M.E. INDUSTRIAL SAFETY ENGINEERING

2014 Regulations, Curriculum & Syllabi

BANNARI AMMAN INSTITUTE OF TECHNOLOGY
(Autonomous Institution Affiliated to Anna University of Technology –Coimbatore
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Program Educational Objectives (PEOs)

I. Effectively communicate information on Health safety and environment facilitating collaboration with experts across various disciplines so as to create and execute safe methodology in complex engineering activities.

II. Competent safety Engineer rendering expertise to the industrial and societal needs at national and global level.

III. Possess a mastery of Health safety and environment knowledge and safety management skills, to reach higher levels in their profession.

IV. Demonstrate professional and ethical attitude with awareness of current legal issues by rendering expertise to wide range of industries.

Programme Outcomes (POs)

a. Apply knowledge of Mathematics, Science, Engineering fundamentals and an engineering specialization for hazard identification, risk assessment and control of occupational hazards.

b. Design, Establish, Implement maintain and continually improve an occupation health and management system to improve safety.

c. Conduct investigations on unwanted incidents using root cause analysis and generate corrective and preventive action to prevent recurrence and occurrence of such incidents.

d. Design complex man machine systems using human factors engineering tools so as to achieve comfort, worker satisfaction, efficiency, error free and safe workplace environment.

e. Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings so as to provide practical solutions to safety problems.

f. Communicate effectively on health and safety matters among the employees and with society at large.

g. Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to occupation health and safety practices.

h. Understand and commit to comply with legal and contractual requirements, professional ethics and responsibilities and general norms of engineering practice.

i. Understand the impact of Health safety and environment solutions on productivity, quality and society at large.

j. Demonstrate the use of state of the art occupational health and safety practices in controlling risks of complex engineering activities and understand their limitations.

Mapping of PEOs with POs

PEOs	POs
I. Effectively communicate information on Health safety and environment facilitating collaboration with experts across various disciplines so as to create and execute safe methodology in complex engineering activities.	f. Communicate effectively on health and safety matters among the employees and with society at large. h. Understand and commit to comply with legal and contractual requirements, professional ethics and responsibilities and general norms of engineering practice. i. Understand the impact of Health safety and environment solutions on productivity, quality and society at large.
II Competent safety Engineer rendering expertise to the industrial and societal needs at national and global level.	b. Design, Establish, Implement maintain and continually improve an occupation health and management system to improve occupational health and safety performance. e. Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings so as to provide practical solutions to safety problems. d. Design complex man machine systems using human factors engineering tools so as to achieve comfort, worker satisfaction, efficiency, error free and safe workplace environment.
III Possess a mastery of Health safety and environment knowledge and safety management skills, to reach higher levels in their profession.	a. Apply knowledge of Mathematics, Science, Engineering fundamentals and an engineering specialization for hazard identification, risk assessment and control of occupational hazards. c. Conduct investigations on unwanted incidents using root cause analysis and generate corrective and preventive action to prevent recurrence and occurrence of such incidents.
IV Demonstrate professional and ethical attitude with awareness of current legal issues by rendering expertise to wide range of industries.	g. Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to occupation health and safety practices. j. Demonstrate the use of state of the art occupational health and safety practices in controlling risks of complex engineering activities and understand their limitations.

Curriculum: Regulation 2014

M.E. Industrial Safety and Engineering (Full Time)

First Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
14IS11	Probability and Statistics	III	(a), (c)	3	1	0	4
14IS12	Safety Management	II	(b), (e), (d)	3	0	0	3
14IS13	Occupational Health and Hygiene	I, III	(c), (f) (i), (h)	3	0	0	3
14IS14	Safety in Engineering Industry	I	(f), (h),(i)	4	0	0	4
14IS15	Industrial Safety, Health and Environment (SHE) Acts	IV	(g), (j)	4	0	0	4
14IS16	Reliability Engineering	III	(c), (a)	3	0	0	3
14IS17	Internship Training	IV	(c) , (h), (i)	0	0	6	2
			Total	**20**	**1**	**6**	**23**
Second Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
14IS21	Computer Aided Risk Analysis	III	(a), (c)	3	1	0	4
14IS22	Electrical Safety	II	(b), (e), (d)	4	0	0	4
14IS23	Fire Engineering and Explosion	II	(b), (e), (d)	4	0	0	4
	Elective I	-	-	3	0	0	3
	Elective II	-	-	3	0	0	3
	Elective III	-	-	3	0	0	3
14IS27	Industrial Safety laboratory	IV	(g), (j)	0	0	3	1
14IS28	Technical Seminar	I	(f), (h), (i)	0	0	2	1
			Total	**20**	**1**	**5**	**23**

Third Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
	Elective IV			3	0	0	3
	Elective V			3	0	0	3
	Elective VI			3	0	0	3
14IS34	Project Work Phase – I	III, IV	(e), (f), (g)	-	-	-	6
			Total	**9**	**0**	**0**	**15**
Fourth Semester							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
14IS41	Project Work Phase – II	III, IV	(e), (f), (g)	-			12
			Total	-			**12**

Note: Hours & Credit Pattern: Minimum number of credits to be earned for the award of M.E.(Industrial Safety And Engineering) **Programme: 73**

List of Electives							
Code No.	**Course**	**Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
14IS51	Environmental Pollution Control	I	(f), (h), (i)	3	0	0	3
14IS52	Safety in Construction	I	(f), (h), (i)	3	0	0	3
14IS53	Safety in Powder Handling	III	(c), (a)	3	0	0	3
14IS54	Industrial Noise and Vibration Control	III	(c), (a)	3	0	0	3
14IS55	Safety in Chemical Industry	I	(f), (h), (i)	3	0	0	3
14IS56	Fireworks safety	I	(f), (h), (i)	3	0	0	3
14IS57	Safety in Process Industries	II	(b), (e), (d)	3	0	0	3
14IS58	Nuclear Engineering and Safety	III	(c), (a)	3	0	0	3
14IS59	Plant Layout and Material Handling	II, III	(e), (a), (b)	3	0	0	3
14IS60	Design of Industrial Ventilation System	I	(f), (h), (i)	3	0	0	3
14IS61	Safety in Petrochemical Industries	II	(b), (c), (d)	3	0	0	3
14IS62	Maintainability Engineering	IV	(g), (j)	3	0	0	3
14IS63	Safety in Textile Industry	I	(f), (h), (i)	3	0	0	3
14IS64	Vibration and Noise Control	III	(c), (a)	3	0	0	3
14IS65	Physical and Chemical Treatment of Water and Wastewater	II	(b), (e), (d)	3	0	0	3
14IS66	Environmental Impact Assessment	IV	(g), (j)	3	0	0	3

14IS11 PROBABILITY AND STATISTICS

L	T	P	C
3	1	0	4

Course Objectives (COs):

- To review the basic concept of probability and to give the applications of probability distributions.
- To understand the concept of correlation, regression and estimation theory.
- To provide information about testing of hypothesis and design of experiments. To forecast the future trends using various forecasting methods.

Course Outcomes (COs):

1. To apply the concept of probability and probability distributions in their field. To acquire the concept of estimation theory
2. To do testing of hypothesis which will be useful in solving engineering problems.
3. To design and analyze the statistical experiments.

Program Outcomes (POs):

a) Apply knowledge of Mathematics, Science, Engineering fundamentals and an engineering specialization for hazard identification, risk assessment and control of occupational hazards.

c) Conduct investigations on unwanted incidents using root cause analysis and generate corrective and preventive action to prevent recurrence and occurrence of such incidents.

Unit I
Probability and Random Variable
Probability – Random variables – Moments – Moment generating function – Standard distributions – Functions of random variables – Two-dimensional R.Vs – Correlation and Regression. **12 Hours**

Unit II
Estimation Theory
Principle of least squares – Regression – Multiple and Partial correlations – Estimation of Parameters – Maximum likelihood estimates – Method of moments. **12 Hours**

Unit III
Testing of Hypothesis
Sampling distributions – Test based on Normal, t-distribution, chi-square, and F-distributions – Analysis of variance – One-way and two way classifications.
12 Hours

Unit IV
Design of Experiments
Completely Randomized Design – Randomized Block Design – Latin Square Design – 2 Factorial Design.
12 Hours

Unit V

Time Series

Characteristics and Representation – Moving averages – Exponential smoothing – Auto Regressive Processes.

12 Hours

Total: 60 Hours

Reference (s)

1. Richard Scheaffer, Madhuri Mulekar, James McClave, *"Probability and Statistics for Engineers*", Cengage Learning, USA, 2010.
2. Gupta, S.C. and Kapur, V.K. "*Fundamentals of Mathematical Statistics*", Sultan Chand and Sons, New Delhi, 2011.
3. Fruend John, E. and Miller, Irwin, "*Probability and Statistics for Engineering",* Prentice Hall, 5th Edition, 1994.
4. Jay, L. Devore, "*Probability and Statistics for Engineering and Sciences*", Brooks/Cole Publishing Company Monterey, California, 1982.
5. Montgomery D.C and Johnson, L.A.*,"Forecasting and Time Series*", McGraw-Hill. 2005.
6. Anderson, O.D., " *Time Series Analysis: Theory and practice* ", I. North - Holland, Amsterdam, 1982.

