# ANNA UNIVERSITY OF TECHNOLOGY MADURAI
# MADURAI - 625 002
# REGULATION 2010
# CURRICULUM AND SYLLABI
# M.E. INDUSTRIAL SAFETY ENGINEERING

## SEMESTER – I

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## SEMESTER – II

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Total Credits to be Earned for the Award of the Degree = 72
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SEMESTER – I

10277PS101 PROBABILITY AND STATISTICS

L T P C
3 1 0 4

1. PROBABILITY AND RANDOM VARIABLE


2. ESTIMATION THEORY


3. TESTING OF HYPOTHESIS

Sampling distributions – Test based on Normal, t-distribution, chi-square, and F-distributions – Analysis of variance – One-way and two way classifications.

4. DESIGN OF EXPERIMENTS

Completely Randomized Design – Randomized Block Design – Latin Square Design – 2 Factorial Design.

5. TIME SERIES

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

Total : 45

REFERENCES:

1. CONCEPTS AND TECHNIQUES


2. SAFETY AUDIT - INTRODUCTION

Components of safety audit, types of audit, audit methodology, non conformity reporting (NCR), audit checklist and report – review of inspection, remarks by government agencies, consultants, experts – perusal of accident and safety records, formats – implementation of audit indication - liaison with departments to ensure co-ordination – check list – identification of unsafe acts of workers and unsafe conditions in the shop floor.

3. ACCIDENT INVESTIGATION AND REPORTING


4. SAFETY PERFORMANCE MONITORING

ANSI (Z16.1) Recommended practices for compiling and measuring work injury experience – 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.

5. SAFETY EDUCATION AND TRAINING


Total: 45
TEXT BOOKS:

REFERENCES:
2. Relevant India Acts and Rules, Government of India.
1. **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-CFC.

2. **WATER POLLUTION**


3. **HAZARDOUS WASTE MANAGEMENT**


4. **ENVIRONMENTAL MEASUREMENT AND CONTROL**


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

5. **POLLUTION CONTROL IN PROCESS INDUSTRIES**


**REFERENCES:**

1. 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

2. 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

3. BIOLOGICAL AND ERGONOMICAL HAZARDS

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

Work Related Musculoskeletal Disorders –carpal tunnel syndrome CTS- Tendon pain-disorders of the neck- back injuries.
4. 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

5. OCCUPATIONAL PHYSIOLOGY


Total: 45

TEXT BOOK:


REFERENCE:

1. **FACTORIES ACT – 1948**

Statutory authorities – inspecting staff, health, safety, provisions relating to hazardous processes, welfare, working hours, employment of young persons – special provisions – penalties and procedures-Tamilnadu Factories Rules 1950 under Safety and health chapters of Factories Act 1948

2. **ENVIRONMENT ACT – 1986**

General powers of the central government, prevention, control and abatement of environmental pollution-Biomedical waste (Management and handling Rules, 1989-The noise pollution (Regulation and control) Rules, 2000-The Batteries (Management and Handling Rules) 2001- No Objection certificate from statutory authorities like pollution control board.


3. **MANUFACTURE, STORAGE AND IMPORT OF HAZARDOUS CHEMICAL RULES 1989**


4. **OTHER ACTS AND RULES**


5. **INTERNATIONAL ACTS AND STANDARDS**


**Total**: 60
REFERENCES:

1. PHYSICS AND CHEMISTRY OF FIRE


2. FIRE PREVENTION AND PROTECTION


3. INDUSTRIAL FIRE PROTECTION SYSTEMS


4. 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.

5. EXPLOSION PROTECTING SYSTEMS

Principles of explosion-detonation and blast waves-explosion parameters – Explosion Protection, Containment, Flame Arrestors, isolation, suppression, venting, explosion relief of large enclosure-explosion venting-inert gases, plant for generation of inert gas-rupture disc in process vessels and lines explosion, suppression system based on carbon dioxide (CO₂) and halons-hazards in LPG, ammonia (NH₃), sulphur dioxide (SO₃), chlorine (CL₂) etc.

Total : 45
TEXT BOOK:


REFERENCES:

3. Dinko Tuhtar, “Fire and explosion protection”
1. HAZARD, RISK ISSUES AND HAZARD ASSESSMENT

Introduction, hazard, hazard monitoring-risk issue, group or societal risk, individual risk, voluntary and involuntary risk, social benefits Vs technological risk, approaches for establishing risk acceptance levels, Risk estimation.

Hazard assessment, procedure, methodology; safety audit, checklist analysis, what-if analysis, safety review, preliminary hazard analysis(PHA), human error analysis, hazard operability studies(HAZOP), safety warning systems.

