MASTER OF TECHNOLOGY (M.Tech.)
INDUSTRIAL SAFETY ENGINEERING

SYLLABUS
FOR
CREDIT BASED CURRICULUM
(From the academic year 2018-2019 Onwards)

DEPARTMENT OF MECHANICAL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI – 620 015, INDIA.

JUNE-2018

Vision & Mission of the Department of Mechanical Engineering:

Vision:

To be a centre of excellence in Mechanical Engineering where the best of teaching, learning and research synergize.

Mission:

- Prepare intellectually sharp and ethically responsible graduate and post-graduate engineers for global requirements by providing quality education.
- Conduct basic and applied research, provide consultancy services and cultivate the spirit of entrepreneurship.
- Develop the habit of continuous learning, team work and fulfill the societal needs.

Programme Educational Objectives (PEOs)

1. Graduates will be successful and socially responsible industrial safety engineers
2. Graduates will possess the habit of continuous learning in the emerging safety engineering technology and advanced field of study
3. Graduates will work harmoniously in group with ethical and professional code of conduct.

Programme Outcomes (POs)

On successful completion of the post-graduate programme M.Tech. Industrial Safety Engineering, the Industrial Safety Engineering graduates will,

1. Acquire in-depth knowledge in field of safety engineering and technology including wider and global perspective, with an ability to discriminate, evaluate, analyse and synthesise existing and new knowledge, and integration of the same for enhancement of industrial safety.
2. Analyse safety, health and environmental problems and issues critically, apply independent judgments for synthesising information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.
3. Think laterally and originally, conceptualise and solve safety, health and environmental problems and issues, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors.
4. Extract information pertinent to unfamiliar safety, health and environmental problems and issues through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyse

and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge.

5. Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling to safety, health and environmental engineering activities with an understanding of the limitations.
6. Possess knowledge and understanding of group dynamics, recognise opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals.
7. Apply the management principles to one's own work, as a member or leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economical and financial factors adhering to occupational health and safety standards.
8. Communicate with the engineering community, employees, and with society at large, regarding safety, health and environmental activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.
9. Recognise the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.
10. Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.
11. Observe and examine critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

M.Tech. - INDUSTRIAL SAFETY ENGINEERING
The total credits required for completing the M.Tech. Programme is 64

SEMESTER I

Code	Course of Study	L	T	P	C
MA 611	Probability and Statistics	3	0	0	3
ME 653	Safety Management	3	0	0	3
ME 655	Occupational Health and Hygiene	3	0	3	3
	Elective I	3	0	0	3
	Elective II	3	0	0	3
	Elective III	3	0	0	3
ME 661	Industrial Hygiene and Ergonomics Laboratory	0	0	3	2
		18	**1**	**3**	**20**

SEMESTER II

Code	Course of Study	L	T	P	C
ME 652	Computer Aided Risk Analysis	3	0	0	3
ME 654	Safety in Chemical Industry	3	0	0	3
ME 656	Fire Engineering and Explosion Control	3	0	0	3
	Elective IV	3	0	0	3
	Elective V	3	0	0	3
	Elective VI	3	0	0	3
ME 658	Industrial Safety Lab	0	0	3	2
		18	**0**	**3**	**20**

SEMESTER III

Code	Course of Study	L	T	P	C
ME 663	Summer Industrial Internship	0	0	0	Pass/Fail
ME 797	Project work - Phase I	0	0	0	12

SEMESTER IV

Code	Course of Study	L	T	P	C
ME 798	Project work - Phase II	0	0	0	12

Total Credits 64

LIST OF ELECTIVES

Code	Course of Study	L	T	P	C
ME 659	Regulation for Health, Safety and Environment	3	0	0	3
ME 671	Environmental Pollution Control	3	0	0	3
ME 672	Safety in Construction	3	0	0	3
ME 674	Electrical Safety	3	0	0	3
ME 676	Design of Air pollution control systems	3	0	0	3
ME 677	Industrial Noise and Vibration Control	3	0	0	3
ME 678	Biomechanics and Human body vibration	3	0	0	3
ME 679	Work study and ergonomics	3	0	0	3
ME 680	Transport Safety	3	0	0	3
ME 681	Safety in textile industry	3	0	0	3
ME 682	Safety in mines	3	0	0	3
ME 683	Dock safety	3	0	0	3
ME 684	Sensitivity measurements and evaluation of energetic material	3	0	0	3
ME 685	Safety in powder handling	3	0	0	3
ME 686	Nuclear engineering and safety	3	0	0	3
ME 687	Disaster management	3	0	0	3
ME 691	ISO 45001 and ISO 14001	3	0	0	3
ME 689	Safety in On and Off Shore Drilling	3	0	0	3
ME 690	Human factors and ergonomics	3	0	0	3

OPEN ELECTIVES

Code	Course of Study	L	T	P	C
ME 657	Safety in Engineering Industry	3	0	0	3
ME 675	Material Handling and PPE	3	0	0	3

MA 611 - PROBABILITY AND STATISTICS (3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- the concepts of probability and statistics to safety engineering problems
- reliability engineering theory in determining the reliability of the safety systems.

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

i. apply standard and special probability distributions to safety engineering problems.
ii. indicate data pictorially and numerically and analyse it.
iii. employ sampling distributions in testing various hypotheses.
iv. use t-test, F-test and Chi-square test in determining the validity of data.
v. predict the relationship between parameters through correlation and regression analysis and compute the reliability of safety systems.

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

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

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

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

Basics concepts of reliability - Failure rate analysis – Reliability of systems – Series, Parallel – Maintenance - Preventive and corrective – Maintainability equation – Availability – Quality and Reliability.

Introduction to data analytical and data mining

References:

1. BOWKER and LIBERMAN, Engineering *Statistics*, Prentice-Hall.
2. GUPTA, S.C. and KAPOOR, V.K., *Fundamentals of Mathematical Statistics*, Sultan Chand and Sons.
3. SPIEGEL, MURRAY R., *Probability and Statistics*, Schaum's series.
4. SPIEGEL, MURRAY R., *Statistics*, Schaum's series.
5. TRIVEDI K.S., *Probability and Statistics with Reliability and Queuing and Computer Science Applications*, Prentice Hall of India.

ME 653 – SAFETY MANAGEMENT (3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- safety management functions and techniques
- accident reporting and investigation procedures
- safety education and training, evaluation of safety performance in an organisation.

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

i. apply principles of safety management, its functions and technique in any organization,
ii. classify and categorize the factors contributing to accident,
iii. formulate accident investigation program in an organization, develop and practice accident reporting system,
iv. recognize the importance of safety education and training in an organization,
v. practice safety professional ethics,
vi. identify and comply with statutory and regulatory requirement.

CONCEPTS AND TECHNIQUES

Evolution of modern safety concept, Safety as integral part of business-Safety policy- Safety Organization- line and staff functions for safety- Safety Committee-budgeting for safety. Incident Recall Technique (IRT), disaster control, Job Safety Analysis (JSA), safety survey, safety inspection, safety sampling, Safety Audit.

ACCIDENT INVESTIGATION AND REPORTING

Concept of an accident, reportable and non-reportable accidents, contribution factor for accident – 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, root cause analysis, Records of accidents, accident reports- Class exercise with case study.