14IS12 SAFETY MANAGEMENT

L	T	P	C
3	0	0	3

Course Objectives (COs):

- To achieve an understanding of principles of safety management.
- To enable the students to learn about various functions and activities of safety department.
- To enable students to conduct safety audit and write audit reports effectively in auditing situations.
- To have knowledge about sources of information for safety promotion and training.
- To familiarize students with evaluation of safety performance.

Course Outcomes (COs):

1. To understand the functions and activities of safety engineering department.
2. To carry out a safety audit and prepare a report for the audit.
3. To prepare an accident investigation report.
4. To estimate the accident cost using supervisors report and data.
5. To evaluate the safety performance of an organization from accident records.
6. To identify various agencies, support institutions and government organizations involved in safety training and promotion.

Program Outcomes (POs):

b. Design, Establish, Implement maintain and continually improve an occupation health and management system to improve safety.

e. Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings so as to provide practical solutions to safety problems.

d. Design complex man machine systems using human factors engineering tools so as to achieve comfort, worker satisfaction, efficiency, error free and safe workplace environment.

Unit I

Concepts

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

9 Hours

Unit II

Techniques

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

9 Hours

Unit III

Accident Investigation and Reporting

Concept of an accident, reportable and non reportable accidents, 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.

9 Hours

Unit IV

Safety Performance Monitoring

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.

9 Hours

Unit V

Safety Education and Training

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 - safety training to workers.

9 hours

Total: 45 Hours

Reference(s)

1. Subramanian.V., *"The Factories Act 1948 with Tamilnadu factories rules 1950"*, Madras Book Agency, 21st ed., Chennai, 2000.
2. C.Ray Asfahl "*Industrial Safety and Health management*" Pearson Prentice Hall,2003.
3. National Safety Council, *"Accident Prevention Manual for Industrial Operations"*, N. S. C. Chicago, 1988.
4. Heinrich H.W. "*Industrial Accident Prevention*" McGraw-Hill Company, New York, 1980.
5. Krishnan N.V. *"Safety Management in Industry*" Jaico Publishing House, Bombay, 1997.
6. John Ridley, "*Safety at Work*", Butterworth & Co., London, 1983.
7. Blake R.B., "*Industrial Safety*" Prentice Hall, Inc., New Jersey, 1973

14IS13 OCCUPATIONAL HEALTH AND HYGIENE

L	T	P	C
3	0	0	3

Course Objectives (COs):

- To understand the basic knowledge on anatomy of human organs and its basic functions.
- To enable the students to learn about various functions and activities of occupational health services.
- To enable students to compare the hazards with the permissible levels.
- To have knowledge about types of hazards arising out of physical, chemical and biological agents.

Course Outcomes (COs):

1. To understand the various physiological functions of our body and the test methods for periodical monitoring of health.
2. To understand the functions and activities of occupational health services.
3. To identify various types of hazards arising out of Physical, Chemical and Biological agents in a process.
4. To identify notifiable occupational diseases arising out of occupation and suggest methods for the prevention of such diseases.

Program Outcomes (POs):

f. Communicate effectively on health and safety matters among the employees and with society at large.
h. Understand and commit to comply with legal and contractual requirements, professional ethics and responsibilities and general norms of engineering practice.
i. Understand the impact of Health safety and environment solutions on productivity, quality and society at large.

Unit I

Physical Hazards

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- hot environments, thermal comfort, heat stress indices, acclimatization, estimation and control

9 Hours

Unit II

Chemical Hazards

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, design specifications - General Control Methods - training and education.

9 Hours

Unit III

Biological and Ergonomical Hazards

Classification of Biohazardous agents –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 Musculoskeltal Disorders –carpal tunnel syndrome CTS- Tendon pain-disorders of the neck- back injuries.

9 Hours

Unit IV

Occupational Health and Toxicology

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, Aaluminosis and Anthrax, Lead-nickel, Chromium and Manganese toxicity, Gas poisoning (such as CO, ammonia, coal and dust etc) their effects and prevention – cardio pulmonary resuscitation, audiometric tests, eye tests, vital function tests.

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

9 Hours

Unit V

Occupational Physiology

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.

9 Hours

Total: 45 Hours

Reference(s)

1. Louis J. Di Berardinis, *"Handbook of occupational safety and health*", Wiley, 1999.
2. Danuta Koradecka, *"Handbook of Occupational Health and Safety",* CRC, 2010.
3. Lawrence Slote , *"Handbook of occupational safety and health",* Wiley, 1987.
4. McCornick, E.J. and Sanders, M.S., "*Human Factors in Engineering and Design"*, Tata McGraw-Hill, 1982.

14IS14 SAFETY IN ENGINEERING INDUSTRY

L	T	P	C
4	0	0	4

Course Objectives (COs):

- To provide in depth knowledge in Principles of Environmental safety and its applications in various fields.
- To provide the knowledge of air and water pollution and their control.
- To expose the students to the basics in hazardous waste management.
- To design emission measurement devices.

Course Outcomes (COs):

1. Illustrate and familiarize the basic concepts scope of environmental safety.
2. Understand the standards of professional conduct that are published by professional safety organizations and certification bodies.
3. Explain the ways in which environmental health problems have risen due to air and water pollution.
4. Illustrate the role of hazardous waste management and use of critical thinking to identify and assess environmental health risks.
5. Discuss concepts of measurement of emissions and design emission measurement devices.

Program Outcomes (POs):

f. Communicate effectively on health and safety matters among the employees and with society at large.
h. Understand and commit to comply with legal and contractual requirements, professional ethics and responsibilities and general norms of engineering practice.
i. Understand the impact of Health safety and environment solutions on productivity, quality and society at large.

Unit I

Safety in Metal Working Machinery and Wood Working Machines

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.

12 Hours

Unit II

Principles of Machine Guarding

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

12 Hours

Unit III

Safety in Welding and Gas Cutting

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.

12 Hours

Unit IV

Safety in Cold Forming and Hot Working of Metals

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.

12 Hours

Unit V

Safety in Finishing, Inspection and Testing

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.

12 Hours

Total: 60 Hours

Reference(s)

1. Philip E. Hagan, John Franklin Montgomery, James T. O'Reilly “Accident Prevention Manual” – NSC, Chicago, 2009.
2. Charles D. Reese, “Occupational Health and Safety Management”,CRC Press, 2003.
3. John V. Grimaldi and Rollin H. Simonds “Safety Management by All India Travelers Book seller”, New Delhi, 1989.
4. John Davies, Alastair Ross, Brendan Wallace “Safety Management: A Qualitative Systems Approach” CRC Press, 2003.
5. Health and Safety in welding and Allied processes, welding Institute, UK, High Tech. Publishing Ltd., London, 1989.

14IS15 INDUSTRIAL SAFETY, HEALTH AND ENVIRONMENT (SHE) ACTS

L	T	P	C
4	0	0	4

Course Objectives (COs):

- To provide exposure to the students about safety and health provisions related to hazardous processes as laid out in Factories act 1948.
- To familiarize students with powers of inspectorate of factories.
- To help students to learn about Environment act 1948 and rules framed under the act.
- To provide wide exposure to the students about various legislations applicable to an industrial unit.

Course Outcomes (COs):

1. To list out important legislations related to Health , Safety and Environment
2. To list out requirements mentioned in factories act for the prevention of accidents. To understand the health and welfare provisions given in factories act.
3. To understand the statutory requirements for an Industry on registration, license and its renewal.
4. To prepare onsite and offsite emergency plan.

Program Outcomes (POs):

g. Demonstrate understanding of the Societal, Health, Safety, Legal and Cultural Issues and the Consequent Responsibilities relevant to occupation health and safety practices.

j. Demonstrate the use of state of the art occupational health and safety practices in controlling risks of complex engineering activities and understand their limitations.

Unit I

Factories Act – 1948

Statutory authorities – inspecting staff, health, safety, provisions relating to hazardous processes, welfare – special provisions – penalties and procedures- Tamilnadu Factories Rules 1950 under Safety and health chapters of Factories Act 1948 - Tamilnadu safety officer rules 2005.

12 Hours

Unit II

Environment Act – 1986

General Powers of the central government, prevention, control and abatement of environmental Pollution - Biomedical waste (Management and handling Rules), 1989-The noise pollution (Regulation and control) Rules, 2000-The Batteries (Management and Handling Rules) 2001- No Objection certificate from statutory authorities like pollution control board. Air Act 1981 and Water Act 1974: Central and state boards for the prevention and control of air pollution-powers and functions of boards – prevention and control of air pollution and water pollution – fund – accounts and audit, penalties and procedures – ISO 14001 and ISO 18001 and ISO clauses for safety and waste management.

