

# **M. Tech. DEGREE INDUSTRIAL SAFETY ENGINEERING**

## **SYLLABUS FOR CREDIT BASED CURRICULUM (2011 -2012)**



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

**JUNE-2011**

**M.Tech. - INDUSTRIAL SAFETY ENGINEERING**

The total credits required for completing the M.Tech. Programme is 63

**SEMESTER I**

<b>Code</b>	<b>Course of Study</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
MA 611	Probability and Statistics	3	1	0	4
ME 653	Safety Management	3	0	0	3
ME 655	Occupational Health and Hygiene	3	0	3	4
ME 657	Safety in Engineering Industry	3	0	0	3
ME 659	Regulation for Health, Safety and Environment	3	0	0	3
	Elective I	3		0	3
		<b>18</b>	<b>1</b>	<b>3</b>	<b>20</b>

**SEMESTER II**

<b>Code</b>	<b>Course of Study</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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
ME 658	Industrial Safety Lab	0	0	3	1
	Elective II	3	0	0	3
	Elective III	3	0	0	3
	Elective IV	3	0	0	3
		<b>18</b>	<b>0</b>	<b>3</b>	<b>19</b>

**SEMESTER III**

<b>Code</b>	<b>Course of Study</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
ME 797	Project work - Phase I	0	0	0	12

**SEMESTER IV**

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

**Total Credits 63**

**LIST OF ELECTIVES**

<b>Code</b>	<b>Course of Study</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
ME 671	Environmental Pollution Control	3	0	0	3
ME 672	Safety in Construction	3	0	0	3
ME 673	Human Factors Engineering	3	0	0	3
ME 674	Electrical Safety	3	0	0	3
ME 675	Safety in Material Handling	3	0	0	3
ME 676	Design of Air pollution control system	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 688	OHSAS 18000 and ISO 14000	3	0	0	3
ME 689	Safety in On and Off Shore Drilling	3	0	0	3

## **MA 611 - PROBABILITY AND STATISTICS (3 – 1 – 0) 4**

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.

### **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**

### **CONCEPTS**

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

### **TECHNIQUES**

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

## **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.

## **SAFETY EDUCATION AND TRAINING**

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

### ***References***

1. Accident Prevention Manual for Industrial Operations”, N.S.C.Chicago, 1982
2. Heinrich H.W. “Industrial Accident Prevention” McGraw-Hill Company, New York, 1980.
3. Krishnan N.V. “Safety Management in Industry” Jaico Publishing House, Bombay, 1997.
4. John Ridley, “Safety at Work”, Butterworth & Co., London, 1983.
5. Roland P. Blake , “Industrial Safety” Prentice Hall, Inc., New Jersey, 1973
6. “Industrial safety management”, L M Deshmukh, TATA McGraw Hill, 2010

## **ME 655 – OCCUPATIONAL HEALTH AND HYGIENE (3 – 0 – 3) 4**

### **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 AND ERGONOMICAL HAZARDS**

Classification of Bio hazardous agents –bacterial agents, rickettsial and chlamydial agents, viral agents, fungal, parasitic agents, infectious diseases - Biohazard control program, employee health program-laboratory safety program-animal care and handling-biological safety cabinets - building design.

Work Related Musculoskeletal Disorders –carpal tunnel syndrome CTS- Tendon pain disorders of the neck- back injuries.

## **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, 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, 1982.

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

### **SAFETY IN METAL WORKING MACHINERY AND WOOD WORKING MACHINES**

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

### **PRINCIPLES OF MACHINE GUARDING**

Guarding during maintenance, Zero Mechanical State (ZMS), Definition, Policy for ZMS – guarding of hazards - point of operation protective devices, machine guarding, types, fixed guard, interlock guard, automatic guard, trip guard, electron eye, positional control guard, fixed guard fencing- guard construction- guard opening.

Selection and suitability: lathe-drilling-boring-milling-grinding-shaping-sawing-shearing-presses- forge hammer-flywheels-shafts-couplings-gears-sprockets wheels and chains-pulleys and belts-authorized entry to hazardous installations-benefits of good guarding systems.