2. COMPUTER AIDED INSTRUMENTS

Applications of Advanced Equipments and Instruments, Thermo Calorimetry, Differential Scanning Calorimeter(DSC), Thermo Gravimetric Analyser(TGA), Accelerated Rate Calorimeter(ARC), Reactive Calorimeter(RC), Reaction System Screening Tool(RSST) - 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.

3. RISK ANALYSIS QUANTIFICATION AND SOFTWARES

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

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. **CREDIBILITY OF RISK ASSESSMENT TECHNIQUES**

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

**Total : 45**

**REFERENCES:**

6. Hazop and Hazom, by Trevor A Klett, Institute of Chemical Engineering.
7. Quantitative Risk assessment in Chemical Industries, Institute of Chemical Industries, Centre for Chemical process safety.
1. RELIABILITY CONCEPT:


2. FAILURE DATA ANALYSIS:

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

3. RELIABILITY PREDICTION MODELS:


4. RELIABILITY MANAGEMENT:


5. RISK ASSESSMENT:

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

Total: 45

REFERENCES:

1. 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.

2. 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.

3. 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

4. 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
5. **STORAGES**

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

**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 Industries, Centre for Chemical Process safety.
2. Fawcett, H.h. and Wood, “Safety and Accident Prevention in Chemical
EXPERIMENTS:

1) **Noise Level Measurement and Analysis**
   Measurement of sound pressure level in dB for impact, continuous and intermittent sources at various networks, peak and average values.

2) **Exhaust gas Measurement and Analysis** of SOx, NOx, COx, hydrocarbons.

3) **Burst strength test** of packaging materials like paper bags, corrugated cartoons, wood etc. Auto ignition temperature test.

4) **Particle size Measurement** – Sieve analysis method

5) Dry Bulb Temperature, Wet Bulb Temperature, and Determination of relative humidity, Flash and fire point of fuels

6) **Torsion measurement and analysis**

7) **Electrical safety**
   - Insulation resistance for motors and cables
   - Estimation of earth resistance
   - Earth continuity test
   - Sensitivity test for ELCB

8) **Illumination measurement and analysis** - Lux meter.

9) **Software Usage**
   - Accident Analysis
   - Safety Audit Packages
   - Consequence Analysis (CISCON)
   - Fire, Explosion and Toxicity Index (FETI)
   - Reliability Analysis for Mechanical system and Electrical System
   - Failure Mode Analysis

STUDY:

1) **Friction test**
   Explosive materials like barium nitrate, gun powder, white powder etc.

2) **Impact test**
   Explosive materials like gun powder, white powder etc.

3) Air sampling analysis, Air pollution
4) **Personal Protective Equipments**
   Respiratory and non-respiratory-demonstration-self contained breathing apparatus. Safety helmet, belt, hand gloves, goggles, safety shoe, gum boots, ankle shoes, face shield, nose mask, ear plug, ear muff, anti static and conducting plastics/rubber materials, apron and leg guard.

5) **Fire extinguishers and its operations**
   Water, Foam, Carbon dioxide (CO₂), Dry chemical powder

6) **Identification and characterization of hazardous waste**

7) **First-Aid**

8) **Road safety signals and symbols**

**EQUIPMENTS REQUIRED:**

1) Noise level meter :  1 No
2) Exhaust gas analyzer :  1 No
3) Burst strength testing equipment :  1 No
4) PPE Set :  1 No
5) Fire extinguisher set :  1 No
6) First aid kid :  1 No
7) Torsion testing machine :  1 No
8) Software : CISION, FETI & Failure Mode analysis
9) Road safety signals, symbols and posters.
1. ACCIDENTS CAUSES AND MANAGEMENT SYSTEMS 9
Problems impeding safety in construction industry- causes of fatal accidents, types and causes of accidents related to various construction activities, human factors associated with these 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

2. HAZARDS OF CONSTRUCTION AND PREVENTION 9

3. WORKING AT HEIGHTS 9
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.

4. CONSTRUCTION MACHINERY 9
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:

4. Handbook of OSHA Construction safety and health charles D. Reese & James V. Edison
1. **PROPERTIES OF FIREWORKS CHEMICALS**

Fire properties – potassium nitrate (KN03), potassium chlorate (KCl03), barium nitrate (BaNO3), calcium nitrate (CaNO3), Sulphur (S), Phosphorous (P), antimony (Sb), Pyro Aluminum (A1) powder-Reactions-metal powders, Borax, ammonia (NH3) – Strontium Nitrate, Sodium Nitrate, Potassium per chloride. Fire and explosion, impact and friction sensitivity.

