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**

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<tr>
<th>Code</th>
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<tbody>
<tr>
<td>MA 611</td>
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**SEMESTER II**

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Total Credits 63
## LIST OF ELECTIVES

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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.


References:
1. BOWKER and LIBERMAN, Engineering Statistics, Prentice-Hall.

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

References

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

References

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, planning machine and grinding machines, CNC machines, Wood working machinery, types, safety principles, electrical guards, work area, material handling, inspection, standards and codes- saws, types, hazards.

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

SAFETY IN COLD FORMING AND HOT WORKING OF METALS
Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot-operated presses, power press electric controls, power press set up and die removal, inspection and maintenance-metal sheers-press brakes.

Hot working safety in forging, hot rolling mill operation, safe guards in hot rolling mills – hot bending of pipes, hazards and control measures.

Safety in gas furnace operation, cupola, crucibles, ovens, foundry health hazards, work environment, material handling in foundries, foundry production cleaning and finishing foundry processes.

SAFETY IN FINISHING, INSPECTION AND TESTING
Heat treatment operations, electro plating, paint shops, sand and shot blasting, safety in inspection and testing, dynamic balancing, hydro testing, valves, boiler drums and headers, pressure vessels, air leak test, steam testing, safety in radiography, personal monitoring devices, radiation hazards, engineering and administrative controls, Indian Boilers Regulation.

References
5. Indian Boiler acts and Regulations, Government of India.
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

7. ISO 9000 to OHSAS 18001, Dr. K.C. Arora, S.K. Kataria& Sons, Delhi

SEMMEREST – 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)

M.Tech. (Industrial Safety Engineering)

Department of Mechanical Engineering, National Institute of Technology, Tiruchirappalli – 620 015.
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
3. Hazop and Hazon, by Trevor A Klett, Institute of Chemical Engineering.
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
References


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

PHYSICS AND CHEMISTRY OF FIRE

FIRE PREVENTION AND PROTECTION

INDUSTRIAL FIRE PROTECTION 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 (CO2) and halons-hazards in LPG, ammonia (NH3), sulphur dioxide (SO2), chlorine (CL2) etc.

TEXT BOOK
REFERENCES
3. Dinko Tuhtar, “Fire and explosion protection”

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

1. NOISE LEVEL MEASUREMENT AND ANALYSIS

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

3. FRICTION SENSITIVITY TEST

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 (CO₂), dry chemical powder, halon.

ELECTIVES

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

AIR POLLUTION

WATER POLLUTION

HAZARDOUS WASTE MANAGEMENT

ENVIRONMENTAL MEASUREMENT AND CONTROL

POLLUTION CONTROL IN PROCESS INDUSTRIES

REFERENCES
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

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

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 and James V. Edison
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 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 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**
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**

**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 classification-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 arrester, installation – earthing, specifications, earth resistance, earth pit maintenance.

**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.

**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

REFERENCES
2. Indian Electricity Act and Rules, Government of India.
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 hoist
ing 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
ME 676 – DESIGN OF AIR POLLUTION CONTROL SYSTEM (3 – 0 – 0) 3


Integrated Air pollution control systems.

References

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
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**

**References**

**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:**
WORK STUDY

ERGONOMICS

PERSONAL PROTECTION

PROCESS AND EQUIPMENT DESIGN

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:
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

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

REFERENCES
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:

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”

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

OPENCAST MINES
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

RISK ASSESSMENT

ACCIDENT ANALYSIS AND MANAGEMENT

TEXT BOOK

REFERENCES

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.

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-pay loaders etc. Working with electricity and electrical management – Storage – types, hazardous cargo.

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

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

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

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

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

EMERGENCY ACTION PLAN AND DOCK WORKERS (SHW)
REGULATIONS 1990
Emergency action Plans for fire and explosions - collapse of lifting appliances and buildings, sheds etc., - gas leakages and precautions concerning spillage of dangerous goods etc., - Preparation of on-site emergency plan and safety report.

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

TEXT BOOKS:

2.”Dock Safety” Thane Belapur Industries Association, Mumbai.
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

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

INTRODUCTION

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

RADIATION CONTROL

TEXT BOOKS:

REFERENCES:
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


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-objects 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

ME 688 - OHSAS 18000 AND ISO 14000

OHSAS STANDARD
OHSAS 18001 POLICY AND PLANNING

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.

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


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