12 Hours

Unit III

Manufacture, Storage & Import of Hazardous Chemical Rules 1989

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

12Hours

Unit IV

Other Acts and Rules

Indian Boiler (Amendments) Act 2007, static and mobile pressure vessel rules (SMPV), motor vehicle rules, The Mines and Minerals (Development & Regulation) Act, 2010, workman compensation act, rules – electricity act and rules – hazardous wastes (management and handling) rules, 1989, with amendments in 2000 - the building and other construction workers act 1996., Petroleum rules, Gas cylinder rules-Explosives Act 1983-Pesticides Act – Tamilnadu lifts act 1997 .

12 Hours

Unit V

International Acts And Standards

Occupational Safety and Health act of USA (The William - Steiger's Act of 1970) – Health and safety work act (HASAWA 1974, UK) – OSHAS 18000 – ISO 14000- Benefits and Elements.

12 Hours

Total: 60 Hours

Reference(s)

1. Subramanian.V., "*The Factories Act 1948 with Tamilnadu factories rules 1950",* Madras Book Agency, 21st ed., Chennai, 2000.
2. "*The Environment Act (Protection) 1986 with allied rules"*, Law Publishers (India) Pvt. Ltd., Allahabad.
3. *"Water (Prevention and control of pollution)* act 1974", Law publishers (India) Pvt. Ltd., Allahabad.
4. "*Air (Prevention and control of pollution) act 1981",* Law Publishers (India) Pvt. Ltd., Allahabad.
5. *"The Indian boilers act 1923 with amendments*", Law Publishers (India) Pvt. Ltd., Allahabad.
6. *"The Indian Electricity act 2003 with rules",* Law publishers (India) Pvt. Ltd., New Delhi.
7. Indian School of Labour education, *"Industrial safety and Laws*", Chennai, 1982.

14IS16 RELIABILITY ENGINEERING

L T P C
3 0 0 3

Course Objectives (COs):

- To provide in depth knowledge about the concept of reliability equipment.
- To gain the knowledge on various reliability prediction modeling.
- To recognise techniques to maintain reliability in Industrial.
- To develop knowledge on risk assessment study.

Course Outcomes (COs):

- Course would be helpful to know various failure mode of any equipment and their effects Students would be trained to maintain reliability by reducing failure time in Industry to maintain safety and productivity.
- Course will provide the students to know about various reliability models.
- Course would equip the students to effectively conduct risk assessment study by applying reliability in hazardous industries.

Programmed Outcomes (PO):

a. Apply knowledge of Mathematics, Science, Engineering fundamentals and an engineering specialization for hazard identification, risk assessment and control of occupational hazards.
c. Conduct investigations on unwanted incidents using root cause analysis and generate corrective and preventive action to prevent recurrence and occurrence of such incidents.

Unit I
Reliability Concept
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.
9 Hours

Unit II
Failure Data Analysis
Time to failure distributions – Exponential, normal, Gamma, Weibull, ranking of data – probability plotting techniques – Hazard plotting.
9 Hours

Unit III
Reliability Prediction Models
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.
9 Hours

Unit IV
Reliability Management

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

9 Hours

Unit V

Risk Assessment

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

9 Hours

Total: 45 Hours

Reference(s)

1. Srinath L.S, *"Reliability Engineering"*, Affiliated East-West Press Pvt Ltd, New Delhi, 1998.
2. Modarres*, "Reliability and Risk analysis"*, Maral Dekker Inc.1993.
3. John Davidson, *"The Reliability of Mechanical system"* published by the Institution of Mechanical Engineers, London, 1988.
4. Smith C.O. *"Introduction to Reliability in Design"*, McGraw Hill, London, 1976.

14IS17 INTERNSHIP TRAINING

L	T	P	C
0	0	6	2

Course Objectives (COs):

• To get an industrial exposure through various industrial environmental experiences and learning safety measures.
• To enhance the collective skills between theoretical knowledge and real-time safety implementations.

Course Outcomes (COs):

1. Able to select and analysis the effective industry safety methods for the given field applications.

Programmed Outcomes (PO):

c. Conduct investigations on unwanted incidents using root cause analysis and generate corrective and preventive action to prevent recurrence and occurrence of such incidents.
h. Understand and commit to comply with legal and contractual requirements, professional ethics and responsibilities and general norms of engineering practice.
i. Understand the impact of Health safety and environment solutions on productivity, quality and society at large.

Guidelines:

- The students are expected to undergo meaningful, practical and hands-on-work experiences related to safety measures through industrial training.
- A faculty guide is to be allotted and he / she will guide and monitor the progress of the student's training activities and maintain attendance also.
- Minimum duration of internships period is 3-4 weeks.
- Post internship program, Students should submit a report (within 50 pages) which contains brief observations of training (process, product, layout, safety measures and methods, etc.,) and give a presentation.
- Internship should be evaluated through final presentation with viva-voce exam.

14IS21 COMPUTER AIDED RISK ANALYSIS

L	T	P	C
3	1	0	4

Course Objectives (COs):

- To provide knowledge on risk, hazard and their assessment techniques in Industry .
- To understand the principles of operation of various equipment for safety application .
- To know the consequences of fire, explosion and toxic release.
- To know the various software available for risk quantification.
- To conduct a risk assessment technique in Industries.

Course Outcomes (COs):

1. This course would make familiarizing of basic concepts in risk and hazard
2. Course would be helpful to understand the various instruments to bring safety in Industries. Students would be trained to find solution for risk assessment studies through the use of software.
3. Students would be able to make use of a risk assessment technique to quantify the risk Course would equip the students to effectively employ hazard analysis techniques in Industry and helpful to prevent the accidents in Industry.

Program Outcomes (POs):

a. Apply knowledge of Mathematics, Science, Engineering fundamentals and an engineering specialization for hazard identification, risk assessment and control of occupational hazards.
c. Conduct investigations on unwanted incidents using root cause analysis and generate corrective and preventive action to prevent recurrence and occurrence of such incidents.

Unit I

Hazard, Risk Issues and Hazard Assessment

Introduction, 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)

12 Hours

Unit II

Instrumentation

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, Sensitive Test, Impact Sensitive Test (BAM) and Friction Sensitive Test (BAM), Shock Sensitive Test, Card Gap Test.

12 Hours

Unit III

Risk Analysis Quantification and Softwares

Fault Tree Analysis & Event Tree Analysis, Logic Symbols, Methodology, minimal cut set ranking - fire explosion and toxicity index(FETI), various indices - Hazard analysis(HAZAN)- Failure Mode and Effect Analysis(FMEA)- Basic concepts of Software on Risk analysis, CISCON, FETI, ALOHA

12 Hours

Unit IV

Consequences Analysis

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.

12 Hours

UNIT V

Credibility of Risk Assessment Techniques

Past accident analysis as information sources for Hazard analysis and consequences analysis of chemical accident, Mexico disaster, Flixborough, Bhopal, Seveso, Pasadena, Feyzin disaster(1966), Port Hudson disaster- convey report, hazard assessment of nonnuclear installation- Rijnmond report, risk analysis of size potentially Hazardous Industrial objects- Rasmussen masses report, Reactor safety study of Nuclear power Plant.

12 Hours

Total: 60 Hours

References

1. Frank P. Less Butterworth-Hein, "*Loss Prevention in Process Industries*" (Vol.I, II and III), Butterworth-Hein UK 1990.
2. *"Loss Prevention in Process Industries"* -Frank P. Less Butterworth-Hein UK 1990 (Vol.I, II & III)
3. F.I. Khan, S.A. Abbasi, *"Risk Assessment In Chemical Process Industries*", Discovery Publishing House,1998 .
4. "Center for Chemical Process Safety (CCPS), *Quantitative Risk assessment in Chemical Industries", Institute of Chemical Industries, Centre for Chemical process safety.* second Edition, 2000.
5. "Guidelines for Hazard Evaluation Procedures, Centre for Chemical Process safety", AICHE 1992.

14IS22 ELECTRICAL SAFETY

L	T	P	C
4	0	0	4

Course Objectives (COs):

- To provide knowledge on basics of electrical fire and statutory requirements for electrical safety.
- To understand the causes of accidents due to electrical hazards.
- To know the various protection systems in Industries from electrical hazards.
- To know the importance of breathing.
- To distinguish the various hazardous zones and applicable fire proof electrical devices.

Course Outcomes (COs):

1. This course would make familiar of basic concepts in electrical circuit and hazards involved in it.
2. Course would be helpful to understand the electrical hazards in Industries.
3. Students would be able to understand the operation of various protection systems from electrical hazards.
4. Recognize different hazardous zones in Industries.
5. Students would be able to gain knowledge on selection of suitable electrical equipment in different hazardous zone.

Program Outcomes (POs):

b. Design, Establish, Implement maintain and continually improve an occupation health and management system to improve occupational health and safety performance.
e. Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings so as to provide practical solutions to safety problems.
d. Design complex man machine systems using human factors engineering tools so as to achieve comfort, worker satisfaction, efficiency, error free and safe workplace environment.

