MECHANICAL ENGINEERING

M.Tech
Industrial Safety Engineering

DEPARTMENT OF MECHANICAL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI,620015
TAMIL NADU,INDIA

M.Tech Degree

In

Industrial Safety Engineering

Curriculum Structure

(for Students Admitted in 2024-25 onwards)

Department of Mechanical Engineering
National Institute of Technology
Tiruchirappalli

VISION OF THE INSTITUTE

- To be a university globally trusted for technical excellence where learning and research integrate to sustain society and industry.

MISSION OF THE INSTITUTE

- To offer undergraduate, postgraduate, doctoral and modular programmes in multi-disciplinary / inter-disciplinary and emerging areas.
- To create a converging learning environment to serve a dynamically evolving society.
- To promote innovation for sustainable solutions by forging global collaborations with academia and industry in cutting-edge research.
- To be an intellectual ecosystem where human capabilities can develop holistically.

VISION OF THE DEPARTMENT

To be a globally renowned Department in Mechanical Engineering where the best of teaching, learning and research synergize to fulfil the requirements of industry and society.

MISSION OF THE DEPARTMENT

The Mechanical Engineering Department is committed to:

- Prepare effective and responsible engineers for global requirements by providing quality education through graduate, post graduate and doctoral research programmes.
- Constantly strive to improve the teaching and learning processes by adopting innovative pedagogical methods.
- Respond effectively to the needs of the industry and society by offering sustainable and innovative solutions.
- Conduct basic and interdisciplinary research to publish in reputed international journal and to generate intellectual property.
- Provide consultancy services and cultivate the spirit of entrepreneurship.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1	Graduates will be successful and socially responsible industrial safety engineers
PEO2	Graduates will possess the habit of continuous learning in the emerging safety engineering technology and advanced field of study
PEO3	Graduates will work harmoniously in group with ethical and professional code of conduct.

PROGRAMME OUTCOMES (POs)

PO1	An ability to independently carry out research /investigation and development work to solve practical problems.
PO2	An ability to write and present a substantial technical report/document.
PO3	Students should be able to demonstrate a degree of mastery on Industrial Safety Engineering at a lever higher than the requirements in their Undergraduate programs.

CURRICULUM

SEMESTER I

Code	Course of Study	Credit
MA611	Program Core 1 - Probability and statistics	4
ME651	Program Core 2 - Safety management	4
ME652	Program Core 3 - Occupational health and hygiene	4
MEXXX	Program Elective I	4
MEXXX	Program Elective II	3
MEXXX	Program Elective III	3
ME661	Laboratory I: Industrial hygiene and ergonomics Lab	2
		24

SEMESTER II

Code	Course of Study	Credit
ME653	Program Core 4 - Computer aided risk analysis	4
ME654	Program Core 5 - Safety in process industries	4
ME655	Program Core 6 - Fire and explosion: prevention and control	4
MEXXX	Program Elective IV	4
MEXXX	Program Elective V	3
MEXXX	Program Elective VI	3
ME662	Laboratory II - Industrial safety lab	2
		24

SUMMER TERM **(evaluation in the III semester)**

Code	Course of Study	Credit
ME663	Internship / Industrial Training / Academic Attachment (I/A) (6 weeks to 8 weeks)	2

SEMESTER III

Code	Course of Study	Credit
ME797	Project work (Phase I)	12

SEMESTER IV

Code	Course of Study	Credit
ME798	Project work (Phase II)	12

PROGRAMME ELECTIVES (PE)

PEs with 4 credits

Sl. No.	Code	Course of Study	Credit
1.	ME671	Regulation for health, safety and environment	4
2.	ME672	Safety in construction and material handling	4
3.	ME673	Design of air pollution control systems	4
4.	ME674	Transport safety	4
5.	ME675	Safety in mines	4
6.	ME676	Dock safety	4

PEs with 3 credits

Sl. No.	Code	Course of Study	Credit
1.	ME677	Safety in engineering industry	3
2.	ME678	Environmental pollution control	3
3.	ME679	Electrical safety	3
4.	ME680	Human factors and ergonomics	3
5.	ME681	Industrial noise and vibration control	3
6.	ME682	Work study and ergonomics	3
7.	ME683	Safety in textile industry	3
8.	ME684	Sensitivity measurements and evaluation of energetic material	3
9.	ME685	Safety in powder handling	3
10.	ME686	Nuclear engineering and safety	3
11.	ME687	Disaster management	3
12.	ME688	ISO 45001 and ISO 14001	3
13.	ME689	Safety in refrigeration and cryogenics	3
14.	ME690	Biomechanics and human body vibration	3
15.	ME691	Safety in on and off shore drilling	3