2. **STATIC CHARGE AND DUST**


Dust: size-respirable, non-respirable-biological barriers-hazards-personal protective equipment-pollution prevention.

3. **PROCESS SAFETY**


4. **MATERIAL HANDLING**

Manual handling – wheel barrows-trucks-bullock carts-cycles-automobiles-fuse handling – paper caps handling-nitric acid handling in snake eggs manufacture-handling the mix in this factory-material movement-godown-waste pit.

Transportation:
Packing-magazine-design of vehicles for explosive transports loading into automobiles-transport restrictions-case studies-overhead power lines-driver habits-intermediate parking-fire extinguishers-loose chemicals handling and transport.

5. **WASTE CONTROL AND USER SAFETY**


Consumer anxiety-hazards in display-methods in other countries-fires, burns and scalds-sales outlets-restrictions-role of fire service.

**Total**: 45
TEXT BOOKS :


REFERENCES :

1. “Seminar on explosives”, Dept.of of explosives.
2. J.A.Purkiss, “Fireworks-Fire Safety Engineering”
5. A.Chelladurai, “Fireworks related accidents”
6. A.Chelladurai, “Fireworks principles and practice”
7. A.Chelladurai, “History of the fireworks in India”    Brock,“History of fireworks”
UNIT I
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

UNIT II
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

UNIT III

UNIT IV
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-

UNIT V
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
5. Principles of Environmental Science and Engineering, R. Sivakumar
1. **STATISTICAL PROCESS CONTROL**


2. **ACCEPTANCE SAMPLING**

Economics of sampling – Acceptance sampling by variables and attributes – Single, double and sequential plans – OC curves – ATI, ASN, AOQL – Standard sampling tables.

3. **DESIGN OF EXPERIMENTS**

Factorial experiments – single factor, multi factor, $2^k$ design – Taguchi methods – use of orthogonal arrays.

4. **QUALITY MANAGEMENT**

ISO 9000 and TQM concepts - Quality circles, tools – Zero defect management, 6 sigma – Quality Function Deployment (QFD).

5. **RELIABILITY**

Reliability concepts - Reliability prediction – Series and Parallel systems – Reliability testing.

**Total : 45**

**REFERENCES:**

4. Grant E L, “Statistical Quality Control”
1. WORK STUDY


2. ERGONOMICS


3. PERSONAL PROTECTION


4. PROCESS AND EQUIPMENT DESIGN


5. MAN MACHINE SYSTEMS


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:

REFERENCES:

1. **HISTORY OF SAFETY LEGISLATION**


2. **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.

3. **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.

4. **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.
5. **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.

**Total: 45**

**TEXT BOOKS:**


**REFERENCES:**

2. Srinivasan, “Harbour, Dock and Tunnel Engineering”
10222ISE41 SAFETY IN POWDER HANDLING

1. 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.

2. 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.

3. 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.

4. 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—corona—insulating powders—propagating brush discharge—discharge in bulk lightning hazards in powder coating—electroplating.

5. DUST EVALUATION AND CONTROL

Evaluation, methodology, Quantitative, sampling, measurements—control approaches and strategies—control of dust sources, dust transmission—role of workers, PPE and work practice—Housekeeping—storage—labelling—warning sign—restricted areas—Environmental protections.

Evaluation procedures and control measures for particulates (Respirable), Asbestos and other fibres, silica in coal mine—NIOSH guide to the selection and use of particulate respirators—case studies.
REFERENCES:

1. CONCEPTS AND STATUTORY REQUIREMENTS


2. ELECTRICAL HAZARDS

Primary and secondary hazards-shocks, burns, scalds, falls-human safety in the use of electricity.

Energy leakage-clearances and insulation-classes of insulation-voltage classifications-excess energy-current surges-Safety in handling of war 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.

3. PROTECTION SYSTEMS


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.

4. 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.
5. HAZARDOUS ZONES

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

Total: 45

TEXT BOOK:


REFERENCES:

2. Indian Electricity Act and Rules, Government of India.
ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS

1. INTRODUCTION:

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

2. COGNITIVE PSYCHOLOGY

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

3. KNOWLEDGE ENGINEERING

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

4. EXPERT SYSTEMS:


5. INTRODUCTION TO NEURAL NETWORKS


Total: 45
TEXT BOOK:


REFERENCES:

1. 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.

2. ROAD TRANSPORT


3. 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

4. ROAD SAFETY

5. **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.

**Total: 45**

**TEXT BOOKS:**


**REFERENCES:**

5. K.W.Ogden, “Safer Roads – A guide to Road Safety Engineering”
1. **INTRODUCTION**


2. **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.