Unit I

Concepts and Statutory Requirements

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

12 Hours

Unit II

Electrical Hazards

Primary and secondary hazards - shocks, burns, scalds, falls - human safety in the use of electricity. Energy leakage-clearances and insulation-classes of insulation-voltage classifications excess energy-current surges-Safety in handling of war equipment-over current and short circuit current-heating effects

of current-electromagnetic forces-corona effect-static electricity –definition, sources, hazardous conditions, control, electrical causes of fire and explosion-ionization, spark and arc-ignition energy-national electrical safety code ANSI. Lightning, hazards, lightning arrestor, installation – breathing, specifications, earth resistance, earth pit maintenance.

12 Hours

Unit III

Protection Systems

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.

12 Hours

Unit IV

Selection, Installation, Operation and Maintenance

Role of environment in selection-safety aspects in application - protection and interlock self diagnostic features and fail safe concept-lock out and work permit system discharge rod and earthing devices-safety in the use of portable tools-cabling and cable joints-preventive maintenance. **12 Hours**

12 Hours

Unit V

Hazardous Zones

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

12 hours

Total: 60 Hours

Reference(s)

1. John Cadick, *"Electrical safety Handbook"*, Third Edition, Mc Graw Hill, 2006
2. Fordham Cooper, W., *"Electrical Safety Engineering"* Butterworth and Company, London, 1986.
3. N.S.C, "*Accident prevention manual for industrial operations*", N.S.C.,Chicago, 1982.
4. B. R. Jolly Bahri Bros, "*Indian Electricity Act and Rules"* Government of India, 1956 .
5. TNEB, Power Engineers – Handbook of TNEB, Chennai, 1989.
6. Martin Glov, *"'Electrostatic Hazards in powder handling, Research Studies",* England, 1988.
7. Dr.Massim A.G.Mitolo, *"Electrical safety of Low voltage systems",* Mc Graw Hill, 2009

14IS23 FIRE ENGINEERING AND EXPLOSION CONTROL

L	T	P	C
4	0	0	4

Course Objectives (COs):

- To provide an in depth knowledge about the science of fire.
- To understand the causes and effects of fire.
- To know the various fire prevention systems and protective equipment.
- To understand the science of explosion and its prevention techniques.
- To understand the various fire prevention techniques to be followed in a building.

Course Outcomes (COs):

1. To make familiar of basic concepts of fire and explosion science.
2. To know the different source of ignition and their prevention techniques .
3. To understand the operation of various types of fire-fighting equipment.
4. To understand the causes and prevention of explosion.
5. To equip the students to effectively employ explosion protection techniques and their significances to suit the industrial requirement.

Program Outcomes (POs):

b. Design, Establish, Implement maintain and continually improve an occupation health and management system to improve occupational health and safety performance.

e. Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings so as to provide practical solutions to safety problems.

d. Design complex man machine systems using human factors engineering tools so as to achieve comfort, worker satisfaction, efficiency, error free and safe workplace environment.

Unit I

Physics and Chemistry of Fire

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

12 Hours

Unit II

Fire Prevention and Protection

Sources of ignition – fire triangle – 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 – layout of stand pipes – fire station-fire alarms and sirens – maintenance of fire trucks – foam generators – escape from fire rescue operations – fire drills – notice-first aid for burns.

12 Hours

Unit III

Industrial Fire Protection Systems

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

Portable extinguishers – flammable liquids – tank farms – indices of inflammability-fire fighting systems.

12 Hours

Unit IV

Building Fire Safety

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.

12 Hours

Unit V

Explosion Protecting Systems

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).

12 Hours

Total: 60 Hours

Reference(s)

1. Gupta, R.S., *"Hand Book of Fire Technology*" Orient Blackswan,2010
2. Derek, James, "*Fire Prevention Hand Book*", Butter Worths and Company, London,1986.
3. Arthur E Cote "*Fire protection Handbook"* NFPA 2008.
4. V K Jain "*Fire Safety in Building*" New Age International 1996.
5. McElroy, Frank E "*Accident Prevention manual for industrial operations*" N.S.C., Chicago, 1988.
6. Dinko Tuhtar, *"Fire and explosion protection – A System Approach*" Ellis Horwood Ltd, Publisher, 1989.
7. Charles J. Baker ," *Fire Fighter's Handbook of Hazardous Materials",* Van Nostrand Rein Hold, Jones & Bartlett Learning ,New York, 2006.
8. Dennis P. Nolan *"Handbook of Fire & Explosion Protection Engineering Principles for Oil, Gas, Chemical, & Related Facilities*", William Andrew Publishers, 1996.

14IS27 INDUSTRIAL SAFETY LABORATORY

L	T	P	C
0	0	3	2

Course Objectives (COs):

- To provide opportunity to operate the equipment to acquire practical knowledge.
- To know the various PPEs and software.
- To carry out experiments to find out the environmental parameters.
- To assess the impact of sensitivity of chemicals on Explosivity.
- To run the software to assess the consequence effects of major accidents.

Course Outcomes (COs):

1. This course would make students to know and run the various equipment to bring out the safety environment in the industry.
2. Course would be helpful for the students to measure the particular matter and assess the impact of air pollution.
3. Students would be trained to conduct experiments and also to find out various environmental parameters.
4. Students would able to use personal protective equipment independently.
5. Students can recognize the various problems with the use of software and hence to predict the real situations on major accidents.

Program Outcomes (POs):

g. Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to occupation health and safety practices.

j. Demonstrate the use of state of the art occupational health and safety practices in controlling risks of complex engineering activities and understand their limitations.

List of Exercises

1. TRAINING IN USAGE AND SKILL DEVELOPMENT PERSONAL PROTECTIVE EQUIPMENTS

Safety Helmet, Belt, Hand Gloves, Goggles, Safety Shoe, Gum Boots, Ankle Shoes, Face Shield, Nose Mask, Ear Plug, Ear Muff, Apron And Leg Guard and study of road safety signals and symbols.

2. BREATHING ZONE CONCENTRATION

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

3. EXHAUST GAS MEASUREMENT AND ANALYSIS

Measurement of Sox, NOx, Cox, hydrocarbons. Waste water analysis, Sampling and Analysis of water (pH, COD, DO, Sulphate and heavy metals)

4. NOISE LEVEL MEASUREMENT AND ANALYSIS

Measurement of sound pressure level in dB for Impact, continuous and intermittent sources at various networks, peak and average values And Vibration Measuring Instruments.

5. STUDY OF FIRE EXTINGUISHERS

Selection and demonstration of first-aid fire extinguishers: soda acid, foam, carbon dioxide (CO_2), dry chemical powder, halon.

6. FRICTION TEST

Explosive materials like barium nitrate, gun powder, white powder etc.

7. ANALYSIS OF SAFETY MEASURES

Accident Analysis, Safety Auditing Packages, Threat Zone Estimations and Reliability Analysis for Mechanical system.

Total: 45 Hours

14IS28 TECHNICAL SEMINAR

L	T	P	C
0	0	3	1

Course Objectives (COs):

- To develop journal paper reading and understanding skill.
- To improve communication and presentation skill of students.

Course Outcomes (COs):

2. Able to select the method, analysis and optimize the given problem for the given field applications.

Programmed Outcomes (PO):

f. Communicate effectively on health and safety matters among the employees and with society at large.
h. Understand and commit to comply with legal and contractual requirements, professional ethics and responsibilities and general norms of engineering practice.
i. Understand the impact of Health safety and environment solutions on productivity, quality and society at large.

The students are expected to make a presentation on the state of research on a particular topic based on current journal publications in that topic. A faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also. Students are encouraged to use various teaching aids such as Over Head Projectors, Power Point Presentation and Demonstrative Models.

14IS51– ENVIRONMENTAL POLLUTION CONTROL

L	T	P	C
3	0	0	3

Course Objectives (COs):

- To provide in depth knowledge in Principles of Environmental safety and its applications in various fields.
- To give understanding of air and water pollution and their control.
- To expose the students to the basics in hazardous waste management.
- To design emission measurement devices.

Course Outcomes (COs):

1. Illustrate and familiarize the basic concepts scope of environmental safety.
2. Understand the standards of professional conduct that are published by professional safety organizations and/or certification bodies.
3. Explain the ways in which environmental health problems have arisen due to air and water pollution.

Programmed Outcomes (PO):

f.Communicate effectively on health and safety matters among the employees and with society at large.
h. Understand and commit to comply with legal and contractual requirements, professional ethics and responsibilities and general norms of engineering practice.
j. Demonstrate the use of state of the art occupational health and safety practices in controlling risks of complex engineering activities and understand their limitations.

Unit I

Air pollution

Air pollution– Classification and properties of Air pollutants-Pollution sources-Control of air pollution – Gravitational settling chambers-Cyclone separators, ESP, Wet scrubber.

9 Hours

Unit II

Control of Gaseous Pollutants

Dispersion of Air pollutants-Plume behavior-Control of gaseous pollutants, sulphur dioxides, nitrogen oxides, Carbon monoxide and Hydrocarbons. Air pollution laws and Standards.

9 Hours

Unit III

Water Pollution

Water pollution- Classification of water pollutant and their effects on receiving bodies. Advanced wastewater treatments by Physical, Chemical, Biological and Thermal Methods-Effluent quality standards.