OPEN ELECTIVES (OE)

Sl. No.	Code	Course of Study	Credit
1	ME689	Safety in refrigeration and cryogenics	3
2	ME690	Biomechanics and human body vibration	3
3	ME691	Safety in on and off shore drilling	3

PROGRAM CORE

Course Code	**:**	**MA611**
Course Title	**:**	**Probability and statistics**
Type of Course	**:**	PC
Prerequisites	**:**	NIL
Contact Hours	**:**	4 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	The concepts of probability and statistics to solve safety engineering problems.
CLO2	Reliability engineering theory to assess and determine the reliability of safety systems.
CLO3	Applying sampling distributions in testing various hypotheses.
CLO4	T-test, F-test and Chi-square test in determining the validity of data.
CLO5	Conducting correlation and regression analysis and computing the reliability of safety systems.

Course Content

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

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

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

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

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

Introduction to data analytics and data mining

Case Studies and problem discussion with reference to safety engineering

References

1.	Eisenhart, C.,1962. *Engineering Statistics*
2.	Gupta, S.C. and Kapoor, V.K., 2020. *Fundamentals of Mathematical Statistics*. Sultan Chand & Sons.
3.	Spiegel, M.R., Schiller, J. and Srinivasan, R.A., 2000. *Probability and Statistics: Schaum S Outline of Probability and Statistics*. McGraw-Hill Education.
4.	Spiegel, M.R. 1998. *Statistics*. Schaum's Outline Series in Mathematics. McGraw-Hill Education.
5.	Trivedi, K.S., 2008. *Probability & statistics with reliability, queuing and computer science applications*. John Wiley & Sons.
6.	NPTEL: "Introduction to Probability Theory and Statistics" by Dr. S Dharmaraja, IIT Delhi <https://archive.nptel.ac.in/courses/111/102/111102160/>

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Apply standard and special probability distributions to safety engineering problems.
CO2	Represent and analyse data both pictorially and numerically.
CO3	Employ sampling distributions to test various hypotheses.
CO4	Use t-test, F-test and Chi-square test to evaluate the validity of data.
CO5	Predict the relationship between parameters through correlation and regression analysis and compute the reliability of safety systems.

Course Code	**:**	**ME651**
Course Title	**:**	**Safety management**
Type of Course	**:**	PC
Prerequisites	**:**	NIL
Contact Hours	**:**	4 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Safety management functions and techniques.
CLO2	Accident reporting and investigation procedures.
CLO3	Evaluation of safety performance in an organization.
CLO4	Importance of safety education and training in an organization.
CLO5	Compliance of statutory and regulatory requirement.

Course Content

CONCEPTS AND TECHNIQUES

Evolution of modern safety concept, Safety as integral part of business-Safety policy-Safety Organization- line and staff functions for safety- Safety Committee-budgeting for safety.

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

Preparation of model occupational health & safety policy, JSA sheet format.

ACCIDENT INVESTIGATION AND REPORTING

Concept of an accident, reportable and non-reportable accidents, contribution factor for accident – principles of accident prevention, Supervisory role- Role of safety committee – Accident causation models - Cost of accident.

Overall accident investigation process - Response to accidents, reporting requirement, Planning document, Planning matrix, Investigators Kit, functions of investigator, four types of evidence, root cause analysis, Records of accidents.

Preparation of accident investigation reports.

SAFETY PERFORMANCE MONITORING

Reactive and proactive monitoring techniques - Permanent total disabilities, permanent partial disabilities, temporary total disabilities - Calculation of accident indices, frequency rate, severity rate, frequency severity incidence, incident rate, accident rate, safety “t” score, safety activity rate – problems, modern tool usage, accident data analysis.

SAFETY EDUCATION AND TRAINING

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

Development of model safety training program for various industries

EFFECTIVE SAFETY MANAGEMENT SYSTEM AND ETHICS

Purpose, Safety Culture, Safety functions, Elements of process safety management, Behaviour Based Safety, Elements of Safety Management System, Concept of BBIP, OSHA guidelines, Voluntary Safety and Health Program management guidelines, 1989, Introduction, basic principles, duties and obligations, conditions of execution of the functions of occupational safety professionals.