SAFETY PERFORMANCE MONITORING

Reactive and proactive monitoring techniques - 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, modern tool usage, accident data analysis.

SAFETY EDUCATION AND TRAINING

Importance of training-identification of training needs-training methods – training evaluation methods-program, 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.

EFFECTIVE SAFETY MANAGEMENT SYSTEM AND ETHICS

Purpose, Safety Culture, Safety functions, Elements of process safety management, Behavior Based Safety, Elements of Safety Management System, Concept of BBIP, OSHA guidelines, Voluntary Safety and Health Program management guidelines, 1989

Introduction, basic principles, duties and obligations, conditions of execution of the functions of occupational safety professionals.

References

1. Accident Prevention Manual for Industrial Operations", N.S.C.Chicago, Third edition 2008.
2. Heinrich H.W. "Industrial Accident Prevention" McGraw-Hill Company, New York, Fifth Edition 2007.
3. Krishnan N.V. "Safety Management in Industry" Jaico Publishing House, Bombay, 1997.
4. John Ridley, "Safety at Work", Butterworth & Co., London, Sixth Edition ,1999.
5. Roland P. Blake , "Industrial Safety" Prentice Hall, Inc., New Jersey, Second Edition, 1997
6. "Industrial safety management", L M Deshmukh, TATA McGraw Hill, Forth edition, 2010.

ME 655 – OCCUPATIONAL HEALTH AND HYGIENE (3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- workplace hazards and control strategies to control the hazards
- promotion of occupational health and prevention of occupational diseases.

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

i. identify different types of physical, chemical and biological hazards in the workplaces, and analyse work environment.
ii. employ risk analysis process on health hazards and recommend control measures for different types of physical, chemical and biological hazards in the workplaces, and be able to choose between different control strategies.
iii. select appropriate protective devices based on hazard characterization.
iv. formulate plans for promotion of occupational health and prevention of occupational diseases.
v. analyse workplaces, equipment and work postures to recognize ergonomics deficiencies and suggest solutions.

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

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

BIOLOGICAL 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.

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

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

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.

References

1. *Handbook of Occupational Health and Safety*, NSC Chicago, vol 1, 2 1982.
2. *Encyclopedia of Occupational Health and Safety*, Vol. I & II, International Labour Organisation, Geneva, 1985.
3. McCornick, E.J. and Sanders, M.S., *Human Factors in Engineering and Design*, Tata McGraw-Hill, Fifth Edition 1996.

ME 661 INDUSTRIAL HYGIENE AND ERGONOMICS LABORATORY (0 – 0 – 3) 2

The objectives of this course is to imbibe knowledge on,

- Measurement of parameters relevant to health, safety and environment
- Evaluation of occupational health hazards and control strategies to control the hazards

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

- Compute noise and vibration level in work environment and apply suitable countermeasures
- Demonstrate exhaust gas measurement and analyze the implications
- Compute dust and fume level in breathing air and conduct ambient air analysis
- Demonstrate fatigue level and analyze the implications on work activity
- Compute the heat stress and UV radiation from the various environments
- Demonstrate illumination level and analyze the implications

1. NOISE LEVEL MEASUREMENT AND ANALYSIS
Measurement of noise level for various sources – Impact, continuous and intermittent. Frequency and spectrum analysis of noise: *Instrument – precision type of Noise level meter with frequency and spectrum analyzer.*

2. MEASUREMENT OF HEAT STRESS INDEX
Determination of heat stress index using WBGT instrument in indoor and outdoor environments.

3. MESUREMENT OF ULTRAVIOLET RADIATION
Determination of ultraviolet radiation during welding operation and outdoor environment

4. MEASUREMENT OF ILLUMINATION LEVEL
Determination of level of illumination in various labs in the department.

5. EXHAUST GAS MEASUREMENT AND ANALYSIS
Measurement of Exhaust gas measurement of IC engines: *Instrument – Gas analyzer*

6. BREATHING ZONE CONCENTRATION
Measurement of breathing zone concentration of dust and fumes: *Instrument – personal air sampler, Measurement of particulate matters (PM2.5, PM1, PM0.5 and PM 0.25) in the Breathing zone*

7. AMBIENT AIR MONITORING
Measurement of respirable and non-respirable dust in the ambient air: *Instrument* – High volume sampler

8. FUME FORMATION RATE(FFR)
Measurement of fume formation rate in welding operation using Total fume chamber as per ISO 15011-1

9. DETERMINATION OF GAS AND VAPOUR
Determination of gas and vapour by using air sampling instruments.

10. VIBRATION MEASUREMENT AND ANALYSIS
Measurement of whole body vibration for various acceleration: *Instrument – vibration simulator and vibration analyzer*

11. DIGITAL HUMAN MODELING SOFTWARE FOR VIRTUAL ERGONOMICS EVALUATION

12. BIOMECHANICAL ANALYSIS (COGNITIVE WORKLOAD AND FATIGUE) WITH EMG INSTRUMENT

SEMESTER – II

ME 652 – COMPUTER AIDED RISK ANALYSIS (3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- hazard evaluation and risk analysis
- instrumentation techniques and computing tools available for risk analysis.

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

i. outline hazard evaluation techniques
ii. select and apply appropriate hazard evaluation techniques at different stages of process lifetime
iii. recognize and summarize various instrumentation techniques used to characterize the unstable materials
iv. estimate and analyze consequences of hazards
v. estimate the adequacy of safeguard using latest risk determination methods
vi. evaluate the hazards using hazard evaluation softwares.

1. INTRODUCTION

Introduction, hazard, hazard monitoring, different stages of process life time – Hazard reduction approaches and inherent safety review

Selection of hazard evaluation techniques - Factors influencing the selection of hazard evaluation techniques- decision making process- hazard review for management changes- combined hazard review- hazard evaluation - Risk issues

2. HAZARD EVALUATION TECHNIQUES

Non Scenario Based

Checklist analysis, safety review, relative ranking, preliminary hazard analysis (PHA), fire explosion and toxicity index (FETI)

Scenario Based

Fault Tree Analysis & Event Tree Analysis, Logic symbols, methodology, minimal cut set ranking - various indices – what-if analysis/checklist analysis - hazard operability studies (HAZOP) -Hazard analysis (HAZAN) - Failure Mode and Effect Analysis (FMEA)

3. INSTRUMENTS FOR HAZARD CHARACTERIZATION

Applications of Advanced Equipments and Instruments, Thermo Calorimetry, Differential Scanning Calorimeter (DSC), Thermo Gravimetric Analyzer (TGA), Accelerated Rate Calorimeter (ARC), Principles of operations, Controlling parameters, Applications, advantages.

Explosive Testing, Deflagration Test, Detonation Test, Ignition Test, Minimum ignition energy Test, Sensitiveness Test, Impact Sensitiveness Test(BAM) and Friction Sensitiveness Test (BAM), Shock Sensitiveness Test, Card Gap Test.

4. 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.