9 Hours

Unit IV

Solid waste management

Solid waste management - methods of collection – Disposal of solid waste, land filling, Handling of toxic and radioactive wastes – Incineration and Verification.

9 Hours

Unit V

Pollution Control in Industries

Pollution control in process industries – Cement, paper, petroleum, fertilizer and petrochemical.

9 Hours

Total: 45 Hours

Reference(s)

1. Rao, C.S., "*Environmental Pollution Control Engineering",* Wiley Eastern Ltd., New Delhi, 2006.
2. Trividi, P,R, "Environmental Pollution and Control", Paragon-Nivin Shahdara, New Delhi, 2008.

14IS52 SAFETY IN CONSTRUCTION

L	T	P	C
3	0	0	3

Course Objectives (COs):

- To know causes of accidents related to construction activities and human factors associated with these accident.
- To understand the construction regulations and quality assurance in construction .
- To have the knowledge in hazards of construction and their prevention methods.
- To know the working principles of various construction machinery.
- To gain knowledge in health hazards and safety in demolition work.

Course Outcomes (COs):

Upon completion of the course the students will be able

- To identify the problems impeding safety in construction industries.
- To Identify types and causes of accidents, and designing aids for safe construction.
- To understand the hazards during construction of power plant , road works, high rise buildings constructions.
- To understand the safety procedure for working at heights during constructions.
- To have knowledge in selecting, operations, inspection and testing of various construction machinery.
- To list out construction regulations and Indian standards for construction and demolition work.

Programmed Outcomes (PO):

f.Communicate effectively on health and safety matters among the employees and with society at large.

h.Understand and commit to comply with legal and contractual requirements, professional ethics and responsibilities and general norms of engineering practice.

j.Demonstrate the use of state of the art occupational health and safety practices in controlling risks of complex engineering activities and understand their limitations.

Unit I

Accidents Causes and Management Systems

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

9 Hours

Unit II

Hazards of Construction and Prevention

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

9 Hours

Unit III

Working at Heights

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

9 Hours

Unit IV

Construction Machinery

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

9 Hours

Unit V

Safety in Demolition Work

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

9 Hours

Total: 45 Hours

Reference(s)

1. Hudson, R.*"Construction hazard and Safety Hand book*" , Butter Worth's, 1985.
2. Jonathan D.Sime, *"Safety in the Built Environment",* London, 1988.
3. V.J.Davies and K.Thomasin *"Construction Safety Hand Book*" Thomas Telford Ltd., London, 1990.
4. Charles D. Reese and James V.Edison *"Handbook of OSHA Construction safety and health"*,CRC Press Taylor & Francis group, 2006.
5. McElroy, Frank E *"Accident Prevention Manual for Industrial Operations*" – NSC, Chicago, 1988.

14IS53 SAFETY IN POWDER HANDLING

L	T	P	C
3	0	0	3

Course Objectives (COs):

- Students will be provided with the knowledge of the process of analyzing and developing information to produce a plant layout based on the locations and working conditions.
- To educate the students about the basic things of work conditions which includes ventilation, comfort, lighting and its effect based on various nature of work.

Course Outcomes (COs):

- The students will be able to identify equipment requirements for a specific process and for various locations and working conditions.
- The students will be able to understand the benefit of an efficient material handling system

Programmed Outcomes (PO):

b. Design, Establish, Implement maintain and continually improve an occupation health and management system to improve occupational health and safety performance.
c. Conduct investigations on unwanted incidents using root cause analysis and generate corrective and preventive action to prevent recurrence and occurrence of such incidents.
d. Design complex man machine systems using human factors engineering tools so as to achieve comfort, worker satisfaction, efficiency, error free and safe workplace environment.

Unit I
INTRODUCTION
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.

9 Hours

Unit II
METAL POWDERS AND CHARACTERIZATION
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.

9 Hours

Unit III

DUST EXPLOSION

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.

9 Hours

Unit IV

DUST HANDLING PLANTS AND ELECTRO STATIC HAZARDS

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

9 Hours

Unit V

DUST EVALUATION AND CONTROL

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.

9 Hours

Total: 45 Hours

Reference(s)

1. SRMC,"*Hazard recognition and prevention in the work place-airborne dust"* Vol. I & II, Chennai, 2000.
2. ASM, *"Metals hand book - Powder Metallurgy."*, Vol.7, 9th ed.., 1984.
3. Edelstein. A. S and Cammarata.R. C., *"Nanomaterials: Synthesis, Properties and Applications"*, Taylor & Francis, NewYork, 1996.

14IS54 INDUSTRIAL NOISE AN VIBRATION CONTROL

L	T	P	C
3	0	0	3

Course Objectives (COs):

- To educate the designing of Exhaust system based on various exhaust system taking into consideration of various parameters and validating the same with proper testing methods.
- To provide knowledge on how to select the ventilation system for the specific usage based on industrial experience.

Course Outcomes (COs):

- The course could provide the students in remembering the basic knowledge and principles of ventilation and exhaust system.
- The student could understand the various types of Ventilation systems and the mechanism and testing processes behind each ventilation systems.
- The students could able to apply the acquired knowledge in selection various ventilation systems based upon end use.

Programmed Outcomes (PO):

a. Apply knowledge of Mathematics, Science, Engineering fundamentals and an engineering specialization for hazard identification, risk assessment and control of occupational hazards.
c. Conduct investigations on unwanted incidents using root cause analysis and generate corrective and preventive action to prevent recurrence and occurrence of such incidents.

Unit I
Introduction

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.

9 Hours

Unit II
Instrumentation and Auditory

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.

9 Hours

Unit III
Sources of Noise and Ratings

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.

9 Hours

Unit IV

Noise Control

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.

9 Hours

Total: 45 Hours

Unit V

Abatement Of Noise

Active noise attenuators and scope for abatement of industrial noise.

References

1. Irwin, J.D and Graf, E. R, “Noise and Vibration Control”, Prentice Hall Inc. New Jercy, 1979.
2. Irwing B Crandall, “Theory of Vibrating Systems and Sound”, D. Vannostrand Company,New Jercy, 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.

14IS55 SAFETY IN CHEMICAL INDUSTRY

L	T	P	C
3	0	0	3

Course Objectives (COs):

- To understand the fundamentals of Quantitative risk analysis.
- To know the procedure for risk assessment.
- To gain knowledge on various tools on consequence analysis.
- To develop the skill of risk estimation in a process plant.
- To familiarize with international risk assessment reports like Canvey report, Rijnmond report .etc.

Course Outcomes (COs):

The students will be able

- To carryout frequency estimation using event tree analysis.
- To estimate the consequences of BLEVE and Fire Ball.
- To assess the risk for the given fire or dispersion scenario.
- To list out the data required for risk estimation.

Programmed Outcomes (PO):

f. Communicate effectively on health and safety matters among the employees and with society at large.
h. Understand and commit to comply with legal and contractual requirements, professional ethics and responsibilities and general norms of engineering practice.
i. Understand the impact of Health safety and environment solutions on productivity, quality and society at large.

Unit I

Safety in Process Design and Pressure System Design

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

9 Hours

Unit II

Plant Commissioning and Inspection

Commissioning phases and organization, pre-commissioning documents, process commission-ing, 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.

9 Hours

Unit III

Plant Maintenance, Modification and Emergency Planning

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.

9 Hours

Unit IV

Storages and Transportation

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

9 Hours

Unit V

Plant Operations

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 for Cement, paper, pharmaceutical, petroleum, petro-chemical, rubber, fertilizer and distilleries.

9 Hours

Total: 45 Hours

Reference(s)

1. Lees, F.P. *"Loss Prevention in Process Industries"* Butterworths and Company, 1996.
2. *"Quantitative Risk Assessment in Chemical Process Industries*" American Institute of Chemical Industries, Centre for Chemical Process safety.
3. Fawcett, H.h. and Wood, *"Safety and Accident Prevention in Chemical Operations"* Wiley inters, Second Edition.
4. *"Accident Prevention Manual for Industrial Operations"* NSC, Chicago, 1982.
5. GREEN, A.E., *"High Risk Safety Technology*", John Wiley and Sons,. 1984.
6. "Petroleum Act and Rules", Government of India.
7. "Carbide of Calcium Rules", Government of India.

14IS56 FIREWORKS SAFETY

L T P C
3 0 0 3

Course Objectives (COs):

- To study about the pyrotechnic chemicals properties.
- To know about the factories act and explosive act and rules.
- To know about the fireworks industries' risk related processes and their layout.
- To understand the pyrotechnic chemicals material handling, storage and their transportation.

Course Outcomes (COs):

Upon completion of the course the students will be able

- To gain the knowledge in Fireworks chemicals properties and their reactions.
- To understand materials used, Fireworks layout, maintenance and legal requirements.
- To know about the Causes, effects and hazards in fireworks industries.
- Understanding the various processes such as mixing, filling, packing and storage in warehouses related to safety aspects.

Programmed Outcomes (PO):

f. Communicate effectively on health and safety matters among the employees and with society at large.
h. Understand and commit to comply with legal and contractual requirements, professional ethics and responsibilities and general norms of engineering practice.
i. Understand the impact of Health safety and environment solutions on productivity, quality and society at large.