Case studies and discussion on development of BBS

References

1	*Accident Prevention Manual for Industrial Operations*, 2008. 3rd ed, National Safety Council. Chicago.
2	Heinrich, H.W. 2016. *Industrial Accident Prevention*. 5th ed. New York: McGraw-Hill Company.
3	Krishnan, N.V., 1997. *Safety Management in Industry*. Bombay: Jaico Publishing House.
4	Deshmukh, L.M., 2017. *Industrial Safety Management: Hazard Identification and Risk Control*. McGraw Hill Education.
5	Kaila, H.L., 2020. *Behaviour-Based Safety in Organizations*. Dreamtech Press.
6	NPTEL: “Industrial Safety Engineering” by Prof. J. Maiti, IIT Kharagpur <https://archive.nptel.ac.in/courses/110/105/110105094/>

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Apply principles of safety management, its functions and techniques in any organization.
CO2	Classify and categorize the factors contributing to accident.
CO3	Formulate accident investigation program in an organization, develop and practice accident reporting system.
CO4	Realize the importance of safety trainings and awareness programs in an organization.
CO5	Determine key performance indicators for safety management system in an organization.

Course Code	**:**	**ME652**
Course Title	**:**	**Occupational health and hygiene**
Type of Course	**:**	PC
Prerequisites	**:**	NIL
Contact Hours	**:**	4 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Workplace hazards and control strategies to manage occupational diseases.
CLO2	Occupational health and the use of health monitoring equipment.
CLO3	Classification of different occupational Hazards and their health consequences.
CLO4	Different occupational diseases, their causes and toxicology.
CLO5	Occupational physiology and its application in workplace health and safety.

Course Content

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 standards, 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.

BIOLOGICAL HAZARDS

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

OCCUPATIONAL HEALTH AND TOXICOLOGY

Concept and spectrum of health - functional units and activities of occupational health services, pre-employment and post-employment medical examinations - occupational 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.

Case studies and discussion on recognition, evaluation and control of physical and chemical hazards specific to industries.

References

1	National Safety Council (1982). *Handbook of Occupational Health and Safety*, Vol. 1 & 2. Chicago: National Safety Council.
2	Niland, J. and Elam, L.A. 2021. *Fundamentals of Industrial Hygiene*. 7th ed. Chicago: National Safety Council
3	International Labour Organisation 1998. *Encyclopaedia of Occupational Health and Safety*, Vol. I & II. Geneva
4	McCormick, E.J. and Sanders, M.S. 1992. *Human Factors in Engineering and Design*. 7th ed. New Delhi: Tata McGraw-Hill education
5	ILO Encyclopedia of Occupational Health and Safety-ILO <https://www.iloencyclopaedia.org/>
6	NPTEL: “Chemical Process Safety” by Prof. Shishir Sinha, IIT Roorkee <https://archive.nptel.ac.in/courses/103/107/103107156/>

Course Outcomes (CO)
At the end of the course, student will be able to:

CO1	Identify different types of physical, chemical and biological hazards in the workplace.
CO2	Employ risk analysis processes for health hazards, recommend control measures for various workplace hazards, and select appropriate control strategies.
CO3	Select appropriate monitoring equipment and measuring techniques based on hazard characterization.
CO4	Formulate plans for promotion of occupational health and prevention of occupational diseases.
CO5	Analyze workplace, equipment and work postures to recognize ergonomic deficiencies and suggest solutions.

Course Code	**:**	**ME661**
Course Title	**:**	**Industrial hygiene and ergonomics laboratory**
Type of Course	**:**	Essential Laboratory Requirements (ELR)
Prerequisites	**:**	NIL
Contact Hours	**:**	3 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Measurement of parameters relevant to health, safety and environment.
CLO2	Evaluation of occupational health hazards and control strategies to control the hazards.
CLO3	Ergonomic and biomechanical assessments using digital modelling and EMG instruments to enhance workplace safety and comfort.
CLO4	Measuring noise levels from various sources using a noise level meter.
CLO5	Assessing heat stress indices in indoor and outdoor environments using the WBGT instrument.

Course Content

NOISE LEVEL MEASUREMENT AND ANALYSIS

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

MEASUREMENT OF HEAT STRESS INDEX

Determination of heat stress index using WBGT instrument in indoor and outdoor environments.

MEASUREMENT OF ULTRAVIOLET RADIATION

Determination of ultraviolet radiation during welding operation and outdoor environment

MEASUREMENT OF ILLUMINATION LEVEL

Determination of the level of illumination in various labs in the department.

EXHAUST GAS MEASUREMENT AND ANALYSIS

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

BREATHING ZONE CONCENTRATION

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

AMBIENT AIR MONITORING

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

FUME FORMATION RATE(FFR)

Measurement of fume formation rate in welding operation using Total fume chamber as per ISO 15011-1

DETERMINATION OF GAS AND VAPOUR

Determination of gas and vapour by using air sampling instruments.