### **SAFETY IN WELDING AND GAS CUTTING**

Gas welding and oxygen cutting, resistance 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, 1982.
2. “Occupational safety Manual” BHEL, Trichy, 1988.
3. “Safety Management by John V. Grimaldi and Rollin H. Simonds, All India Travelers Book seller, New Delhi, 1989.
4. “Safety in Industry” N.V. Krishnan 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 659 – REGULATIONS FOR HEALTH, SAFETY AND ENVIRONMENT  
(3 – 0 – 0) 3**

Factories act and rules - Workmen compensation act.  
Indian explosive act - Gas cylinder rules - SMPV Act - Indian petroleum act and rules.  
Environmental pollution act  
Manufacture, Storage and Import of Hazardous Chemical rules 1989  
Indian Electricity act and rules.  
Overview of OHSAS 18000 and ISO 14000

**References**

1. The Factories Act 1948, Madras Book Agency, Chennai, 2000  
*M.Tech. (Industrial Safety Engineering)*  
*Department of Mechanical Engineering, National Institute of Technology, Tiruchirappalli – 620 015.*
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, 10<sup>th</sup> Edition
6. The manufacture, storage and import of hazardous chemical rules 1989, Madras Book Agency, Chennai.
7. ISO 9000 to OHSAS 18001, Dr. K.C. Arora, S.K. Kataria & Sons, Delhi

**SEMESTER – II**

**ME 652 – COMPUTER AIDED RISK ANALYSIS (3 – 1 – 0) 4**

**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

**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)



## **RISK-BASED DETERMINATION OF THE ADEQUACY OF SAFEGUARD**

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), HazardReview *LEADER*, HAZOP manager, HAZOP+ (Reliability workbench), PHA manager, LOPA manager, PHA-Pro, FEME-Pro, ALOHA

## **INSTRUMENTATION**

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

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

## **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.

## **References**

1. Loss Prevention in Process Industries-Frank P. Less Butterworth-Hein UK 1990 (Vol.I, II & III)
2. Methodologies for Risk and Safety Assessment in Chemical Process Industries, Commonwealth Science Council, UK
3. Hazop and Hazon, by Trevor A Klett, Institute of Chemical Engineering.
4. “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 INDUSTRIES (3 – 0 – 0) 3**

### **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, non destructive 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, 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 TRANSPORTATION**

General consideration, petroleum product storages, storage tanks and vessel- storages layout segregation, separating distance, secondary containment- venting and relief, atmospheric vent, pressure, vacuum valves, flame arrestors, fire relief- fire prevention and protection- LPG storages, pressure storages, layout, instrumentation, 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, fertilizer and distilleries.

### ***Text Book***

1. Lees, F.P. “Loss Prevention in Process Industries” Butterworths and Company, 1996.

## **References**

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

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

### **PHYSICS AND CHEMISTRY OF FIRE**

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

### **INDUSTRIAL FIRE PROTECTION SYSTEMS**

Sprinkler-hydrants-stand pipes – special fire suppression systems like deluge and emulsifier, selection criteria of the above installations, reliability, maintenance, evaluation and standards – alarm and detection systems. Other suppression systems – CO<sub>2</sub> system, foam system, dry chemical powder (DCP) system, halon system – need for halon replacement – smoke venting. Portable extinguishers – flammable liquids – tank farms – indices of inflammability-fire fighting systems.

### **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 gasrupture disc in process vessels and lines explosion, suppression system based on carbon dioxide (CO<sub>2</sub>) and halons-hazards in LPG, ammonia (NH<sub>3</sub>), sulphur dioxide (SO<sub>2</sub>), chlorine (CL<sub>2</sub>) etc.

### **TEXT BOOK**

1. Derek, James, “Fire Prevention Hand Book”, Butter Worths and Company, London, 1986.

## REFERENCES

1. Gupta, R.S., “Hand Book of Fire Technology” Orient Longman, Bombay 1977.
2. “Accident Prevention manual for industrial operations” N.S.C., Chicago, 1982.
3. Dinko Tuhtar, “Fire and explosion protection”
4. “Davis Daniel et al, “Hand Book of fire technology”
5. Fire fighters hazardous materials reference book Fire Prevention in Factories”, an Nostrand Rein Hold, New York, 1991.
6. “Fire Prevention and fire fighting”, Loss prevention Association, India.
7. Relevant Indian Acts and rules, Government of India.

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

### 1. NOISE LEVEL MEASUREMENT AND ANALYSIS

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

### 2. VIBRATION MEASUREMENT AND ANALYSIS

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

### 3. FRICTION SENSITIVITY TEST

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

### 4. IMPACT SENSITIVITY TEST

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

### 5. THERMAL REACTIVITY TEST

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

### 6. EXHAUST GAS MEASUREMENT AND ANALYSIS

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

### 7. BREATHING ZONE CONCENTRATION

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

### 8. AMBIENT AIR MONITORING

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

### 9. CONSEQUENCE ANALYSIS

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

### 10. STUDY OF PERSONAL PROTECTIVE EQUIPMENT:

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

## **11. STUDY OF FIRE EXTINGUISHERS**

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

## **ELECTIVES**

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

#### **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- Chloro Fluoro Carbon(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 – dyeing and pigment industries - eco-friendly energy.