5. RISK-ESTIMATION

Scenarios from scenario-based Hazard Evaluations- Severity of consequence- Frequency of Initiating Causes- Effectiveness of Safeguards- Risk Estimation using Risk Matrix or Direct Calculation, Layer of Protection Analysis (LOPA), Safety Integrity Level (SIL). Hazard evaluation software aids – Risk Phast V 6.6 (DNV), ALOHA

References

1. Loss Prevention in Process Industries-Frank P. Less Butterworth-Hein UK, Second Edition 1990 (Vol.I, II & III)
2. Methodologies for Risk and Safety Assessment in Chemical Process Industries, Commonwealth Science Council, UK
3. Hazop and Hazon, by Trevor A Klett, Institute of Chemical Engineering, Forth Edition,1999.
4. "Guidelines for Chemical Process Quantitative Risk Analysis", second edition, Centre for Chemical Process safety, AICHE, 2000
5. Guidelines for Hazard Evaluation Procedures, Third Edition, Centre for Chemical Process safety, AICHE 2008.
6. Layer of Protection Analysis, Centre for Chemical Process safety, AICHE

ME 654 – SAFETY IN CHEMICAL INDUSTRY (3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- safe design, operation, inspection and maintenance of chemical process plants and equipment
- material safety data sheet (MSDS) of chemicals
- on-site and off-site emergency preparedness in a chemical process industry.

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

i. interpret material safety data sheet (MSDS) of chemicals
ii. understand the standards and codes associated with pressure system.
iii. differentiate the different types of testing like non-destructive testing, pressure testing, leak testing.
iv. formulate procedure for operation, inspection, and emergency procedures for chemical industry.
v. prepare emergency planning and disaster planning for safety of chemical industry .

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.

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, nondestructive testing, pressure testing, leak testing and monitoring- plant monitoring, performance monitoring, condition, vibration, corrosion, acoustic emission-pipe line inspection.

PLANT MAINTENANCE, MODIFICATION AND EMERGENCY PLANNING

Management of maintenance, hazards- preparation for maintenance, isolation, purging, cleaning, confined spaces, work 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

STORAGES AND TRASPORTATION

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
Hazards during transportation – pipeline transport

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, power plant, fertilizer and distilleries.

References

1. Lees, F.P. “Loss Prevention in Process Industries” Butterworths and Company, Second Edition 1990 (Vol.I, II & III)
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 1984.
4. “Accident Prevention Manual for Industrial Operations” NSC, Chicago, Third Edition 2008.
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.

ME 656 – FIRE ENGINEERING AND EXPLOSION CONTROL (3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- principles of fire and explosion and characteristics of various materials
- design of fire prevention and suppression systems.

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

i. explain the physics and chemistry of fire.
ii. identify the class of fire and suitable extinguishing method to suppress that.
iii. outline the main principles and practices of fire and explosion prevention and protection.
iv. describe the behavior of structural materials, buildings and building contents in a fire.
v. state and comply with the relevant statutory and regulatory requirements in fire and explosion safety.

PHYSICS AND CHEMISTRY OF FIRE

Fire properties of solid, liquid and gases - fire spread - toxicity of products of combustion - combustion characteristic- flash point, fire point, ignition temperature, LFL, UFL, flame propagation. Flames- diffusion flame, pyrolysis, premixed flame. Glowing combustion, Smouldering, Deep seated fire. theory of combustion and explosion – properties of explosive, propellent.– 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, Peterborough and Bombay Victoria dock ship explosions.

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 – 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, Emergency rescue techniques in high rise buildings, chemical industries and oil and gas industries. Safety requirements for Hot work in oil and gas industry.

INDUSTRIAL FIRE PROTECTION SYSTEMS

Sprinkler-hydrants-stand pipes – special fire suppression systems like deluge and emulsifier, selection and design criteria of the above installations, reliability, maintenance, evaluation and standards – alarm and detection systems. Other suppression systems – CO2 system, foam system, dry chemical powder (DCP) system, halon system, Inergen, FM200, Novec – need for halon replacement – smoke venting. Portable extinguishers – flammable liquids – tank farms – indices of inflammability-fire fighting systems. Fire tender- Operations, Equipment and maintenance- Overview of NFPA.

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 - exists – width calculations - fire certificates – fire safety requirements for high rise buildings –snookers.

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 (CO_2) and halons-hazards in LPG, ammonia (NH_3), sulphur dioxide (SO_2), chlorine (CL_2) etc.

REFERENCES

1. Derek, James, "Fire Prevention Hand Book", Butter Worths and Company, London, Ninth Edition, 2016
2. Gupta, R.S., "Hand Book of Fire Technology" Orient Longman, Bombay, Second Edition, 1993.
3. "Accident Prevention manual for industrial operations" N.S.C., Chicago, Third Edition 2008.
4. DinkoTuhtar, "Fire and explosion protection" Third Edition, 2007.
5. "Davis Daniel et al, "Hand Book of fire technology" Two Edition 1991.
6. Fire fighters hazardous materials reference book Fire Prevention in Factories", an Nostrand Rein Hold, New York, 1991.
7. "Fire Prevention and fire fighting", Loss prevention Association, India.
8. Relevant Indian Acts and rules, Government of India.

ME 658 – INDUSTRIAL SAFETY LABORATORY (0 – 0 – 3) 2

The objectives of this course is to imbibe knowledge on,

- Measurement of parameters relevant to health, safety and environment
- Sensitivity and reactivity characteristics of hazardous chemicals
- Demonstration of safety gadgets including personal protective equipment and first aid fire fighting equipment.

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

i. Analyze the sensitivity and thermal reactivity characteristics of unstable materials
ii. Predict the consequences of fire and explosion of various scenarios through computer simulation
iii. Identification of low conductivity fuels to avoid the fire and explosion
iv. Distinguish and choose right personal protective equipment for various practices.

1. FRICTION SENSITIVITY TEST

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

2. IMPACT SENSITIVITY TEST

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

3. THERMAL REACTIVITY TEST

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

f). STUDY OF PERSONAL PROTECTIVE EQUIPMENT:
Safety helmet, belt, hand gloves, goggles, safety shoe, gum boots, ankle shoes, face shield, nose mask, ear plug, ear muff, apron and leg guard.

5. STUDY OF FIRE EXTINGUISHERS
Selection and demonstration of first-aid fire extinguishers: soda acid, foam, carbon dioxide (CO2), dry chemical powder, halon.

6. CONSEQUENCE ANALYSIS
Soft computing skills on developing effects of fire & explosion and dispersion: *Software – RISK PHAST V 6.6 (DNV) and ALOHA.*

7.TANK TESTING EXPERIMENT
Measurement of Pressure-Time and Temperature-Time relationship of gas generant compositions on ignition used in Automotive Airbag applications.

8.STATIC ELECTRICITY MEASUREMENT OF FUELS
Conductivity measurement of low conductivity hydrocarbon fuels using conductivity meter

SEMESTER III

ME 663 SUMMER INDUSTRIAL INTERNSHIP (0 – 0 – 0) 0*

The objective of this course is,

- To provide students with hands-on experience on various safety management functions in industry.
- To apply their theoretical knowledge and to provide solutions to the problems faced in the industrial activities.
- To learn the inter personal skills that are expected for the safety professionals in the industries.

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

i. To achieve confidence in decision making quality as the safety professional.
ii. To understand the role and responsibilities of safety officer
iii. To identify the practical problems faced by the industries for the students project work
iv. To recognize the need and ability to engage in life-long learning.