3. **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.

4. **SAFETY OF NUCLEAR REACTORS**


5. **RADIATION CONTROL**


**Total: 45**

**TEXT BOOKS:**


**REFERENCES:**

1. **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.

2. **TEXTILE HAZARDS-I**

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

3. **TEXTILE HAZARDS-II**

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

4. **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.

5. **SAFETY STATUS**

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

**Total:** 45

**TEXT BOOK:**


**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
5. Little, A.H., “Water supplies and the treatment and disposal of effluent”
1. **OPENCAST MINES**


2. **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.

3. **TUNNELLING**


4. **RISK ASSESSMENT**


5. **ACCIDENT ANALYSIS AND MANAGEMENT**


**TEXT BOOK:**


**REFERENCES:**

1. 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.

2. 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.


3. 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.

4. SAFETY IN COLD FARMING 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.
5. **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.

Health and welfare measures in engineering industry-pollution control in engineering industry-industrial waste disposal.

**Total : 45**

**REFERENCES:**

5. Indian Boiler acts and Regulations, Government of India.
1. **PLANT LOCATION**

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

2. **PLANT LAYOUT**

Safe layout, equipment layout, safety system, fire hydrant locations, fire service rooms, facilities for safe effluent disposal and treatment tanks, site considerations, approach roads, plant railway lines, security towers.

Safe layout for process industries, engineering industry, construction sites, pharmaceuticals, pesticides, fertilizers, refineries, food processing, nuclear power stations, thermal power stations, metal powders manufacturing, fireworks and match works

3. **WORKING CONDITIONS**

Principles of good ventilation, purpose, physiological and comfort level types, local and exhaust ventilation, hood and duct design, air conditioning, ventilation standards, application.

Purpose of lighting, types, advantages of good illumination, glare and its effect, lighting requirements for various work, standards- House keeping, principles of 5S

4. **MANUAL MATERIAL HANDLING AND LIFTING TACKLES**

Preventing common injuries, lifting by hand, team lifting and carrying, handling specific shape machines and other heavy objects – accessories for manual handling, hand tools, jacks, hand trucks, dollies and wheel barrows – storage of specific materials - problems with hazardous materials, liquids, solids – storage and handling of cryogenic liquids - shipping and receiving, stock picking, dock boards, machine and tools, steel strapping and sacking, glass and nails, pitch and glue, boxes and cartons and car loading – personal protection – ergonomic considerations

Fiber rope, types, strength and working load inspection, rope in use, rope in storage - wire rope, construction, design factors, deterioration causes, sheaves and drums, lubrication, overloading, rope fitting, inspection and replacement – slings, types, method of attachment, rated capacities, alloy chain slings, hooks and attachment, inspection
5. MECHANICAL MATERIAL HANDLING

Hoisting apparatus, types - cranes, types, design and construction, guards and limit devices, signals, operating rules, maintenance safety rules, inspection and inspection checklist – conveyors, precautions, types, applications.

Powered industrial trucks, requirements, operating principles, operators selection and training and performance test, inspection and maintenance, electric trucks, gasoline operated trucks, LPG trucks – power elevators, types of drives, hoist way and machine room emergency procedure, requirements for the handicapped, types - Escalator, safety devices and brakes, moving walks – man lifts, construction, brakes, inspection.

Total : 45

TEXT BOOKS:


REFERENCES:

1. OHSAS STANDARD

2. OHSAS 18001 POLICY & PLANNING
   Planning – Guidelines, methodology steps developing action plan – Analysis and identify the priorities, objective & Targets, short term action plan, benefits and cost of each option, Development of action plan.

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

4. ISO 14001
   EMS, ISO 14001, specifications, objectives, Environmental Policy, Guidelines & 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.

5. 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.

Total : 45
REFERENCE:

1. ISO 9000 to OHSAS 18001, Dr. K.C. Arora, S.K. Kataria & Sons, Delhi.
1. **ERGONOMICS AND ANATOMY**

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

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

2. **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.

3. **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.
4. MAN - MACHINE SYSTEM AND REPETITIVE WORKS AND MANUAL HANDLING TASK

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

Ergonomics interventions in Repetitive works, handle design, key board design-measures for preventing in work related musculoskeltal 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

5. 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.

Total : 45

REFERENCES:

1. Introduction to Ergonomics, R.S. Bridger, Taylor & Francis
2. Ergonomic design for organizational effectiveness, Michael O’Neill
3. Human factors in engineering & design, MARK S.SANDERS
4. The Ergonomics manual, Dan Mc Leod, Philip Jacobs & Nancy Larson