Unit I
Properties Of Fireworks Chemicals
Fire properties – potassium nitrate (KNO3), potassium chlorate (KClO3), barium nitrate (BaNO3), calcium nitrate (CaNO3), Sulphur (S), Phosphorous (P), antimony (Sb), Pyro Aluminium (A1) powder-Reactions-metal powders, Borax, ammonia (NH3) – Strontium Nitrate, Sodium Nitrate, Potassium per chloride. Fire and explosion, impact and friction sensitivity.

9 Hours

UNIT II
Static Charge And Dust
Concept-prevention-earthing-copper plates-dress materials-static charge meter lightning, Causes-effects-hazards in fire works 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.

9 Hours

UNIT III

Process Safety

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.

9 Hours

UNIT IV

Material Handling

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.

9 Hours

UNIT V

Waste Control And Safety

Concepts of wastes – Wastes in fire works-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.

9 Hours

Total: 45 Hours

Reference(s)

1. Shimizu,T. *"Firecrackers: The Art, Science and Technique*", Maruzen Co, Tokyo; 1996.
2. Ghosh.K.N, "The Principles of Firecrackers", 2nd edition, Economic Enterprises; 1981.
3. Conkling.J, "Chemistry of Pyrotechnics: Basic Principles and Theory" Marcel Dekker Inc.: New York; 1985.
4. Shanmugam et al, *"Fireworks safety 1999: Proceedings of the National seminar"*, Vikas publications,1999.
5. Brock.H, , "A history of fireworks", First edition Harrap ., 1949

14IS57 SAFETY IN PROCESS INDUSTRIES

L T P C
3 0 0 3

Course Objectives (COs):

- To know the safety rules and regulations, standards and codes.
- To study various mechanical machines and their safety importance.
- To understand the principles of machine guarding and operation of protective devices.
- To know the working principle of mechanical engineering processes such as metal forming and joining process and their safety risks.

Course Outcomes (COs):

- Students can have the knowledge in safety rules, standards and codes in various mechanical engineering processes.
- They can design their own machine guarding systems for various machines such as lathe, drilling, boring, milling etc.,
- They can implement the safety concepts in welding, gas cutting, storage and handling of gas cylinders, metal forming processes etc..

Programmed Outcomes (PO):

b. Design, Establish, Implement maintain and continually improve an occupation health and management system to improve occupational health and safety performance.
d. Design complex man machine systems using human factors engineering tools so as to achieve comfort, worker satisfaction, efficiency, error free and safe workplace environment.
e. Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings so as to provide practical solutions to safety problems.

Unit I

Safety in Process Design and Pressure System Design

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.

9 Hours

Unit II

Plant Commissioning and Inspection

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.

9 Hours

Unit III

Plant Operations

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.

9 Hours

Unit IV

Plant Maintenance, Modification and Emergency Planning

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 .

9 Hours

Unit V

Storages

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.

9 Hours

Total: 45 Hours

Reference(s)

1. Lees, F.P., *"Loss Prevention in Process Industries*" Butterworth publications, London, 2nd edition, 1990.
2. Sanoy Banerjee, *"Industrial hazards and plant safety"*, Taylor & Francis, London, 2003.
3. "*Quantitative Risk Assessment in Chemical Process Industries*" American Institute of Chemical Industries, Centre for Chemical Process safety.
4. Fawcett, H. and Wood, *"Safety and Accident Prevention in Chemical Operations"* Wiley inters, Second Edition.
5. McElroy, Frank E., "*Accident Prevention Manual for Industrial Operations"*, NSC, Chicago, 1980.
6. Green, A.E., *"High Risk Safety Technology*", John Wiley and Sons, 1984.

14IS58 NUCLEAR ENGINEERING AND SAFETY

L T P C
3 0 0 3

Course Objectives (COs):

- To know about nuclear energy and fission fusion process.
- To gain knowledge in reactor types, design considerations and their operational problems.
- To know the current status of India in nuclear energy.
- To study about the nuclear reactors operational safety and their emergency preparedness.

Course Outcomes (COs):

- The students will be able to gain knowledge in nuclear fission and fusion process and their utilization.
- The students will be able to understand types of reactors and their control requirements.
- The students will be able to understand the safety design principles and safety regulation process.

Programmed Outcomes (PO):

a. Apply knowledge of Mathematics, Science, Engineering fundamentals and an engineering specialization for hazard identification, risk assessment and control of occupational hazards.
c. Conduct investigations on unwanted incidents using root cause analysis and generate corrective and preventive action to prevent recurrence and occurrence of such incidents.

Unit I
Introduction

Binding energy – fission 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.

9 Hours

Unit II
Reactor Control

Control requirements in design considerations – means of control – control and shut down rods – their operation and operational problems – control rod worth – control instrumentation and monitoring – online central data processing system.

9 Hours

Unit III
Reactor Types

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.

9 Hours

Unit IV

Safety of Nuclear Reactors

Safety design principles – 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.

9 Hours

Unit V

Radiation Control

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.

9 Hours

Total: 45 Hours

Reference(s)

1. M.M.E.L.Wakil, *"Nuclear Power Engineering",* International Text Book Co.
2. Sterman U.S.'"Thermal and Nuclear Power Stations", MIR Publications, Moscow, 1986.
3. *"Loss prevention in the process Industries*" Frank P.Lees Butterworth-Hein-UK, 1990.
4. M.M.E.L.Wakil, *"Nuclear Energy Conversion*", International Text Book Co.
5. R.L.Murray, *"Introduction to Nuclear Engineering",* Prentice Hall.
6. Sri Ram K, *"Basic Nuclear Engineering"* Wiley Eastern Ltd., New Delhi, 1990.
7. Loffness, R.L., *"Nuclear Power Plant"* Van Nostrand Publications, 1979.

14IS59 PLANT LAYOUT AND MATERIAL HANDLING

L	T	P	C
3	0	0	3

Course Objectives (COs):

- Students will be provided with the knowledge of the process of analyzing and developing information to produce a plant layout based on the locations and working conditions.
- To educate the students about the basic things of work conditions which includes ventilation, comfort, lighting and its effect based on various nature of work.

Course Outcomes (COs):

- The students will be able to identify equipment requirements for a specific process and for various locations and working conditions.
- The students will be able to understand the benefit of an efficient material handling system.
- The students will be able to recognize the effect of process layout on the material handling system.

Programmed Outcomes (PO):

f. Communicate effectively on health and safety matters among the employees and with society at large.
h. Understand and commit to comply with legal and contractual requirements, professional ethics and responsibilities and general norms of engineering practice.
i. Understand the impact of Health safety and environment solutions on productivity, quality and society at large.

Unit I
Plant Location
Selection of plant locations, territorial parameters, considerations of land, water, electricity, location for waste treatment and disposal, further expansions Safe location of chemical storages in the form of bullets, spheres, cylinders for LPG, LNG, CNG, acetylene, ammonia, chlorine – explosives and propellants.

9 Hours

Unit II
Plant Layout
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.

9 Hours

Unit III
Working Conditions
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.

9 Hours

Unit IV

Manual Material Handling and Lifting Tackles

Preventing common injuries, lifting by hand, team lifting and carrying, handling specific shape machines and other heavy objects – accessories for manual handling, hand tools, jacks, hand trucks, dollies and wheel barrows – storage of specific materials - problems with hazardous materials, liquids, solids – storage and handling of cryogenic liquids - shipping and receiving, stock picking, dock boards, machine and tools, steel strapping and sacking, glass and nails, pitch and glue, boxes and cartons and car loading – personal protection – ergonomic considerations. Fiber rope, types, strength and working load inspection, rope in use, rope in storage - wire rope, construction, design factors, deterioration causes, sheaves and drums, lubrication, overloading, rope fitting, inspection and replacement – slings, types, method of attachment, rated capacities, alloy chain slings, hooks and attachment, inspection

9 Hours

Unit V

Mechanical Material Handling

Hoisting apparatus, types - cranes, types, design and construction, guards and limit devices, signals, operating rules, maintenance safety rules, inspection and inspection checklist – conveyors, precautions, types, applications. Powered industrial trucks, requirements, operating principles, operators selection and training and performance test, inspection and maintenance, electric trucks, gasoline operated trucks, LPG trucks – power elevators, types of drives, hoist way and machine room emergency procedure, requirements for the handicapped, types- Escalator, safety devices and brakes, moving walks – man lifts, construction, brakes, inspection.

9 Hours

Total: 45 Hours

Reference(s)

1. "*Encyclopedia of occupational safety and health*", ILO Publication, 1985
2. *"Accident prevention manual for industrial operations"* N.S.C., Chicago, 1982.
3. Alexandrov. M.P. *"Material handling equipment"* Mir Publishers, Moscow, 1981
4. APPLE M. JAMES "Plant layout and material handling", 3rd edition, John Wiley & sons.
5. Spivakosky, "Conveyors and related Equipment", Vol.I & II Peace Pub. Moscow, 1982.
6. Rudenko, N., "Material handling Equipments", Mir Publishers, 1981.
7. Reymond, A.Kulwice, "Material Handling Hand Book - II", John Wiley and Sons, New York, 1985.
8. "Safety and good housekeeping", N.P.C. New Delhi, 1985.
9. "Industrial ventilation (A manual for recommended practice)", American conference of Governmental Industrial Hygiene, USA, 1984.