* A training of four weeks' duration is to be undergone by students during summer vacation after the completion of the 2nd semester. The training will be on the practical aspects of Industrial safety, health and environment at various engineering industries/ chemical process industries/ construction project sites etc. A technical report and seminar are to be presented after completion of the training for evaluation.

ME797 PROJECT WORK – PHASE I

The objective of this course is to,

- develop the ability and proficiency in carrying out a project on health, safety and environment problems and find solutions to socially relevant problems.

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

v. conduct thorough literature survey on any specific topic of industrial safety engineering
vi. identify safety issues in industrial scenario.
vii. interpret the working principles of safety engineering systems.
viii. apply the principles of safety engineering and technology to health and safety problems in industries.
ix. conduct experiment to arrive at solutions for safety, health and environmental issues.
x. analyse and evaluate the results of experiments and/or surveys to obtain solution for safety, health and environmental problems and thereby cater to the needs of the society.

SEMESTER IV

ME798 PROJECT WORK – PHASE II

The objective of this course is to,

- develop the ability and proficiency in carrying out a project on health, safety and environment problems and find solutions to socially relevant problems.

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

i. conduct thorough literature survey on any specific topic of industrial safety engineering
ii. identify safety issues in industrial scenario.
iii. interpret the working principles of safety engineering systems.
iv. apply the principles of safety engineering and technology to health and safety problems in industries.
v. conduct experiment to arrive at solutions for safety, health and environmental issues.
i. analyse and evaluate the results of experiments and/or surveys to obtain solution for safety, health and environmental problems and thereby cater to the needs of the society.

ELECTIVES

ME 659 – REGULATIONS FOR HEALTH, SAFETY AND ENVIRONMENT
(3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- regulations and statutory requirements relevant to health, safety and environment
- application of ISO 14001 and ISO 45001 standards in an organisation.

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

i. recall appropriate acts and rules applicable for industries.
ii. administer suitable acts and rules for particular areas.
iii. appraise various acts and rules and use them for development of safe and healthy working environment.
iv. identify the need of ISO 14001 and ISO 45001 standards in an organization.
v. interpret the rules in case any dispute arise.

Factories act and rules
Workmen compensation act.
Indian explosive act
Gas cylinder rules - SMPV Act
Indian petroleum act and rules.
Environmental pollution act,Air Act, Water Act, Fly ash Rules
Manufacture, Storage and Import of Hazardous Chemical rules 1989
Indian Electricity act and rules.
Overview of ISO 45001 and ISO 14001
Inflammable Substance Act, 1952
Building and other construction workers (Regulation of employment and conditions of service) Act, 1996 and The Central Rules, 1998.
Ammonium Nitrate Rules, 2012

References

1. The Factories Act 1948, Madras Book Agency, Chennai, 2000
2. The Environment Act (Protection) 1986, Commercial Law Publishers (India) Pvt.Ltd., New Delhi.
3. Water (Prevention and control of pollution) act 1974, Commercial Law publishers (India) Pvt.Ltd., New Delhi.
4. Air (Prevention and control of pollution) act 1981, Commercial Law Publishers (India) Pvt.Ltd., New Delhi.
5. Explosive Act, 1884 and Explosive rules, 1883 (India), (2002), Eastern Book company, Lucknow, 10th Edition
6. The manufacture, storage and import of hazardous chemical rules 1989, Madras Book Agency, Chennai.

ME 671 – ENVIRONMENTAL POLLUTION CONTROL (3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- principles of environmental pollution control
- control of various pollutants within the permissible limits.

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

i. classify air and water pollutants and hazardous wastes.
ii. apply scientific knowledge to propose control strategies for different pollutions and process industries.
iii. use relevant information about environmental impacts of air, water pollutants and hazardous wastes to discuss environmental pollution in a given case.
iv. recognize and select appropriate environmental pollutant sampling and measurement techniques
v. apply relevant statutory and regulatory requirements concerned with environmental pollution
vi. state the principle and requirements of ISO 14001 standard based environmental management system.

AIR POLLUTION

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

WATER POLLUTION

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

HAZARDOUS WASTE MANAGEMENT

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

ENVIRONMENTAL MEASUREMENT AND CONTROL

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

POLLUTION CONTROL IN PROCESS INDUSTRIES

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

REFERENCES

1. Rao, CS, "Environmental pollution engineering: Wiley Eastern Limited, New Delhi, Third Edition, 2018
2. S.P.Mahajan, "Pollution control in process industries", Tata McGraw Hill Publishing Company, New Delhi, 1993.
3. Varma and Braner, "Air pollution equipment", Springer Publishers, Second Edition,1996

ME 672 – SAFETY IN CONSTRUCTION (3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- safe work practices at construction sites
- prevention and control of occupational disease prevalent in construction sites.

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

i. recognise the different types of existing hazards on-site
ii. distinguish the different types of accident measurement approaches.
iii. demonstrate the importance for improving health & safety in construction
iv. apply safe work practices to improve health & safety in construction
v. implement appropriate measures to prevent occupational and work-related illnesses.
vi. conduct an accident analysis.

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

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 – tunneling – blasting, pre blast and post blast inspection – confined spaces – working on contaminated sites – work over water - road works – power plant constructions – construction of high rise buildings.

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.

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.

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.

REFERENCES

1. Hudson, R.,"Construction hazard and Safety Hand book, Butter Worth's, 1985.
2. JnatheaD.Sime, "Safety in the Build Environment", London, 1988.
3. V.J.Davies and K.Thomasin "Construction Safety Hand Book" Thomas Telford Ltd., London, 1990.
4. Handbook of OSHA Construction safety and health charles D. Reese and James V. Edison
5. Fulman, J.B., *Construction Safety, Security, and Loss Prevention,* John Wiley and Sons, 1979.

ME 674 - ELECTRICAL SAFETY (3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- protection systems and devices to protect from electrical hazards
- regulatory and statutory requirements relevant to electrical safety.

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

i. recognize the extreme importance of observing all safety requirements and practices connected with electricity.
ii. demonstrate what to do during an electrical accident
iii. identify the potential hazards and indicate measures to prevent accidents due to electricity.
iv. illustrate basic safety concepts and techniques while handling electricity
v. choose protection methods for hazardous electrical equipment.

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).

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 classificationsexcess energy-current surges-Safety in handling of war equipments-over current and short circuit current-heating effects of current-electromagnetic forces-corona effect-static electricity – definition, sources, hazardous conditions, control, electrical causes of fire and explosion-ionization, spark and arc-ignition energy-national electrical safety code ANSI.

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

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 equipments.

SELECTION, INSTALLATION, OPERATION AND MAINTENANCE

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

HAZARDOUS ZONES

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

REFERENCES

1. Fordham Cooper, W., "Electrical Safety Engineering" Butterworth and Company, London, Second Edition, 1998.
2."Accident prevention manual for industrial operations", N.S.C.,Chicago, Third Edition 2008.
3. Indian Electricity Act and Rules, Government of India.
4. Power Engineers – Handbook of TNEB, Chennai, 1989.
5. Martin Glov Electrostatic Hazards in powder handling, Research Studies Pvt. LTd., England, 1988.
6. www.osha.gov

ME 676 – DESIGN OF AIR POLLUTION CONTROL SYSTEMS (3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- design aspects of control systems for controlling air pollution
- control measures and techniques to maintain air pollution within permissible limits.