#### **REFERENCES**

1. Rao, CS, “Environmental pollution engineering:”, Wiley Eastern Limited, NewDelhi, 1992.
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.

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

### **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. Jnathea D.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 673 - HUMAN FACTORS ENGINEERING (3 – 0 – 0) 3**

### **ERGONOMICS AND ANATOMY**

Introduction to ergonomics: The focus of ergonomics, ergonomics and its areas of application in the work system, a brief history of ergonomics, attempts to humanize work, modern ergonomics, future directions for ergonomics

Anatomy, Posture and Body Mechanics: Some basic body mechanics, anatomy of the spine and pelvis related to posture, posture stability and posture adaptation, low back pain, risk factors for musculoskeletal disorders in the workplace, behavioural aspects of posture, effectiveness and cost effectiveness, research directions

### **HUMAN BEHAVIOR**

Individual differences, Factors contributing to personality, Fitting the man to the job, Influence of difference on safety, Method of measuring characteristics, Accident Proneness.

Motivation, Complexity of Motivation, Job satisfaction. Management theories of motivation, Job enrichment theory.

Frustration and Conflicts, Reaction to frustration, Emotion and Frustration.

Attitudes-Determination of attitudes, Changing attitudes

Learning, Principles of Learning, Forgetting, Motivational requirements.

### **ANTHROPOMETRY AND WORK DESIGN FOR STANDING AND SEATED WORKS**

Designing for a population of users, percentile, sources of human variability, anthropometry and its uses in ergonomics, principals of applied anthropometry in ergonomics, application of anthropometry in design, design for everyone, anthropometry and personal space, effectiveness and cost effectiveness

Fundamental aspects of standing and sitting, an ergonomics approach to work station design, design for standing workers, design for seated workers, work surface design, visual display units, guidelines for design of static work, effectiveness and cost effectiveness, research directions

### **MAN - MACHINE SYSTEMS AND REPETITIVE WORKS AND MANUAL HANDLING TASK**

Applications of human factors engineering, man as a sensor, man as information processor, man as controller – Man vs Machine.

Ergonomics interventions in Repetitive works, handle design, key board design- measures for preventing in work related musculoskeletal disorders (WMSDs), reduction and controlling, training

Anatomy and biomechanics of manual handling, prevention of manual handling injuries in the work place, design of manual handling tasks, carrying, postural stability

### **HUMAN SKILL & PERFORMANCE AND DISPLAY, CONTROLS AND VIRTUAL ENVIRONMENTS**

A general information-processing model of the users, cognitive system, problem solving, effectiveness.

Principles for the design of visual displays- auditory displays- design of controls- combining displays and controls- virtual (synthetic) environments, research issues.

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

### **References**

1. McCornick, E.J., *Human Factors in Engineering and Design*, Tata McGraw-Hill, 1982.
2. *Accident Prevention Manual for Industrial Operations*, NSC, Chicago, 1982.
3. *Introduction to Ergonomics*, R.S. Bridger, Taylor & Francis
4. *Ergonomic design for organizational effectiveness*, Michael O'Neill
5. *Human factors in engineering & design*, MARK S.SANDERS
6. *The Ergonomics manual*, Dan McLeod, Philip Jacobs & Nancy Larson
7. *Fitting the task to the human*, Fifth edition, K.H.E. Kroemer and E. Grandjean

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

### **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.

### **TEXT BOOK**

1. Fordham Cooper, W., “Electrical Safety Engineering” Butterworth and Company, London, 1986.

### **REFERENCES**

- 1.”Accident prevention manual for industrial operations”, N.S.C.,Chicago, 1982.
2. Indian Electricity Act and Rules, Government of India.
3. Power Engineers – Handbook of TNEB, Chennai, 1989.
4. Martin Glov Electrostatic Hazards in powder handling, Research Studies Pvt.LTd., England, 1988.
5. www.osha.gov

### **ME 675 – SAFETY IN MATERIAL HANDLING (3 – 0 – 0) 3**

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

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

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

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

Storage and Retrieval of common goods of various shapes and sizes in a general store of a big industry.

### **References**

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

## **ME 676 – DESIGN OF AIR POLLUTION CONTROL SYSTEM (3 – 0 – 0) 3**

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 SO<sub>2</sub> – Absorption in fixed blades- Breakthrough. Removal of HCs / VOCs – NO<sub>x</sub> removal – Wet scrubbers.

Integrated Air pollution control systems.