14IS60 DESIGN OF INDUSTRIAL VENTILATION SYSTEM

L T P C
3 0 0 3

Course Objectives (COs):

- The course could provide the basic knowledge on principles of ventilation and its applicability in industries.
- To enforce the knowledge on various types ventilating system, the mechanism of ventilation and the relationship between heat generation and ventilation.
- To educate the designing of Exhaust system based on various exhaust system taking into consideration of various parameters and validating the same with proper testing methods.

Course Outcomes (COs):

- The course could provide the students in remembering the basic knowledge and principles of ventilation and exhaust system.
- The student could understand the various types of Ventilation systems and the mechanism and testing processes behind each ventilation systems.
- The students could able to apply the acquired knowledge in selection various ventilation systems based upon end use.

Programmed Outcomes (PO):

f. Communicate effectively on health and safety matters among the employees and with society at large.
h. Understand and commit to comply with legal and contractual requirements, professional ethics and responsibilities and general norms of engineering practice.
i. Understand the impact of Health safety and environment solutions on productivity, quality and society at large.

Unit I

General Principles of Ventilation

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

9 Hours

Unit II

General Industrial Ventilation

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

9 Hours

Unit III

Local Exhaust Hoods and Air Cleaning Devices

Air contaminant 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.

9 Hours

Unit IV

Design and Testing of Industrial Ventilation

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.

9 Hours

Unit V

Ventilation System for Specific Operations

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.

9 Hours

Total: 45 Hours

Reference(s)

1. ACGIH Industrial Ventilation "*A manual of Recommended Practice*", 23rd edition 1998.
2. Encyclopaedia of *"Occupational Health and Safety*", Vol. I and II, published by International Labour Office, Geneva, 1985.
3. "*Accident Prevention manual for industrial operations*" N.S.C., Chicago, 1982.

14IS61 SAFETY IN PETROCHEMICAL INDUSTRIES

L T P C
3 0 0 3

Course Objectives (COs):

- To provide about the various risks and hazards involved in petrochemical industries and its control measures.
- To impart knowledge on risk analysis, toxic effect and planning for onsite and offsite emergency planning in petrol chemical industries.
- To acquire knowledge on Controlling of safety systems and Relief systems and to acquire knowledge on design activities of safety and relief systems.

Course Outcomes (COs):

- The course could make the students to remember the various terms and terminologies involved in the safety of petrochemical industries.
- The students could be able to understand the various concepts involved in the Risk analysis, hazard assessment, toxicity in petrol chemical industries and able to control the safety and relief systems.
- Knowing the various risk factors and controlling systems the student could be able to apply the various techniques of safety in preventing and mitigating the hazards in petrochemical industries.

Programmed Outcomes (PO):

b. Design, Establish, Implement maintain and continually improve an occupation health and management system to improve occupational health and safety performance.
d. Design complex man machine systems using human factors engineering tools so as to achieve comfort, worker satisfaction, efficiency, error free and safe workplace environment.
e. Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings so as to provide practical solutions to safety problems.

Unit I
Risk Management
Overall risk analysis – E and FI model– Methods for determining consequences effects: Effect of fire, Effect of explosion and toxic effect – Disaster management plan – Emergency planning – Onsite and offsite emergency planning – Risk management – Gas processing complex, refinery – First aids.

9 Hours

Unit II
Control of Safety Systems
Concept of risk, selection of design bases for safety systems, guidelines for risk tolerability, potential process safety systems and design solutions. Control of safety systems, safety system characteristic and design; Safety system computer control; Control of trip, interlock and emergency shut-down systems; Programmable logic and electronic system; Layered control systems for safety.

9 Hours

Unit III

Control of Relief System

Relief Systems: Preventive and protective management from fires and explosion-inserting, static electricity passivation, ventilation, and sprinkling, proofing, relief systems – relief valves, flares, scrubbers. Design of flares, scrubbers and condensers for toxic release from chemical process industries; Design of tank farms for liquid/gaseous fuel storage.

9 Hours

Unit IV

Toxicology of Petro Chemical Industries

Toxicology: Hazards identification-toxicity, fire, static electricity, noise and dust concentration; Material safety data sheet, hazards indices- Dow and Mond indices, hazard operability (HAZOP) and hazard analysis (HAZAN).

9 Hours

Unit V

Controlling of Leakages and Hazards Associated

Leaks and Leakages: 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. Hazards Associated with Hydrocarbon and Other Chemical Products: Crude oil, natural gas, LPG, CNG, LNG, oxygenated hydrocarbons, chlorine, ammonia, hydrogen fluoride.

9 Hours

Total: 45 Hours

Reference(s)

1. Crowl D.A. and Louvar J.F., "*Chemical Process Safety: Fundamentals with Applications*", 2nd Ed., Prentice Hall, 2001.
2. Mannan S., "*Lee's Loss Prevention in the Process Industries*", Vol. III, 3rd Ed., Butterworth- Heinemann,2005.
3. Sanders R.E., "*Chemical Process Safety: Learning from Case Histories*"
4. Davletshina T.A. and Cheremisinoff N.P., *"Fire and Explosion Hazards Handbook of Industrial Chemicals*" Jaico Publication, 2003.
5. 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 .
6. "*Guidelines for Design Solutions for Process Equipment Failures*", ISBN: 978-0-8169-0684-0, Centre for Chemical Process Safety (CCPS). 1998
7. Cheremisinoff N.P., "*Pressure Safety Design Practices for Refinery and Chemical Operations"* Noyes Publications,1998 .
8. Jones, J.C., "*Hydrocarbon Process Safety*", Penn Well Books. 2003 .
9. Sanders R.E., *"Chemical process safety*: learning from case histories" Elsevier, 2005.
10. Henley E.J., Kumamoto H*., "Designing for Reliability and Safety Control"* Englewood Cliffs, 1985.

14IS62 MAINTAINABILITY ENGINEERING

L	T	P	C
3	0	0	3

Course Objectives (COs):

- To provide the students about the basic concept of maintainability engineering.
- To feed knowledge on various maintenance models, maintenance policies and replacement model of various equipment.
- To enforce the knowledge on logistics for the effective utilization of existing resources and facilities availability of spares parts.

Course Outcomes (COs):

- The course could lead students in remembering various terms and terminologies about the maintenance concept.
- The student could able to understand the various maintenance modes and logistics meant for the execution of various services.
- The course could help the student in applying their knowledge in areas where the down time, over replacement are existing and could lead to improve the productivity and quality.

Programmed Outcomes (PO):

g. Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to occupation health and safety practices.
j. Demonstrate the use of state of the art occupational health and safety practices in controlling risks of complex engineering activities and understand their limitations.

Unit I
Maintenance Concept
Need for maintenance – Maintenance definition – Maintenance objectives – Challenges of Maintenance management – Tero technology – Scope of maintenance department – Maintenance costs.

9 Hours

Unit II
Maintenance Models
Proactive/Reactive maintenance – Imperfect maintenance – Maintenance policies – PM versus b/d maintenance – Optimal PM schedule and product characteristics – Optimal Inspection frequency: Maximizing profit – Minimizing downtime – Replacement models.

9 Hours

Unit III
Maintenance Logistics
Human factors – Crew size decisions: Learning curves – Simulation – Maintenance resource requirements: Optimal size of service facility – Optimal repair effort – Maintenance planning – Maintenance scheduling – Spare parts control – Capital spare.

9 Hours

Unit IV

Maintenance Quality

Maintenance excellence –Five Zero concept –FMECA –Root cause analysis – System effectiveness – Design for maintainability – Maintainability allocation – CMMS – Reliability Centerd Maintenance.

9 Hours

Unit V

Total Productive Maintenance

TPM features – Chronic and sporadic losses – Equipment defects – Six major losses – Overall Equipment Effectiveness – TPM pillars –TPM implementation – Autonomous maintenance.

9 Hours

Total: 45 Hours

Reference(s)

1. Andrew K.S.Jardine & Albert H.C.Tsang, “Maintenance, Replacement and Reliability”, Taylor and Francis, 2006.
2. Bikas Badhury & S.K.Basu, “Tero Technology: Reliability Engineering and Maintenance Management”, Asian Books, 2003.
3. Seichi Nakajima, “Total Productive Maintenance”, Productivity Press,1993.

14IS63 SAFETY IN TEXTILE INDUSTRY

L T P C
3 0 0 3

Course Objectives (COs):

- To provide the student about the basic knowledge about the textile industries and its products by using various machineries.
- To enforce the knowledge on textile processing and various processes in making the yarn from cotton or synthetic fibres.
- To understand the various hazards of processing textile fibres by using various activities.