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

i. identify industrial sources of air pollution
ii. formulate emission control strategies and policies in line with statutory regulations
iii. categorize particulate and gaseous pollutants and employ suitable control methods and techniques
iv. specify air pollution control systems for a sustainable environment.

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

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

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

Integrated Air pollution control systems.

References

1. Lawrence. K. Wang, Norman. C Perelra, Yung-Tse-Hung., *Air Pollution Control Engineering*, Tokyo, Second Edition, 1996.
2. Noel de Nevers, *Air Pollution Control Engineering*. McGraw Hill, New York, Second Edition.

ME 677 – INDUSTRIAL NOISE AND VIBRATION CONTROL (3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- concepts of vibration and noise and their causation factors
- measurement and control of vibration and noise in industrial environments.

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

i. explain the basic concepts of vibration
ii. select and apply suitable instrumentation techniques to measure vibration and noise in industrial environment
iii. identify sources of vibration and employ actions to reduce or eliminate them at source
iv. describe the concepts of noise and methods of reducing the noise
v. demonstrate actions to eliminate or reduce industrial noise at source.

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 far field – frequency analysis and vibration and noise spectrum – Signature analysis and condition monitoring.

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.

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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.

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.

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.

ME 678- BIOMECHANICS AND HUMAN BODY VIBRATION (3 - 0 -0) 3

The objectives of this course is to imbibe knowledge on,

- concepts of biomechanical systems and human body vibration
- biomechanical models to enhance occupational health and safety.

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

i. explain the basic concepts of vibration
ii. interpret the working of musculoskeletal system and applications of anthropometry
iii. evaluate mechanical work capacity
iv. describe the established biomechanical models and their intervention with health and safety systems
v. illustrate the implications of whole body and segmental vibrations in work environment.

VIBRATION

Introduction, vibration exciters, control systems, Performance specification, motion sensors and transducers.

MUSCULARSKELETAL SYSTEM AND ANTHROPOMETRY IN BIOMECHANICS

Introduction, structure and function of musculoskeletal system - Connective Tissue, Skeletal Muscle, Joints

Measurement of body segment, physical properties, Anthropometric data for biomechanical studies in industry.

MECHANICAL WORK CAPACITY EVALUATION AND BIOINSTRUMENTATION

Joint motion, human motion analysis system, applied electromyography, intradiscal pressure measurement, intrabdominal measurement, force platform system, whole body vibration measurement.

BIOMECHANICAL MODELS

Planar static biomechanical models, static 3D modelling, dynamic biomechanical models, special purpose biomechanical models.

WHOLE BODY AND SEGMENTAL VIBRATION

Vibration on human body, whole body vibration, Hand-Transmitted Vibration, segmental vibration, vibration exposure criteria.

Reference:

1. Vibration and Shock Handbook, Clarence W. De Silva, Taylor and Francis Group, 2005
2. Occupational Biomechanics, Don B. Chaffin and Gunnar B.J.Andersson, John Wiley and sons,Inc, Forth Edition, May 2006.

ME 679 WORK STUDY AND ERGONOMICS(3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- principles, need and application of work study in organisations
- man-machine interface to create a safe and sustainable work environment.

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

i. employ and conduct work study in organisations
ii. apply the principles of ergonomics in industrial work environment
iii. illustrate the process of inherently safer design
iv. practice the procedures for procurement, storage, inspection and testing personal protective environment
v. relate the interaction between man and machine to improve safety levels in industrial environment.

WORK STUDY

Study of operations – work content – work procedure – breakdown – human factors – safety and method study – methods and movements at the workplace – substitution with latest devices – robotic concepts – applications in hazardous workplaces – productivity, quality and safety (PQS).

ERGONOMICS

Definition – applications of ergonomic principles in the shop floor – work benches – seating arrangements – layout of electrical panels- switch gears – principles of motion economy – location of controls – display locations – machine foundations – work platforms, fatigue, physical and mental strain – incidents of accident – physiology of workers.

PERSONAL PROTECTION

Concepts of personal protective equipment – types – selection of PPE – invisible protective barriers – procurement, storage, inspection and testing – quality – standards – ergonomic considerations in personal protective equipment design.

PROCESS AND EQUIPMENT DESIGN

Process design – equipment – instrument – selection – concept modules – various machine tools - in-built safety – machine layout-machine guarding-safety devices and methods – selection, inspection, maintenance and safe usage – statutory provisions, operator training and supervision – hazards and prevention.

MAN MACHINE SYSTEMS

Job and personal risk factors – standards-selection and training-body size and posture-body dimension (static/dynamic) – adjustment range – penalties – guide lines for safe design and postures – evaluation and methods of reducing posture strain.

Man-machine interface-controls -types of control-identification and selection-types of displays-compatibility and stereotypes of important operations-fatigue and vigilance-measurement characteristics and strategies for enhanced performance.

REFERENCES:

1. Introduction to Work Study", ILO, Oxford and IBH Publishing company, Bombay, 1991".
2. "Work Study", National Productivity Council, New Delhi, 1995.
3. E.J.McCormick and M.S.Sanders "Human Factors in Engineering and Design", TMH, New Delhi, 1982.
4. W.BenjaminNeibal Motion and Time Study, 7th Edition.
5.Mundel, Motion and Time Study, 6th Edition, Allied Publishers, Madras, 1989.
6."Accident Prevention Manual for Industrial Operations", NSC Chicago, Third Edition, 2008.
7.Hunter, Gomas, "Engineering Design for Safety", McGraw Hill Inc., 1992.

ME 680 - TRANSPORT SAFETY (3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- safe transport, handling and storage of hazardous goods
- elements road safety, features of roads and vehicles, derive safety programme

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

i. recognize the safety aspects in design of tanker lorries
ii. summarize the loading and decanting procedures of hazardous goods
iii. identify the factors for improving safety on roads
iv. analyze the causes of road accidents
v. relate road safety with the features of roads and vehicles
vi. administer a driver safety programme

TRANSPORTATION OF HAZARDOUS GOODS

Transport emergency card (TREM) – driver training-parking of tankers on the highways-speed of the vehicle – warning symbols – design of the tanker lorries -static electricity-responsibilities of driver – inspection and maintenance of vehicles-check list- loading and decanting procedures – communication.

ROAD TRANSPORT

Introduction – factors for improving safety on roads – causes of accidents due to drivers and pedestrians-design, selection, operation and maintenance of motor trucks-preventive maintenance-check lists-motor vehicles act – motor vehicle insurance and surveys.

DRIVER AND SAFETY

Driver safety programme – selection of drivers – driver training-tacho-graph-driving test-driver's responsibility-accident reporting and investigation procedures-fleet accident frequency-safe driving incentives-slogans in driver cabin-motor vehicle transport workers act-driver relaxation and rest pauses – speed and fuel conservation – emergency planning and Haz mat codes

ROAD SAFETY

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

Plant railway: Clearance-track-warning methods-loading and unloading-moving cars-safety practices.

