barnard W W, "Six Sigma: Breaktrough and Be-yond", Tata McGraw-Hill, NewDelhi, 2005.
2. Pyzdek T and Berger R W, "Quality Engineering Handbook", Tata-McGraw Hill, New Delhi, 1996.

<b>IH7012</b>	<b>OHSAS 18000, ISO 14000 AND ISO 9000</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVE**

To provide the concepts on OHSAS Standard and policy

**UNIT I OHSAS STANDARD 9**

Introduction – Development of OHSAS standard – Structure and features of OSHAS 18001 – Benefits of certification-certification procedure – OH & S management system element, specification and scope - Correspondence between OHSAS 18001:2007, ISO 14001:2004 and ISO 9001:2000-Correspondence between OHSAS 18001, OHSAS 18002, and the ILO-OSH:2001.

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

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

**UNIT III CHECKING AND REVIEW GUIDELINES 9**

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

**UNIT IV ISO 14001 and ISO 9000 9**

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

**UNIT V ENVIRONMENT IMPACT ASSESSMENT 9**

ISO 14040(LCA), General principles of LCA, Stages of LCA, Report and Review. ISO 14020 (Eco labelling) – History, 14021, 14024, Type I labels, Type II labels, ISO 14024, principles, rules for eco labelling 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**

**OUTCOME**

Gain the concepts on OHSAS Standard and policy, review guidelines with respect to specific industries.

**TEXT BOOKS:**

1. “Occupational Health and Safety Assessment Series BS (OHSAS) 18001:2007” BSI, UK, 2007.
2. “OHSAS 18002, Occupational Health and Safety Management Systems – Guidelines for the implementation of OHSAS 18001”, OHSAS project group, 2008.
3. “ISO 14001:2004, Environmental Management Systems - Re-quirements with guidance for use”, ISO, 2004.

**REFERENCE BOOKS:**

1. Dr. Arora K.C. “ISO 9000 to OHSAS 18001”, S. K. Kataria & Sons, 2012.
2. “Guidelines on Occupational Health and Safety Management Systems (OSH-MS)” International Labour Organization: 2001.
3. “BS 8800: 2004 Occupational Health and Safety Management

<b>IH7020</b>	<b>SAFETY IN UNDERGROUND STRUCTURES AND MINES</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVE** To provide knowledge on accident analysis and management in mine industries

**UNIT I OPENCAST MINES 9**

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

**UNIT II UNDERGROUND MINES 9**  
 Fall of roof and sides-effect of gases-fire and explosions-water flooding-warning sensors-gas detectors-occupational hazards-working conditions-winding and transportation. – Confined space classifications – Safe entry, working and evacuation from confined space.

**UNIT III TUNNELLING 9**  
 Hazards from: ground collapse, inundation and collapse of tunnel face, falls from platforms and danger from falling bodies. Atmospheric pollution (gases and dusts) – trapping – transport-noise-electrical hazards-noise and vibration from: pneumatic tools and other machines – ventilation and lighting – personal protective equipment.

**UNIT IV RISK ASSESSMENT 9**  
 Basic concepts of risk-reliability and hazard potential-elements of risk assessment – statistical methods – control charts-appraisal of advanced techniques-fault tree analysis-failure mode and effect analysis – quantitative structure-activity relationship analysis-fuzzy model for risk Assessment.

**UNIT V ACCIDENT ANALYSIS AND MANAGEMENT 9**  
 Accidents classification and analysis-fatal, serious, minor and reportable accidents – safety audits-recent development of safety engineering approaches for mines-frequency rates-accident occurrence-investigation-measures for improving safety in mines-cost of accident-emergency preparedness – disaster management.

**TOTAL : 45 PERIODS**

**OUTCOME**

Gain the knowledge on accident analysis and management in mine industries, hazards from tunneling and underground mines.

**TEXT BOOK:**

1. Michael Karmis ed., “Mine Health and Safety Management”, SME, Littleton, Co. 2001.

**REFERENCE BOOKS:**

1. Kejiriwal, B.K. “Safety in Mines”, Publisher Gyan Prakashan, Dhanbad, 2002.
2. DGMS Circulars-Ministry of Labour, Government of India press, OR Lovely Prakashan-DHANBAD, 2002.

<b>IH7004</b>	<b>DISASTER AND INCIDENT MANAGEMENT</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVE**

To provide knowledge on disasters, emergency control and policy initiatives for disaster management

**UNIT I INTRODUCTION 10**

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

**UNIT II TECHNOLOGICAL DISASTERS 10**

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

**UNIT III ENVIRONMENTAL DISASTER MANAGEMENT 8**  
Introduction to Sustainable Development-Bio Diversity-Atmospheric pollution-Global warming and Ozone Depletion-ODS banking and phasing out-Sea level rise-El Nino and climate changes-Eco friendly products-Green movements-Green philosophy - Environmental Policies-Environmental Impact Assessment-case studies-Life cycle.