Course Outcomes (COs):

- The student will able to know the about the overall picture about the textile industries and its operations.
- The student could understand the various concepts underlying in the processes involved in processing of fibres to yarn.
- The student will be able to find out various hazards in the textile industry and will be able to apply the control measures to mitigate the risk emanating from the hazard.

Programmed Outcomes (PO):

f. Communicate effectively on health and safety matters among the employees and with society at large.
h. Understand and commit to comply with legal and contractual requirements, professional ethics and responsibilities and general norms of engineering practice.
i. Understand the impact of Health safety and environment solutions on productivity, quality and society at large.

Unit I

Introduction

Introduction to 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.

9 Hours

Unit II

Textile Hazards I

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.

9 Hours

Unit III

Textile Hazards Ii

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

9 Hours

Unit IV

Health and Welfare

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

9 Hours

Unit V

Safety Status

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

9 Hours

Total: 45 Hours

Reference(s)

1. "*Safety in Textile Industry*", Thane Belapur Industries Association, Mumbai.
2. 100 Textile fires – analysis, findings and recommendations LPA.
3. Groover and Henry DS*, "Hand book of textile testing and quality control*"
4. "*Quality tolerances for water for textile industry", BIS.*
5. Shenai, V.A*. "A technology of textile processing",* Vol. I, Textile Fibres
6. Little, A.H. *,"Water supplies and the treatment and disposal of effluent".*

14IS64 VIBRATION AND NOISE CONTROL

L T P C
3 0 0 3

Course Objectives (COs):

- To provide in depth knowledge about the vibration and noise control.
- To get an exposure about the basic terms and terminologies about the noise and vibration and about its source.
- To analyse and to design the component in such a way that noise and vibration may be controlled by suitable experimental methods.

Course Outcomes (COs):

- This course would make the student in understanding the basic concepts about the Vibration and Noise and its types.
- The student could be able to apply the knowledge on vibration and noise control by suitable methods.

Programmed Outcomes (PO):

a. Apply knowledge of Mathematics, Science, Engineering fundamentals and an engineering specialization for hazard identification, risk assessment and control of occupational hazards.

c. Conduct investigations on unwanted incidents using root cause analysis and generate corrective and preventive action to prevent recurrence and occurrence of such incidents.

Unit I

Basics of Vibration

Introduction, classification of vibration: free and forced vibration, undamped and damped vibration, linear and non linear vibration, response of damped and undamped systems under harmonic force, analysis of single degree and two degree of freedom systems, torsional vibration, determination of natural frequencies.

9 Hours

Unit II

Basics of Noise

Introduction, amplitude, frequency, wavelength and sound pressure level, addition, subtraction and averaging decibel levels, noise dose level, legislation, measurement and analysis of noise, measurement environment, equipment, frequency analysis, tracking analysis, sound quality analysis.

9 Hours

Unit III

Source of Noise and Control

Methods for control of engine noise, combustion noise, mechanical noise, predictive analysis, palliative treatments and enclosures, automotive noise control principles, sound in enclosures, sound energy absorption, sound transmission through barriers.

9 Hours

Unit IV

Vibration Control

Specification of Vibration Limits –Vibration severity standards- Vibration as condition Monitoring tool-Vibration Isolation methods- -Dynamic Vibration Absorber, Torsional and Pendulum Type Absorber- Damped Vibration absorbers- Static and Dynamic Balancing- Balancing machines - Field balancing – Vibration Control by Design Modification- Active Vibration Control.

9 Hours

Unit V

Experimental Methods in Vibration Analysis

Vibration Analysis Overview - Experimental Methods in Vibration Analysis - Vibration Measuring Instruments - Selection of Sensors - Accelerometer Mountings – Vibration Exciters-Mechanical, Hydraulic, Electromagnetic And Electrodynamics – Frequency Measuring Instruments - System Identification from Frequency Response -Testing for resonance and mode shapes.

9 Hours

Total: 45 Hours

Reference(s)

1. Singiresu S.Rao - *"Mechanical Vibrations*" - Pearson Education, ISBM –81-297-0179-0 -2004.
2. Kewal Pujara "Vibrations and Noise for Engineers, Dhanpat Rai & Sons,1992.
3. Bernard Challen and Rodica Baranescu - *"Diesel Engine Reference Book"* – Second edition - SAE International - ISBN 0-7680-0403-9 – 1999.
4. Julian Happian-Smith - "*An Introduction to Modern Vehicle Design*"- Butterworth- Heinemann, ISBN 0750-5044-3 – 2004.
5. John Fenton - *"Handbook of Automotive body Construction and Design Analysis* –Professional Engineering Publishing, ISBN 1-86058-073-1998.
6. Rao V. Dukkipati and J.Srinivas *,"Text book of Mechanical Vibrations*", Prentice-Hall of India P Ltd,New Delhi,2004.

14IS65 PHYSICAL AND CHEMICAL TREATMENT OF WATER AND WASTEWATER

L T P C
3 0 0 3

Course Objectives (COs):

- To know the Sources of pollutants in water and wastewater and characterization.
- To study the physical treatments processes such as sedimentation, reverse osmosis, nano filtration, electro dialysis etc.
- To study the chemical treatment processes such as coagulation flocculation, precipitation, flotation, ion exchange, electrolytic etc.

Course Outcomes (COs):

- To gain knowledge about the classification of water pollution and its characteristics.
- To understand physical treatment methods and its recent advancements.
- To list out various chemical treatment methods.

Programmed Outcomes (PO):

b. Design, Establish, Implement maintain and continually improve an occupation health and management system to improve occupational health and safety performance.

d. Design complex man machine systems using human factors engineering tools so as to achieve comfort, worker satisfaction, efficiency, error free and safe workplace environment.

e. Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings so as to provide practical solutions to safety problems.

Unit I
Introduction

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

9 Hours

Unit II
Physical Treatment Principles

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

9 Hours

Unit III
Chemical Treatment Principles

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

9 Hours

Unit IV

Design of Conventional Treatment Plants

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

9 Hours

Unit V

Design of Industrial Water Treatment and Reclamation

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

9 Hours

Total: 45 Hours

Reference(s)

1. Metcalf and Eddy, "*Wastewater Engineering, Treatment and Reuse*", Tata McGraw-Hill, 2003.
2. "*Manual on Water Supply and Treatment",* CPHEEO, Ministry of Urban Development, Government of India, 1999.
3. Lee, C.C. and Shun dar Lin, *"Handbook of Environmental Engineering Calculations",* McGraw-Hill, 1999.
4. Qasim, S.R., Motley, E.M. and Zhu, G., *"Water works Engineering – Planning, Design and Operation*", Prentice Hall, 2002.
5. Casey, T.J., "*Unit Treatment Processes in Water and Wastewater Engineering"*, John Wiley and Sons, 1993.

14IS66 ENVIRONMENTAL IMPACT ASSESSMENT

L T P C
3 0 0 3

Course Objectives (COs):

- To provide the in depth knowledge on Environment and Its impact on the surroundings when a major project is being carried out in a location.
- To provide the basic knowledge on Environmental impact assessment (EIA) and its legal requirements.
- To understand about the various terms and terminologies relating to EIA

Course Outcomes (COs):

- Course would make the student in knowing the basic things about Environmental Impact assessment and its relevance to the Legal and regulatory aspects.
- Course would be helpful in understanding about the EIA and various components involved in maintaining the environment in balanced way.

Programmed Outcomes (PO):

g.Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to occupation health and safety practices.

j.Demonstrate the use of state of the art occupational health and safety practices in controlling risks of complex engineering activities and understand their limitations.

Unit I

Introduction

Environmental Impact Assessment (EIA) - Environmental Impact Statement (EIS)-Environmental Risk Assessment (ERA) - Legal and Regulatory aspects in India – Types and limitations of EIA - Terms of Reference in EIA- Issues in EIA - national – cross sectoral - social and cultural.

9 Hours

Unit II

Environmental Analysis and Assessment Techniques

Components - screening - setting - analysis - prediction of impacts - mitigation. Matrices Networks - Checklists. Importance assessment techniques - cost benefit analysis - analysis of alternatives - methods for Prediction and assessment of impacts - air - water - soil - noise -biological - cultural - social - economic environments. Standards and guidelines for evaluation. Public Participation in environmental decision-making.

9 Hours

Unit III

Environmental Impact Assessment Evaluation

Trends in EIA practice and evaluation criteria - capacity building for quality assurance. Expert System in EIA - use of regulations and AQM.

9 Hours

Unit IV

Environmental Management Plan

Document planning - collection and organization of relevant information - use of visual display materials – team writing - reminder checklists. Environmental monitoring - guidelines - policies - planning of monitoring programmes. Environmental Management Plan. Post project audit.

9 Hours

Unit V

Case Studies

Case studies of EIA of developmental projects.

9 Hours

Total: 45 Hours

Reference(s)

1. Canter, L.W., *"Environmental Impact Assessment"*, McGraw Hill, New York, 1996.
2. Petts, J., "*Handbook of Environmental Impact Assessment*", Vol. I and II, Blackwell Science, London, 1999.
3. The World Bank Group, *"Environmental Assessment Sourcebook"*, Vol. I, II and III, The World Bank, Washington, 1991.