SHOP FLOOR AND REPAIR SHOP SAFETY

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

REFERENCES:

1. Popkes, C.A. "Traffic Control and Road Accident Prevention" Chapman and Hall Limited, 1986.
2. Babkov, V.F., "Road Conditions and Traffic Safety" MIR Publications, Moscow, 1986.
3. Kadiyali, "Traffic Engineering and Transport Planning" Khanna Publishers, New Delhi, 1983.
4. Motor Vehicles Act, 1988, Government of India.
5. "Accident Prevention Manual for Industrial Operations", NSC, Chicago, 1982.
6. Pasricha, "Road Safety guide for drivers of heavy vehicle" Nasha Publications, Mumbai, 1999.
7. K.W.Ogden, "Safer Roads – A guide to Road Safety Engineering"

ME 681 - SAFETY IN TEXTILE INDUSTRY (3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- hazards, occupational diseases and control measures specific to textile industries
- health and safety measures applicable for textile process industries

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

i. recognize the hazards present in textile processing activities

ii.	interpret the accident hazards, guarding of machinery and safety precautions for textile industry
iii.	identify the occupational hazards and associated diseases involved in textile industry
iv.	choose appropriate personal protective equipment
v.	articulate and administer health and welfare measures specific to textile industry
vi.	state relevant provisions of acts and rules applicable to textile industry.

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.

TEXTILE HAZARDS

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

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

HEALTH AND WELFARE

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

SAFETY STATUS

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

REFERENCES:

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

ME 682 - SAFETY IN MINES (3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- hazards, occupational diseases and control measures specific to mines
- health and safety measures, statutory and regulatory requirements applicable for mines.

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

i.	examine the causes and identify preventive measures to avoid accidents in opencast mines

ii.	recognize the occupational hazards associated with underground mining and tunneling operations
iii.	demonstrate the appropriate usage of personal protective equipment in mining
iv.	predict the extent of risks by carrying out risk assessments
v.	compute accident occurrence, formulate accident investigation, employ measures for improving safety in mines
vi.	administer emergency preparedness and disaster management activities.

OPENCAST MINES

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

UNDERGROUND MINES

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

TUNNELLING

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

RISK ASSESSMENT

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

ACCIDENT ANALYSIS AND MANAGEMENT

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

REFERENCES

1.“Mine Health and Safety Management”, Michael Karmis ed., SME, Littleton, Co.2001.
2.Kejiriwal, B.K. Safety in Mines, GyanPrakashan, Dhanbad, 2001.
3.DGMS Circulars-Ministry of Labour, Government of India press, OR Lovely Prakashan-DHANBAD, 2002.

ME 683 - DOCK SAFETY(3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- hazards, occupational diseases and control measures specific to harbor and docks
- health and safety measures, statutory and regulatory requirements applicable for harbor and docks.

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

i. understand the legislation related to dock safety
ii. enumerate the responsibilities of different agencies for safety, health and welfare involved in dock work
iii. recognize hazards and risks involved in working on a ship and to administer safety measures
iv. demonstrate safety in the use of handling and lifting appliances, special lift trucks and cargo
v. select suitable testing, examination and inspection procedures for handling and lifting appliances, special lift trucks and cargo
vi. interpret Emergency Action Plan and Dock Workers (SHW) Regulations 1990.

HISTORY OF SAFETY LEGISLATION

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

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

WORKING ON BOARD THE SHIP

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

LIFTING APPLIANCES

Different types of lifting appliances – construction, maintenance and use, various methods of rigging of derricks, safety in the use of container handling/lifting appliances like portainers, transtainer, top lift trucks and other containers – testing and examination of lifting appliances – portainers – transtainers – toplift trucks – derricks in different rigging etc.

Use and care of synthetic and natural fiber ropes – wire rope chains, different types of slings and loose gears.

TRANSPORT EQUIPMENT

The different types of equipment for transporting containers and safety in their use-safety in the use of self loading container vehicles, container side lifter, fork lift truck, dock railways, conveyors and cranes.

Safe use of special lift trucks inside containers – Testing, examination and inspection of containers – carriage of dangerous goods in containers and maintenance and certification of containers for safe operation

Handling of different types of cargo – stacking and unstacking both on board the ship and ashore – loading and unloading of cargo identification of berths/walking for transfer operation of specific chemical from ship to shore and vice versa – restriction of loading and unloading operations.

EMERGENCY ACTION PLAN AND DOCK WORKERS (SHW)

REGULATIONS 1990

Emergency action Plans for fire and explosions - collapse of lifting appliances and buildings, sheds etc., - gas leakages and precautions concerning spillage of dangerous goods etc., - Preparation of on-site emergency plan and safety report.

Dock workers (SHW) rules and regulations 1990-related to lifting appliances, Container handling, loading & unloading, handling of hatch coverings and beams, Cargo handling, conveyors, dock railways, forklift.

REFERENCES:

1. Safety and Health in Dock work, IInd Edition, ILO, 1992.
2.”Dock Safety” Thane Belapur Industries Association, Mumbai.
3.Taylor D.A., “”Introduction to Marine Engineering”.
4.Srinivasan “Harbour, Dock and Tunnel Engineering”
5.Bindra SR “Course in Dock & Harbour Engineering”

ME 684 - SENSITIVITY MEASUREMENTS AND EVALUATION OF ENERGETIC MATERIAL (3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- explosion and sensitivity characteristics of energetic materials
- mechanism of explosion of various explosive materials.

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

i. describe the combustion and detonation mechanisms of energetic materials.
ii. outline the various mechanical and thermal sensitivity test methods for energetic materials.
iii. appraise the kinetics of thermal decomposition and methods to measure kinetic parameters
iv. describe the properties of the explosives.

INTRODUCTION-ENERGETIC MATERIAL
Energetic material-Pyrotechnics, propellant and explosives-Definitions, Distinctions, classifications, Characteristics of pyrotechnics, propellant, explosives-Combustion-Physical and chemical aspect, Deflagration, Detonation- burning to detonation, shock to detonation, propagation of the detonation shockwave, heat of reaction, heat of formation, heat of cooling, Sensitiveness

MECHANICAL SENSITIVITY ANALYSIS OF ENERGETIC MATERIAL
Explosive Testing, Deflagration Test, Detonation Test, Ignition Test, Minimum ignition energy Test, Sensitiveness Test, Impact Sensitiveness Test(BAM) and Friction Sensitiveness Test (BAM), Shock Sensitiveness Test, Card Gap Test.

THERMAL SENSITIVITY ANALYSIS OF ENERGETIC MATERIAL
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.

KINETICS OF UNSTABLE ENERGETIC MATERIALS
Kinetics of explosive reactions-activation energy, rate of reactions, kinetics of thermal decomposition, Measurement of kinetic parameters-Differential thermal analysis, thermo gravimetric analysis, Differential Scanning Calorimetry, Accelerated Rate Calorimeter (ARC)

EVALUATION OF EXPLOSIVE PROPERTIES
Theoretical evaluation of explosive properties, oxygen balance methods, mechanism of ignitions, initiation-initiation by heat, Friction, Flash, Percussion, Electrical, Coherent light.