**UNIT IV POLLUTION ASPECTS 8**  
Offshore and onshore drilling-control of fires-Case studies-Marine pollution and control-Toxic, hazardous and Nuclear wastes-state of India's and Global environmental issues carcinogens-complex emergencies-Earthquake disasters-the nature-extreme event analysis-the immune system-proof and limits.

**UNIT V INCIDENT MANAGEMENT 9**  
The fundamentals of incident management, essential for effective industrial incident management covering: Incident Command System; Emergency Leadership, Emergency Risk Management; Mutual Aid & Joint Operations; Crisis Organization & Management; Response Functions & Priorities; Media Management; Scene Safety & Security; Damage Assessment; Salvage & Repair; Business Continuity; Employee Assistance; Incident Investigation; Cleanup & Restoration; and Incident Termination

**TOTAL : 45 PERIODS**

**OUTCOME**

Gain the knowledge on disasters, emergency control and effective industrial incident management covering

**REFERENCE BOOKS:**

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 Engineer-ing", 2004
5. Sivakumar.R., "Principles of Environmental Science and Engineer-ing", 2005

**IH7019 SAFETY IN TEXTILE INDUSTRY L T P C  
3 0 0 3**

**OBJECTIVE**

To provide knowledge on safety measures in textile industries.

**UNIT I INTRODUCTION 9**  
Process flow charts of i) short staple spinning, ii) long staple spinning, iii) viscose rayon and synthetic fibre, manufacturer, iv) spun and filament yarn to fabric manufacture, v) jute spinning and jute fabric manufacture-accident hazard, guarding of machinery and safety precautions in opening, carding, combing, drawing, flyer frames and ring frames, doubles, rotor spinning, winding, warping, softening/spinning specific to jute.

**UNIT II TEXTILE HAZARDS I 9**  
Accident hazards i) sizing processes- cooking vessels, transports of size, hazards due to steam ii) Loom shed – shuttle looms and shuttles looms iii) knitting machines iv) nonwovens.

**UNIT III TEXTILE HAZARDS II 9**  
Scouring, bleaching, dyeing, punting, mechanical finishing operations and effluents in textile processes.

**UNIT IV HEALTH AND WELFARE 9**

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

**UNIT V SAFETY STATUS 9**

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

**TOTAL : 45 PERIODS**

**OUTCOMES**

Students who are able to know the safety measures of machinery in textile industries.

**TEXT BOOK:**

1. "Safety in Textile Industry", Thane Belapur Industries Association, Mumbai.

**REFERENCE BOOKS:**

1. 100 Textile fires – analysis, findings and recommendations LPA.
2. Elliot B. Grover and Hamby D.S, "Hand book of textile testing and quality control" Textile Book Publishers (Interscience), New York, 1960.
3. "Quality tolerances for water for textile industry", BIS.
4. Shenai, V.A. "A technology of textile processing", Vol. I, Evak Publications, 1980.
2. Little, A.H. , "Water supplies and the treatment and disposal of ef-fluent" the textile institute, Manchester, 1975.

**IH7005**

**DOCK SAFETY**

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

**OBJECTIVE**

To provide knowledge on dock safety status and lifting appliances

**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, 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 – toplift 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, 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**

**OUTCOME**

Gain the knowledge on dock safety status and emergency action plan and dock workers regulations

**TEXT BOOKS:**

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.

4.

**REFERENCE BOOKS:**

1. Taylor D.A., "Introduction to Marine Engineering", 2nd ed., Butterworth-Heinemann, 1996
2. Srinivasan "Harbour, Dock and Tunnel Engineering", Charotar Publishing House Pvt. Limited, 2011.
3. Bindra SR "Course in Dock and Harbour Engineering", Dhanpat Rai Publications (P) Ltd., New Delhi, 2013.

<b>IH7018</b>	<b>SAFETY IN POWDER HANDLING</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVE**

To provide basic concepts on dust handling plants and safety measures in dust explosion

**UNIT I INTRODUCTION 9**

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

**UNIT II METAL POWDERS AND CHARACTERIZATION 9**

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

**UNIT III DUST EXPLOSION 9**

Industrial dust, dust explosion accidents – explosibility characteristics, minimum explosive concentration, minimum ignition energy, explosion pressure characteristics, maximum permissible oxygen concentration- explosibility tests, Hartmann vertical tube apparatus, horizontal tube apparatus, inflammatory apparatus, Godbert and Greenward furnace.