VIBRATION MEASUREMENT AND ANALYSIS

Measurement of whole body vibration and Hand arm vibration: Instrument – vibration simulator and vibration analyser

DIGITAL HUMAN MODELING SOFTWARE FOR VIRTUAL ERGONOMICS EVALUATION

BIOMECHANICAL ANALYSIS (COGNITIVE WORKLOAD AND FATIGUE) WITH EMG INSTRUMENT

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Compute noise and vibration levels in the work environment and apply appropriate counter measures.
CO2	Demonstrate exhaust gas measurement and analyse the implications.
CO3	Evaluate dust and fume levels in breathing air and conduct ambient air analysis.
CO4	Demonstrate fatigue level assessment and analyse its implications on work activity.
CO5	Compute the heat stress and UV radiation levels in the various environments.

Course Code	**:**	**ME653**
Course Title	**:**	**Computer aided risk analysis**
Type of Course	**:**	PC
Prerequisites	**:**	NIL
Contact Hours	**:**	4 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Hazard evaluation and risk analysis.
CLO2	Instrumentation techniques and computing tools for risk analysis.
CLO3	Different tests for sensitivity analysis of chemicals.
CLO4	Hazard evaluation softwares.
CLO5	Risk evaluation of process industries.

Course Content

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).

Preparation of HAZOP and what-if analysis work sheets for process industries.

INSTRUMENTS FOR HAZARD CHARACTERIZATION

Applications of Advanced Equipment’s 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.

Interpretation of DSC/ARC thermograms.

CONSEQUENCE ANALYSIS

Logics of consequence 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.

Case studies: Bhopal gas tragedy: dispersion model and effect model. San Juanico disaster: source model and fire model.

RISK-ESTIMATION

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

References

1	Commonwealth Science Council (n.d.). *Methodologies for Risk and Safety Assessment in Chemical Process Industries*. UK.
2	*Guidelines for Chemical Process Quantitative Risk Analysis* (2000). Centre for Chemical Process Safety. 2nd ed. New York: AIChE.
3	*Guidelines for Hazard Evaluation Procedures* (2008). Centre for Chemical Process Safety. 3rd ed. New York: AIChE.
4	Centre for Chemical Process Safety (n.d.). *Layer of Protection Analysis*. New York: AIChE.
5	IS 15656: “Hazard Identification and Risk Analysis - Code of Practice”
6	NPTEL: “Chemical Process Safety” by Prof. Shishir Sinha, IIT Roorkee <https://archive.nptel.ac.in/courses/103/107/103107156/>

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Select and apply appropriate hazard evaluation techniques at different stages of process lifetime.
CO2	Recognize various instrumentation techniques used to characterize unstable materials.
CO3	Estimate and analyze consequences of hazards.
CO4	Estimate the adequacy of safeguards using risk determination methods.
CO5	Assess and analyze hazards using hazard evaluation software.

Course Code	**:**	**ME654**
Course Title	**:**	**Safety in process industries**
Type of Course	**:**	PC
Prerequisites	**:**	NIL
Contact Hours	**:**	4 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Safe design, operation, inspection and maintenance of chemical process plants and equipment.
CLO2	Interpreting of material safety data sheets (MSDS) for chemicals.
CLO3	Various types of testing, including non-destructive testing, pressure testing, and leak testing.
CLO4	Safety precautions related to the storage and transportation of hazardous chemicals.
CLO5	On-site and off-site emergency preparedness in chemical process industries.

Course Content

PROCESS DESIGN AND PRESSURE SYSTEM DESIGN

Design process, conceptual design and detail design, assessment, inherently safer design chemical reactor, types, batch reactors, reaction hazard evaluation, assessment, reactor safety, operating conditions, unit operations and equipment, utilities. Process safety management (PSM) and its elements.

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.

Study and interpretation of piping and instrumentation diagram (P&ID) of any process industry.

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, work permit system- maintenance equipment- hot works- tank cleaning, repair and demolition- online repairs- maintenance of protective devices- modification of plant, problems- controls of modifications.

Emergency planning, disaster planning, onsite emergency- offsite emergency, APELL

Preparation of emergency and maintenance plan for any process industry.
Case study: Safety concerns and accidents in confined space.

STORAGES AND TRASPORTATION

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

Hazards during transportation – pipeline transport

Case Studies: The Flixborough UK cyclohexane disaster, Seveso accident, Vizag styrene gas leak.

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 considerations for Cement, paper, pharmaceutical, petroleum, Petro-chemical, rubber, power plant, fertilizer and distilleries.

Case Studies: Bhopal gas tragedy, Sandoz chemical disaster, The Chernobyl nuclear disaster.