Reference Books

1. Test Methods for Explosives Mohamed-Suceska
2. A manual for pyrotechnic design, development and qualification- Laurence J.Bement, MorryL.Schimmel
3. Guidelines for chemical reactivity evaluation and application to process design -Center for chemical process safety of the American Institute of Chemical Engineers
4. Principles of thermal analysis and calorimetry-P.J.Haines

ME 685 - SAFETY IN POWDER HANDLING (3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- sensitivity characteristics and hazards of metal powders, dust and particulate materials
- safe handling, storage and control of metal powders and particulate materials.

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

i. classify the powders based on their sensitivity
ii. outline the working of characterization techniques such as SEM, AFM.
iii. identify the various tests and apparatus used in the evaluation of dust explosion.
iv. recognize hazardous materials and their safe handling.
v. describe the procedures and control measures for particulates.

INTRODUCTION

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

METAL POWDERS AND CHARACTERIZATION

Atomization, types – milling – electro deposition – spray drying, Production of iron powder, Aluminium powder, Titanium – screening & cleaning of metals – Explosivity and pyrophoricity – toxicity

Particle size and size distribution – measurement, types and significance – particle shape analysis, methods, surface area, density, porosity, flowrate – testing.

Metal powders, applications as fuel, solid propellants, explosives, pyrotechnics.

DUST EXPLOSION

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

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.

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 – House keeping – 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.

REFERENCES:

1. Martin Glor, “Electro Static Hazard in Powder Handling” Research studies Press Ltd., England, 1988.
2. Major hazard control-ILO Geneva, 1987.
3. Seminar on “Hazard recognition and prevention in the work place-airborne dust” Vol.I and 2, SRMC, Chennai, 4/5, Sept.2000.
4. ASM Metals hand book, Ninth edition, Vol.7, Powder Metallurgy.

ME 686 - NUCLEAR ENGINEERING AND SAFETY(3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- elements of nuclear engineering and safe design and operation of nuclear equipment
- control measures to mitigate the release of radiation and safe disposal of radioactive materials.

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

i. describe the elements of nuclear engineering
ii. illustrate control requirements in design of nuclear equipment
iii. identify the various types of nuclear reactors
iv. demonstrate the safe design and operations of nuclear reactors
v. apply control measures for radioactivity release and radiation release
vi. practice appropriate waste management and disposal methods to sustain the environment.

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.

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.

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.

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 & Chernobyl accident.

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.

REFERENCES:

1. M.M.E.L.Wakil, “Nuclear Power Engineering”, International Text Book Co.

2. StermanU.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.

ME 687 - DISASTER MANAGEMENT(3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- principles and elements of disaster management and emergency preparedness
- control measures to mitigate the effects of industrial disasters.

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

i. describe the elements of disaster management practices
ii. develop on-site and off-site emergency plans for hazardous industries and coordinate the implementation of the same
iii. conduct environmental impact assessment for sustainable development
iv. demonstrate countermeasures for natural and man-made disasters.

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

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

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

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

Environmental education-Population and community ecology-Natural resources conservation-Environmental protection and law-Research methodology and systems analysis-Natural resources conservation-Policy initiatives and future prospects-Risk assessment process, assessment for different disaster types-Assessment data use, destructive capacity-risk adjustment-choice-loss acceptance-disaster aid- public liability insurance-stock taking and vulnerability analysis-disaster profile of the country-national policies-objectives and standards-physical event modification-preparedness, forecasting and warning, land use planning

REFERENCES:

1. Introduction to Environmental Engineering and Science, Gilbert, M. Masters
2. Environmental Science, Miller, G. Tylor
3. Environmental Science sustaining the earth, G. Tylor, Miller
4. Principles of Environmental Science and Engineering, Bagad Vilas.
5. Principles of Environmental Science and Engineering, R. Sivakumar

ME 691 – ISO 45001 AND ISO 14001

The objectives of this course is to imbibe knowledge on,

- structure and application of ISO 14001 and ISO 45001 standards
- sustaining the effects of the application of ISO 14001 and ISO 45001 standards.

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

i. explain the need and importance of ISO 45001 standard and ISO 14001 standard
ii. conduct environmental impact assessment and hazard analysis and risk assessment in industries
iii. articulate and administer the implementation of ISO 45001 and ISO 14001 standard in organisations.

ISO 45001 STANDARD

Introduction – Development of ISO 45001 standard – Structure and features of ISO 45001 – Benefits of certification-certification procedure – OH and S management system element, specification and scope - correspondence between ISO 45001, ISO14001 and ISO 9001 – comparison between ISO 45001 and OHSAS 18001.

ISO 45001 POLICY, PLANNING, SUPPORT AND OPERATION

Developing OH and S policy– Guidelines – Leadership and commitment – Developments - procedure - Content of OH and S policy – General principle, strategy and planning, specific goals, compliance –methodology.

Planning – Guidelines, methodology steps developing action plan – Analysis and identifythe priorities, objective and Targets, short term action plan, benefits and cost of eachoption, Development of action plan.

Support – Guidelines, resources, competence, awareness, communication and documented information

Operation – Operational planning and control, emergency planning and control- Guidelines, methodology steps developing action plan

IMPLEMENTATION AND OPERATION, CHECKING AND REVIEW

Guidelines for structure and Responsibilities, Top Management, middle level management, co-ordinator and employees - Developing procedures, identifying trainingneeds, providing training, documentation of training, Training methodology consultationand communications.

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

ISO 14001

EMS, ISO 14001, specifications, objectives, Environmental Policy, Guidelines andPrinciples (ISO 14004), clauses 4.1 to 4.5. Documentation requirements, 3 levels ofdocumentation for a ISO 14001 based EMS, steps in ISO 14001.

Implementation plan, Registration, Importance of ISO 14000 to the Management.Auditing ISO14001-General principles of Environmental Audit, Auditor, steps in audit,Audit plan.

ENVIRONMENT IMPACT ASSESSMENT

ISO 14040(LCA), General principles of LCA, Stages of LCA, Report and Review. ISO14020 (Eco labeling) – History, 14021, 14024, Type I labels, Type II labels, ISO 14024,principles, rules for eco labeling before company attempts for it. Advantages. EIA inEMS, Types of EIA, EIA methodology EIS, Scope, Benefits.

Audit-methodology, Auditors Audit results management review-Continual improvement.

REFERENCE

1. ISO 9000 to OHSAS 18001, Dr. K.C. Arora, S.K. Kataria and Sons, Delhi.

2. The management systems, Quality, Environment, Health & Safety ISO9001: 2000, ISO-14001, ISO 45001.

ME 689 – SAFETY IN ON AND OFF SHORE DRILLING (3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- hazards and risks prevailing in petrochemical industries and emergency preparedness of petrochemical industries
- measure to improve health and safety in petrochemical industries statutory and regulatory requirements of petrochemical industries.

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

i. describe the health and safety issues involved in the processing of petroleum products
ii. interpret the hazards associated with drilling of oil and petroleum extraction and employ control measures to ensure safe working environment
iii. practice standard operating procedures for safe handling and storage of petroleum products.