Explosibility classification – Hybrid test – gas mixtures – Dust ignition sources – Dust explosion prevention – Dust explosion protection – Dust explosion venting, vent coefficient, various methods of design – venting of ducts and pipes – dust fire.

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

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

**UNIT V DUST EVALUATION AND CONTROL 9**

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

**TOTAL : 45 PERIODS**

**OUTCOME**

Gain knowledge on dust handling plants and safety measures in dust explosion and control.

**REFERENCES**

1. Martin Glor, "Electro Static Hazard in Powder Handling" Research studies Press Ltd., England, 1988.
2. International Labour Organization, "Major hazard control", Geneva, 1991.
3. SRMC, "Hazard recognition and prevention in the work place-airborne dust" Vol. I & II, Chennai, 2000.
4. ASM, "Metals hand book - Powder Metallurgy", Vol.7, 9th ed., 1984.
5. Edelstein. A. S and Cammarata.R. C., "Nanomaterials: Synthesis, Properties and Applications", Taylor & Francis, New York, 1996.

<b>IH7008</b>	<b>FIREWORKS SAFETY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVE**

To provide basic knowledge on fire chemistry and process safety in firework industry.

<b>UNIT I</b>	<b>PROPERTIES OF FIREWORKS CHEMICALS</b>	<b>9</b>
<p>Combustion properties – potassium nitrate (KNO<sub>3</sub>), potassium chlorate (KClO<sub>3</sub>), barium nitrate (BaNO<sub>3</sub>), calcium nitrate (CaNO<sub>3</sub>), Sulphur (S), Phosphorous (P), antimony (Sb), Pyro Aluminium (Al) powder-Reactions-metal powders, Borax, ammonia (NH<sub>3</sub>) – Strontium Nitrate, Sodium Nitrate, Potassium per chloride. Fire and explosion, impact and friction sensitivity.</p>		
<b>UNIT II</b>	<b>STATIC CHARGE AND DUST</b>	<b>9</b>
<p>Concept-prevention - earthing -copper plates-dress materials-static charge meter lightning, Causes-effects-hazards in fireworks factories-lightning arrestor: concept-installation earth pit-maintenance-resistance-legal requirements-case studies. Dust: size - respirable, non - respirable-biological barriers-hazards-personal protective equipment-pollution prevention.</p>		
<b>UNIT III</b>	<b>PROCESS SAFETY</b>	<b>8</b>
<p>Safe-quantity, mixing-filling-fuse cutting – fuse fixing – finishing – drying at various stages-packing-storage-hand tools-materials, layout: building-distances- factories act – explosive act and rules – fire prevention and control – emergency planning in fireworks – Automation of manual process.</p>		
<b>UNIT IV</b>	<b>MATERIAL HANDLING</b>	<b>10</b>
<p>Manual handling – wheel barrows-trucks-bullock carts-cycles-automobiles-fuse handling – paper caps handling-nitric acid handling in snake eggs manufacture-handling the mix in this factory-material movement-godown-waste pit. Transportation: Packing-magazine-design of vehicles for explosive transports loading into automobiles transport restrictions-case studies-overhead power lines-driver habits-intermediate parking-fire extinguishers-loose chemicals handling and transport.</p>		
<b>UNIT V</b>	<b>WASTE CONTROL AND USER SAFETY</b>	<b>9</b>
<p>Concepts of wastes – Wastes in fireworks-Disposal-Spillages-storage of residues. Consumer anxiety-hazards in display-methods in other countries-fires, burns and scalds – sales outlets-restrictions-role of fire service.</p>		

**TOTAL : 45 PERIODS**

**OUTCOME**

Sudents should be able to know the fire chemistry and safety issues in firework industry.

**TEXT BOOKS:**

1. Ghosh, K.N. The Principles of Firecrackers, Economic Enterprises, Sivakasi ; 1981.
2. Shanmugam, G. et al, Fireworks safety 1999: Proceedings of the National seminar held at MSEC, Sivakasi on July 17 & 18, 1999.

**REFERENCE BOOKS:**

1. Pyrotech 2013, Proceedings of the 2nd National Fireworks Con-ference, Sivakasi; 2013
2. Conkling J., Chemistry of Pyrotechnics: Basic Principles and The-ory; Marcel Dekker Inc.: New York; 1985.
3. Shimizu, T. Firecrackers: The Art, Science and Technique, Maru-zen Co, Tokyo; 1981.
4. Brock, H. Pyrotechnics - The history and art of fireworks making, London, D.O'Connor, 1949.



<b>IH7001 ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
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**OBJECTIVE**

To provide basic concepts on artificial intelligence and neural networks.