References

1	Sam Mannan, 2012. Lees' Loss prevention in the process industries: Hazard identification, assessment and control, 4th ed. Butterworth-Heinemann.
2	Arendt, J.S. and Lorenzo, D.K., 2010. *Evaluating process safety in the chemical industry: A user's guide to quantitative risk analysis*. John Wiley & Sons.
3	Fawcett, H.H. and Wood, W.S., 1982. *Safety and accident prevention in chemical operations.* Wiley.
4	Klein, J.A. and Vaughen, B.K., 2017. *Process Safety: Key Concepts and Practical Approaches*. CRC Press.
5	*Petroleum Rules 2002*, Ministry of Petroleum and Natural Gas, Government of India.
6	NPTEL: Chemical Process Safety by Prof. Shishir Sinha, IIT Roorkee <https://archive.nptel.ac.in/courses/103/107/103107156/>

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Interpret material safety data sheet (MSDS) of chemicals.
CO2	Understand the standards and codes associated with pressure system.
CO3	Differentiate the different types of testing including non-destructive testing, pressure testing, leak testing.
CO4	Formulate procedures for operation, inspection, and emergency procedures for chemical industry.
CO5	Prepare emergency plan and disaster plan for safety of chemical industry.

Course Code	**:**	**ME655**
Course Title	**:**	**Fire and explosion - prevention and control**
Type of Course	**:**	PC
Prerequisites	**:**	NIL
Contact Hours	**:**	4 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Principles of fire and explosion and characteristics of various materials.
CLO2	Design of fire prevention and suppression systems.
CLO3	Codes and standards of the National Fire Protection Association (NFPA).
CLO4	Behavior of structural materials, buildings and building contents during a fire.
CLO5	Explosion protection systems and their application.

Course Content

Physics and Chemistry of Fire

Fire properties of solid, liquid and gases - fire spread - toxicity of products of combustion - combustion characteristic- flash point, fire point, ignition temperature, LFL, UFL, flame propagation. Flames- diffusion flame, pyrolysis, premixed flame. Glowing combustion, Smoldering, Deep seated fire. theory of combustion and explosion – properties of explosive, propellent. – vapour clouds – flash fire – jet fires – pool fires – unconfined vapour cloud explosion, shock waves - auto-ignition – boiling liquid expanding vapour explosion

Fire Prevention and Protection

Sources of ignition – fire triangle – principles of fire extinguishing – active and passive fire protection systems – various classes of fires – A, B, C, D, E – types of fire extinguishers – fire stoppers – hydrant pipes – hoses – monitors – fire watchers – layout of stand pipes – fire station- fire alarms and sirens – maintenance of fire trucks – foam generators – escape from fire rescue operations – fire drills – notice-first aid for burns, Emergency rescue techniques in high rise buildings, chemical industries and oil and gas industries. Safety requirements for Hot work in oil and gas industry.

Training on usage of fire extinguisher.

Industrial Fire Protection Systems

Sprinkler-hydrants-stand pipes – special fire suppression systems like deluge and emulsifier, selection and design criteria of the above installations, reliability, maintenance, evaluation and standards – alarm and detection systems. Other suppression systems – CO_2 system, foam system, dry chemical powder (DCP) system, halon system, Inergen, FM200, Novec – need for halon replacement – smoke venting. Portable extinguishers –

flammable liquids – tank farms – indices of inflammability-firefighting systems. Fire tender- Operations, Equipment and maintenance- Overview of NFPA.

Estimation of fire load of any facility.

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.

Estimation of evacuation plan and optimum escape route using software tools.

Explosion Protecting Systems

Principles of explosion-detonation and blast waves-explosion parameters – Explosion Protection, Containment, Flame Arrestors, isolation, suppression, venting, explosion relief of large enclosure-explosion venting-inert gases, plant for generation of inert gas rupture disc in process vessels and lines explosion, suppression system based on carbon dioxide (CO_2) and halons-hazards in LPG, ammonia (NH_3), Sulphur dioxide (SO_2), Chlorine (Cl_2) etc.

References

1	James, D., 2016. *Fire prevention handbook*. Elsevier.
2	Gupta, R.S., 2010. *A Handbook of Fire Technology*. Universities Press.
3	Tuhtar, D., 1989. Fire and Explosion Protection: A System Approach.
4	Davis Daniel et al, 1991. *Hand Book of fire technology*
5	Davis, D.J. and Christianson, G.T., 1992. *Firefighter's Hazardous Materials Reference Book*. John Wiley & Sons.
6	National Building Code of India 2016- Part 4 Fire & Life Safety

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Explain the physics and chemistry of fire.
CO2	Identify the class of fire and select the appropriate extinguishing method to suppress it.
CO3	Outline the main principles and practices of fire and explosion prevention and protection.
CO4	Estimate and analyse fire load of any facility.
CO5	Formulate and understand various explosion protection/ suppression systems.