Petroleum and Petroleum products – Fuels- Petroleum solvents – Lubricating oils – Petroleum wax, greases – Miscellaneous product
On and off shore oil operation – Construction of Installation – Pipe line Construction – Maintenance and repair activities – Safety and associated hazards

Drilling oil – Technique and equipment- Work position –Working condition – safety and associated hazards- lighting and its effects
Petroleum Extraction and transport by sea – Oil field products – Operation – Transport of crude by sea – Crude oil hazards.
Petroleum product storage and transport –Storage equipment –Precaution –Tank cleaning

References

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

ME 690 - HUMAN FACTORS AND ERGONOMICS (3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- elements of man-machine interaction to enhance work place safety
- human behavior and perception to create and promote a safe working culture.

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

i. identify musculoskeletal disorders in the work environment and behavioural aspects of work place posture
ii. apply anthropometry in designing work stations
iii. analyse the ergonomical aspects of repetitive works and thereby prevent work related musculoskeletal disorders
iv. Relate human sensory, cognitive, physical capabilities and limitations and suitably design work place displays and controls.

INTRODUCTION

Introduction to Human Factors and ergonomics, ergonomics and its areas of application in the work system, a brief history of ergonomics, scientific management and work study, human relations and occupational psychology, Fitting task to the man, attempts to humanize work, modern ergonomics.

HUMAN BODY AS A MECHANICAL SYSTEM

Posture stability, Body Mechanics, anatomy of the spine and pelvis related to posture, lumbo-pelvic mechanism, low back pain and muscular fatigue, psychosocial factors and physical stressors, tolerance for collisions and shocks, spinal compression, measurement of musculoskeletal pain in the workplace, system integration, role of occupational factors.

ANTHROPOMETRY AND WORKSTATION DESIGN

Anthropometry and its uses in ergonomics, sources of human variability, factors influencing the change in body size of populations, anthropometric surveys, design to fit a target population, cost-benefit analysis and trade-offs, digital human models, workstation design and reach, design adjustable products, space planning for offices, industrial workplace layout.

Anatomy of human posture, Fundamental aspects of standing and sitting, effective workstation design, visual, postural and temporal requirements, holding times for static postures, footrests and foot rails, ergonomics of seated work, dynamic postures, visual display terminals, guidance for office workstation design, work surface design, static work-risk assessment, rapid entire body assessment of working posture using composite risk zone ratings

REPETITIVE RISK ASSESSMENT AND DESIGN OF MANUAL HANDLING

Risk factors associated with pain and injury, models of the development of work related musculoskeletal disorders (WMSDs), hand tools and handle design, limits for hand/wrist exertions in repetitive work, key board design, cell phones and E-games, cursor control devices, strain index, prevention of WMSDs.

Biomechanics of human walking (Gait), postural control in dynamic tasks, anatomy and biomechanics of manual handling, back injuries, foot-floor interface, slips, trips and falls, design of manual handling and carrying tasks, NIOSH lifting equation.

DISPLAY, CONTROLS AND VIRTUAL ENVIRONMENTS

Visual design, measurement of light, avoidance of glare, key principles for display design, head mounted displays, auditory displays, Designing Displays and Controls, Key Principles for Display Design, Guiding Visual Search in Complex Displays, Auditory Displays, Design of Controls, Voice Control, System Integration

Cognitive Fatigue and Human Performance, Factors Affecting Mental Workload, Behavioral Design: Nudging and Friction, Attention Restoration Theory.

References

1. R.S. Bridger, Introduction to Ergonomics, 2nd Edition, Taylor &Francis, 2003
2. Sanders, M.S. and McCormick E.J. Human Factors in Engineering and Design (7th Ed.). McGraw-Hill, Inc, 1997.
3. Kroemer, K.H.E., Kroemer, H.B., and Kroemer-Elbert, K.E. Ergonomics: How to Design for Ease and Efficiency (2nd Ed.). Upper Saddle River, New Jersey: Prentice Hall, 2001.
4. Wickens, C.D., Lee, J.D., Liu, Y., Gordon Becker, S.E. An Introduction to Human Factors in Engineering (2nd Ed.). Upper Saddle River, New Jersey: Pearson Prentice-Hall, 2004.
5. Dul, J. and Weerdmeester,B. Ergonomics for beginners, a quick reference guide, Taylor & Francis, 1993.

OPEN ELECTIVES

ME 657 – SAFETY IN ENGINEERING INDUSTRY (3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- workplace hazards in an manufacturing engineering industry
- appropriate control of hazards and usage of proper personal protective equipment.

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

i. identify and interpret the hazards present in metal working machinery, wood working machinery, welding, gas cutting, hot and cold metal working operations.
ii. demonstrate safe practices in heat treatment operations.
iii. evolve safe operating procedures in hazardous inspection processes.
iv. select and use suitable personal protective equipment.
v. design appropriate guards for machines to protect humans from mechanical hazards.

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.

PRINCIPLES OF MACHINE GUARDING

Design aspects 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-shearingpresses- forge hammer-flywheels-shafts-couplings-gears-sprockets wheels and chains-pulleys and belts-authorized entry to hazardous installations-benefits of good guarding systems.

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.

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.

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.

References

1. "Accident Prevention Manual" – NSC, Chicago, Third Edition 2008.
2. "Occupational safety Manual" BHEL, Trichy, 1988.
3. "Safety Management by John V. Grimaldi and Rollin H. Simonds, All India Travelers Book seller, New Delhi, 1989.
4. "Safety in Industry" N.V. Krishnan JaicoPublishery House, 1996.
5. Indian Boiler acts and Regulations, Government of India.
6. Safety in the use of wood working machines, HMSO, UK 1992.
7. Health and Safety in welding and Allied processes, welding Institute, UK, High Tech. Publishing Ltd., London, 1989.

ME 675 – MATERIAL HANDLING AND PPE (3 – 0 – 0) 3

The objectives of this course is to imbibe knowledge on,

- hazards involved in manual and mechanical material handling
- selection, testing, usage, inspection and maintenance of material handling equipment and PPE's.

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

i. recognize the practical solutions to eliminate and/or minimize hazards in material handling
ii. administer a crane and sling safety to operation.
iii. disseminate the basic safety concepts and techniques in mechanical material handling.
iv. recognise the safe use, inspection and maintenance of PPE's.

MANUAL MATERIAL HANDLING

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.

LIFTING TACKLES

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**.**

HOISTING EQUIPMENT AND CONVEYORS

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.

INDUSTRIAL TRUCKS AND ELEVATORS

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.

PERSONAL PROTECTIVE EQUIPMENT

RESPIRATORY TYPE

Respirator, Breathing Apparatus, Particle Filters – Nanomaterials, specifications, standards selection, inspection, testing and maintenance

NON-RESPIRATORY TYPE

Face-pieces, Half and Full Facemasks, Hoods, Helmets, Visors, Blouses, Suits - , specifications, standards selection, inspection, testing and maintenance

References

1. *Accident Prevention Manual for Industrial Operations*, NSC, Chicago, Third Edition , 2008.
2. Alexandrov, M.P., *Material Handling Equipment*, Mir Publishers, Moscow, 1981.
3. Rudenko N., *Material Handling Equipments*, Mir Publishers, Moscow, 1981.
4. Spivakosky, "Conveyors and related Equipment", Vol.I& II Peace Pub. Moscow, 1982.
5. Reymond, A.Kulwice, "Material Handling Hand Book - II", John Wiley and Sons, New York, 1985.