### **References**

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

## **ME 677 – INDUSTRIAL NOISE AN VIBRATION CONTROL (3 – 0 – 0) 3**

### **INTRODUCTION**

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

### **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.

### **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.

#### ***Text Book***

1. Irwin, J.D and Graf, E. R, Noise and Vibration Control, Prentice Hall Inc. New Jersey, 1979.

#### ***References***

1. Irwing B Crandall, Theory of Vibrating Systems and Sound, D. Vannostrand Company, New Jersey, 1974.
2. Cyril M. Harris, Hand Book of Noise Control, McGraw Hill Book Company, New York, 1971.
3. 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**

### **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

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

#### **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.

#### **TEXT BOOKS:**

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.

#### **REFERENCES:**

1. W.BenjaminNeibal Motion and Time Study, 7<sup>th</sup> Edition.
2. Mundel, Motion and Time Study, 6<sup>th</sup> Edition, Allied Publishers, Madras, 1989.
3. “Accident Prevention Manual for Industrial Operations”, NSC Chicago, 1982.
4. Hunter, Gomas, “Engineering Design for Safety”, McGraw Hill Inc., 1992.

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

### **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.

### **TEXT BOOKS**

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.

### **REFERENCES**

1. Kadiyali, "Traffic Engineering and Transport Planning" Khanna Publishers, New Delhi, 1983.
2. Motor Vehicles Act, 1988, Government of India.

3. “Accident Prevention Manual for Industrial Operations”, NSC, Chicago, 1982.
4. Pasricha, “Road Safety guide for drivers of heavy vehicle” Nasha Publications, Mumbai, 1999.
5. K.W.Ogden, “Safer Roads – A guide to Road Safety Engineering”

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

#### **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 noise generated-control measures-relevant occupational diseases, personal protective equipment-health and welfare measures specific to textile industry, Special precautions for specific hazardous work environments.

#### **SAFETY STATUS**

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

#### **TEXT BOOK:**

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

#### **REFERENCES:**

1. 100 Textile fires – analysis, findings and recommendations LPA
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**

#### **OPENCAS T 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.

## **TEXT BOOK**

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

## **REFERENCES**

1. Kejiriwal, B.K. Safety in Mines, GyanPrakashan, Dhanbad, 2001.
2. DGMS Circulars-Ministry of Labour, Government of India press, OR Lovely Prakashan-DHANBAD, 2002.

## **ME 683 - DOCK SAFETY(3 – 0 – 0) 3**

### **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 forklift trucks-pallet 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.

### **TEXT BOOKS:**

1. Safety and Health in Dock work, IInd Edition, ILO, 1992.
2. "Dock Safety" Thane Belapur Industries Association, Mumbai.



## **REFERENCES:**

1. Taylor D.A., “Introduction to Marine Engineering”.
2. Srinivasan “Harbour, Dock and Tunnel Engineering”
3. Bindra SR “Course in Dock & Harbour Engineering”

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

### **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, Morry L.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**

### **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- 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**

### **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.

### **TEXT BOOKS:**

1. M.M.E.L.Wakil, “Nuclear Power Engineering”, International Text Book Co.
2. Stermann U.S. ”Thermal and Nuclear Power Stations”, MIR Publications, Moscow, 1986.

### **REFERENCES:**

1. “Loss prevention in the process Industries” Frank P.Lees Butterworth-Hein-UK, 1990.
2. M.M.E.L.Wakil, “Nuclear Energy Conversion”, International Text Book Co.
3. R.L.Murray, “Introduction to Nuclear Engineering”, Prentice Hall.
4. Sri Ram K, “Basic Nuclear Engineering” Wiley Eastern Ltd., New Delhi, 1990.
5. Loffness, R.L., “Nuclear Power Plant” Van Nostrand Publications, 1979.

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

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 688 - OHSAS 18000 AND ISO 14000**

#### **OHSAS STANDARD**

Introduction – Development of OHSAS standard – Structure and features of OSHAS 18001 – Benefits of certification-certification procedure – OH and S management system element, specification and scope - correspondence between OHSAS 18001, ISO 14001:1996 and ISO 9001:1994 – Guidelines (18002:2000) for implementing OHSAS 18001.

## **OHSAS 18001 POLICY AND PLANNING**

Developing OH and S policy– Guidelines – 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 identify the priorities, objective and Targets, short term action plan, benefits and cost of each option, Development of 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 training needs, providing training, documentation of training, Training methodology consultation and 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 and Principles (ISO 14004), clauses 4.1 to 4.5. Documentation requirements, 3 levels of documentation for a ISO 14000 based EMS, steps in ISO 14001.

Implementation plan, Registration, Importance of ISO 14000 to the Management. Auditing ISO14000-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. ISO 14020 (Eco labeling) – History, 14021, 14024, Type I labels, Type II labels, ISO 14024, principles, rules for eco labeling before company attempts for it. Advantages. EIA in EMS, Types of EIA, EIA methodology EIS, Scope, Benefits.

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

## **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, OHSAS 18001

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

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.