Course Code	**:**	**ME662**
Course Title	**:**	**Industrial safety laboratory**
Type of Course	**:**	Essential Laboratory Requirements (ELR)
Prerequisites	**:**	NIL
Contact Hours	**:**	3 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Measurement of parameters relevant to health, safety and environment
CLO2	Sensitivity and reactivity characteristics of hazardous chemicals
CLO3	Safety gadgets, including personal protective equipment and first aid fire fighting equipment
CLO4	Assessing the sensitivity of unstable materials to friction, impact, and thermal reactivity using specialized testing instruments
CLO5	Conducting consequence analysis for fire, explosion, and gas dispersion scenarios using advanced simulation software

Course Content

FRICTION SENSITIVITY TEST

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

IMPACT SENSITIVITY TEST

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

THERMAL REACTIVITY TEST

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

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.

STUDY OF FIRE EXTINGUISHERS

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

CONSEQUENCE ANALYSIS

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

TANK TESTING EXPERIMENT

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

STATIC ELECTRICITY MEASUREMENT OF FUELS

Conductivity measurement of low-conductivity hydrocarbon fuels using a conductivity meter

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Analyze the sensitivity and thermal reactivity properties of unstable materials.
CO2	Predict the consequences of fire and explosion in different scenarios using computer simulation.
CO3	Identify low-conductivity fuels to prevent fire and explosion hazards.
CO4	Identify and quantify the sensitivity of unstable materials, leading to improved handling and storage protocols to prevent accidents.
CO5	Distinguish and select the appropriate personal protective equipment for various practices.

Course Code	**:**	**ME663**
Course Title	**:**	**Internship / Industrial training / Academic attachment (I/A)**
Type of Course	**:**	
Prerequisites	**:**	NIL
Contact Hours	**:**	3 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Gaining hands-on experience across various safety management functions within the industry.
CLO2	The roles and responsibilities of a safety officer.
CLO3	Developing interpersonal skills that are expected for safety professionals in the industry.

Course Content

An internship of six to eight weeks duration has to be carried out by the students during summer vacation after the completion of their 2nd semester. The internship may be on the practical aspects of Industrial safety, health and environment. The students have to independently carry out research/ investigation/ developmental work to solve practical problems. A technical report and seminar are to be presented after completion of the internship for evaluation.

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Achieve confidence in quality of their decision-making as a safety professional.
CO2	Provide solutions/ decisions on challenges encountered in industrial activities.
CO3	Identify the practical problems and challenges in the industries with reference to safety.
CO4	Write and present a substantial technical report/ document.

Course Code	**:**	**ME797**
Course Title	**:**	**Project work – Phase I**
Type of Course	**:**	
Prerequisites	**:**	NIL
Contact Hours	**:**	12 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Conducting a thorough literature survey on any specific topic of industrial safety engineering.
CLO2	Identifying and analysing safety issues and challenges.
CLO3	Conducting studies to develop solutions for safety, health and environmental issues.

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Independently carry out research/ investigation and development work to solve Industrial Safety Engineering challenges.
CO2	Write and present a substantial technical report/ document.
CO3	Demonstrate a degree of mastery on Industrial safety engineering.

Course Code	**:**	**ME798**
Course Title	**:**	**Project work – Phase II**
Type of Course	**:**	
Prerequisites	**:**	NIL
Contact Hours	**:**	12 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Conducting a thorough literature survey on any specific topic of industrial safety engineering.
CLO2	Identifying and analysing safety issues and challenges.
CLO3	Conducting studies to develop solutions for safety, health and environmental issues.

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Independently carry out research/ investigation and development work to solve Industrial Safety Engineering issues.
CO2	Write and present a substantial technical report/ document.
CO3	Demonstrate a degree of mastery on Industrial safety engineering.

PROGRAM ELECTIVES

Course Code	**:**	**ME671**
Course Title	**:**	**Regulations for health, safety and environment**
Type of Course	**:**	PE
Prerequisites	**:**	NIL
Contact Hours	**:**	4 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Regulations and statutory requirements relevant to health, safety and environment.
CLO2	Application of ISO 14001 and ISO 45001 standards in an organization.
CLO3	Relevant safety regulations and procedures for compliance, ensuring adherence to industry standards.
CLO4	Evaluation and implementation of safety and health regulations to create a safe and healthy workplace.
CLO5	Prevention and control of occupational diseases prevalent in workplace.

Course Content

Factories Act and Rules,

Workmen Compensation Act
Indian Explosive Act and Rules

Gas Cylinder Rules - SMPV Act

Indian Petroleum Act and Rules.