**UNIT I INTRODUCTION 9**

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

**UNIT II COGNITIVE PSYCHOLOGY 11**

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

**UNIT III KNOWLEDGE ENGINEERING 9**

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

**UNIT IV EXPERT SYSTEMS 9**

Introduction, knowledge acquisition for Expert system, features of Expert systems – System structure, inference Engines, uncertainties, memory mechanisms, range of applications, actual expert systems – VP expert. Assignment – Development of a simple expert system.

**UNIT V INTRODUCTION TO NEURAL NETWORKS 7**

Architecture of Neural Network – Learning methods –Back Propagation Network Architecture – Selection of parameters – Simple variations of BPN.

**TOTAL : 45 PERIODS**

**OUTCOME**

Students who successfully complete this course should be to analyse the risk and hazards by artificial intelligence.

**TEXT BOOK:**

1. Elaine R., and Kevin, “Artificial Intelligence”, 2nd Edition, Tata McGraw Hill, 2009.

**REFERENCE BOOKS:**

1. Rajasekaran S and Vijayalakshmi Pai, G.A, “Neural Networks, Fuzzy Logic and Genetic Algorithms – Synthesis and Applications”, PHI, 2003.
2. Charnaik, E., and McDermott, D., “Introduction to Artificial Intelligence”, Addison Wesley, 1985.
3. Dan W.Patterson, “Introduction to Artificial Intelligence and Expert Systems”, Prentice Hall of India, 1997.
4. Winston, P.H., “Artificial Intelligence”, Addison Wesley, 1992.
5. Nilsson, N.J., “Principles of AI”, Narosa Publishing House, 2002.
6. Schalkoff, R.J., “Artificial Intelligence” – An Engineering Approach”, McGraw Hill International Edition, Singapore, 1992.



<b>IH7003</b>	<b>DESIGN OF INDUSTRIAL VENTILLATION</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVE**

To provide comprehensive knowledge on design of industrial ventilation system

**UNIT I GENERAL PRINCIPLES OF VENTILATION 9**

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

**UNIT II GENERAL INDUSTRIAL VENTILATION 9**

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

**UNIT III LOCAL EXHAUST HOODS AND AIR CLEANING DEVICES 9**

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

**UNIT IV DESIGN AND TESTING OF INDUSTRIAL VENTILATION 9**

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

**UNIT V VENTILATION SYSTEM FOR SPECIFIC OPERATIONS 9**

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

**TOTAL : 45 PERIODS**

**OUTCOME**

Students who successfully complete this course should be able to design the ventilation system for specific operations.

**TEXTBOOKS:**

1. ACGIH Industrial Ventilation “A manual of Recommended Practice for Design”, 28th edition 2013.
2. “Accident Prevention manual for industrial operations” N.S.C., Chicago, 1992

**REFERENCE BOOK:**

1. Jeanne Mager Stellman “Encyclopaedia of Occupational Health and Safety”, Vol. I and II, 4th edition, published by International Labour office, Geneva, 1998.

<b>IH7002</b>	<b>DESIGN OF AIR POLLUTION CONTROL SYSTEM</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
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**OBJECTIVE**

To provide comprehensive knowledge on design of air pollution control system.

**UNIT I AIR POLLUTION 10**

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

**UNIT II PARTICULATE POLLUTANTS AND CONTROL 12**

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

**UNIT III GASEOUS POLLUTANTS AND CONTROL 8**

Gaseous Pollutant control: Gas absorption in tray and packed towers – Absorption with / Without chemical reaction – Removal of SO<sub>2</sub> – Absorption in fixed blades- Breakthrough.

**UNIT IV TOXIC POLLUTANTS REMOVAL 8**

Removal of HCs / VOCs – NO<sub>x</sub> removal – Wet scrubbers.

**UNIT V AIR POLLUTION CONTROL 7**

Integrated Air pollution control systems.

**TOTAL : 45 PERIODS**

**OUTCOMES**

Students who successfully complete this course should be able to design the air pollution control system.

**TEXTBOOKS:**

1. Lawrence. K. Wang, Norman. C Perelra, Yung-Tse-Hung., Air Pollution Control Engineering, Tokyo.
2. Noel de Nevers, Air Pollution Control Engineering., McGraw Hill, New York.

<b>IH7013</b>	<b>PRINCIPLES OF TECHNICAL ANALYSIS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
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**OBJECTIVE**

The elective is aimed to instill in the students a good grasp of the fundamentals and generalizations underlying technical analysis.

**UNIT I QUANTITATIVE ESTIMATION - PRINCIPLE 8**

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

**UNIT II ANALYSIS OF COAL AND FERTILIZER 8**

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