Environmental Pollution Act, Air Act, Water Act, Fly Ash Rules
Manufacture, Storage and Import of Hazardous Chemical Rules 1989
Indian Electricity Act and Rules.

Overview of ISO 45001 and ISO 14001
Inflammable Substance Act, 1952

Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 and The Central Rules, 1998.

Ammonium Nitrate Rules, 2012

Discussion on various regulations and their requirements.

References

1	The Factories Act 1948 (2000) Madras Book Agency, Chennai
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) 10th edn. Eastern Book Company, Lucknow.
6	The Manufacture, Storage and Import of Hazardous Chemicals Rules 1989, Madras Book Agency, Chennai.

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Recall appropriate acts and rules applicable to industries.
CO2	Administer suitable acts and rules for specific areas.
CO3	Appraise various acts and rules and apply them for the development of a safe and healthy working environment.
CO4	Identify the need of ISO 14001 and ISO 45001 standards in an organisation.
CO5	Interpret rules in the event of a dispute.

Course Code	**:**	**ME672**
Course Title	**:**	**Safety in construction and material handling**
Type of Course	**:**	PE
Prerequisites	**:**	NIL
Contact Hours	**:**	4 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Hazards involved in manual and mechanical material handling.
CLO2	Safe work practices at construction sites.
CLO3	Basic safety concepts in handling the equipment's mechanically.
CLO4	Safe operating procedure in utilizing the chains, ropes, links, etc for handling the construction materials.
CLO5	Prevention and control of occupational diseases prevalent in construction site.

Course Content

CONSTRUCTION ACTIVITIES: SAFE PRACTICES, HAZARDS AND PREVENTION

Excavations, basement and wide excavation, trenches, shafts – scaffolding, types, 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 –abandoned bore wells. power plant constructions – construction of high rise buildings - Problems impeding safety in construction industry-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.

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 –case studies.

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 Hoisting apparatus, types.

MECHANICAL MATERIAL HANDLING AND 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, power elevators, types of drives, hoist way.

Concrete mixers, concrete vibrators – safety in earth moving equipment, motor grader, concrete pumps, welding machines, drills, grinding tools. machine room emergency procedure, requirements for the handicapped, types- Escalator, safety devices and brakes, Inspection checklist.

PERSONAL PROTECTIVE EQUIPMENT

Respiratory type: Respirator, Breathing Apparatus, Particle Filters – Nanomaterials, specifications, standards selection, inspection, testing and maintenance.

Non-Respiratory type: Face-pieces, Half and Full Facemasks, Hoods, Helmets, Visors, Blouses, Suits, specifications, standards selection, inspection, testing and maintenance.

References

1	Hinze, J.W., 2013. *Construction Safety*. 2nd ed. Prentice Hall Inc.
2	Coble, R.J., Hinze, J. and Haupt, T.C., 2001. *Construction Safety and Health Management*. Prentice Hall Inc.
3	Reese, C.D. and Eidson, J.V., 2006. *Handbook of OSHA Construction Safety and Health*. CRC Press.
4	Fulman, J.B., 1984. *Construction Safety, Security, and Loss Prevention*. John Wiley and Sons.
5	NPTEL: "Safety in Construction by Prof. Uma Maheshwari" IIT Delhi <https://archive.nptel.ac.in/courses/105/102/105102206/>

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Recognise the practical solutions to eliminate and/or minimize hazards in manual material handling.
CO2	Recognise the different types of existing hazards at construction site.
CO3	Disseminate the basic safety concepts and techniques in mechanical material handling equipment's like cranes, forklifts, trucks, etc.
CO4	Recognise the safe use, inspection and maintenance of chains, links, etc.
CO5	Demonstrate the importance for improving health & safety in construction.

Course Code	**:**	**ME673**
Course Title	**:**	**Design of air pollution control systems**
Type of Course	**:**	PC
Prerequisites	**:**	NIL
Contact Hours	**:**	4 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	The sources of air pollution, their types and their effects on environment.
CLO2	Understanding the basic concepts of air pollution control systems.
CLO3	Particle dynamics of pollutants and fluid dynamics of air.
CLO4	Design aspects of control systems for controlling air pollution.
CLO5	Control measures and techniques to maintain air pollution within permissible limits.

Course Content

Air Pollution - Effects and Regulations

Introduction to Air pollution - Types of Air pollutants - Particulate matter, Volatile Organic Carbon and Gaseous Emissions, Sources, Air Pollution Effects - Human health effects, Measurements of air pollutants - Analytical and sampling methods, emission estimates; Air Pollution Control Regulations - Emission standards. Magnitude of the CO_2 problem; CO_2 prevention: - CO_2 capture and storage, sequestration of CO_2 .

Advanced technologies in Carbon sequestrations.

Meteorology and Air Pollution

General atmospheric circulation patterns; local circulation effects; Atmospheric Movement of Air Pollutants: Horizontal motion, Vertical motion, Wind velocity and direction, Temperature inversions, Fumigation and stagnation; Air Pollutant Concentration Model: - Fixed boxed model, Diffusion/Dispersion model, Plume rise for stack design.

Design of dispersion module of specific flue gas different industry using ALOHA.

Process Design for Removal of Particulate Matter

Introduction to particulate matter, primary and secondary particles, settling velocities and drag forces, Stokes law, Aerodynamic particle diameter, diffusion of particles, particulate behavior in atmosphere;

Design of particulate matter equipment: - Settling chambers, cyclones/centrifugal separator, Settling chambers – Laminar and Turbulent flow - Filtration – Interception – Impaction – Convective diffusion – Collection of particles by fibers and Granular beds – Electrostatic precipitation – Cyclones – Wet Collectors, fabric filters, scrubbers and electrostatic precipitators.

Process Design for Removal of Gaseous Pollutants and Volatile Organic Compounds Part- I

Gaseous pollutants: - SOx and NOx (Thermal, prompt and fuel NOx), chemical reactions in the atmosphere.
Process design for SOx Emission control:- overview, limestone scrubbing, absorption/stripping, removal of sulphur from hydrocarbons (petroleum), modification of combustion process.

Process Design for Removal of Gaseous Pollutants and Volatile Organic Compounds Part- II

Process design for NOx Emission control:- overview, modification of combustion process, post flame treatment.
Process design for Volatile Organic Compounds (VOCs) control: Vapor pressure, water content and evaporation, Condensation, process modification, leakage control, absorption and scrubbing, Adsorption and adsorber design, Combustion.

Integrated Air pollution control systems.

References

1.	Wang, L.K., Pereira, N.C. and Hung, Y.-T., 2010, *Air Pollution Control Engineering: 1 (Handbook of Environmental Engineering).* Humana Press Inc.
2.	De Nevers, N., 2017. *Air pollution control engineering*. Waveland press.
3.	Cooper, C.D. and Alley, F.C., 2010. *Air pollution control: A design approach*. Waveland press.
4.	Peavy, H.S., Matthews, D.R. and Tchobanoglous, G., 2017. Environmental engineering.
5.	Flagan, R.C. and Seinfeld, J.H., 2012. *Fundamentals of air pollution engineering*. Courier Corporation.
6.	Rao, C.S., 2021. *Environmental pollution control engineering*. New Age International.

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Explain basics of air pollution, including types of pollutants, industrial sources and environmental regulations.
CO2	Explain the behaviour of particulate matter in the ambient atmosphere.
CO3	Describe the behaviour of gaseous pollutants and inherent methods for removing the air pollutants.
CO4	Formulate emission control strategies and policies in line with statutory regulations.
CO5	Develop process design for managing gaseous pollutant streams.

Course Code	**:**	**ME674**
Course Title	**:**	**Transport safety**
Type of Course	**:**	PE
Prerequisites	**:**	NIL
Contact Hours	**:**	4
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

The objectives of this course is to imbibe knowledge on:

CLO1	Safe transport, handling and storage of hazardous goods.
CLO2	Elements of road safety, features of roads and vehicles, and driver safety program.
CLO3	Managing emergency response in transport operations.
CLO4	Assessing and implementing road safety measures such as sight distance, intersection safety, and traffic control.
CLO5	Preventing accidents through proper handling and maintenance of shop floor machinery.

Course Content

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.

Legal implications of failing to carry or improperly using TREM cards during the transport of hazardous materials.

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.

Evaluation of a critical road accident and analysis of the factors involved.

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 Hazmat 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-safetypractices.

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 theroad motorized equipment.

Developing standard operating procedures (SOPs) for the safe operation of cranes and conveyors.

References

1.	Popkes, C.A. (1986) *Traffic Control and Road Accident Prevention*. London: Chapman and Hall Limited.
2.	Babkov, V.F., 1986. *Road Conditions and Traffic Safety*. Moscow: MIR Publications.
3.	Kadiyali, D.L., 1999. *Traffic engineering and transport planning*. Khanna publishers.
4.	National Safety Council, 1982. *Accident prevention manual for industrial operations*. National Safety Council.
5.	Ogden, K.W., 1996. *Safer roads: a guide to road safety engineering*.

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Recognize the safety aspects in design of tanker lorries.
CO2	Summarize the loading and decanting procedures of hazardous goods.
CO3	Identify the factors for improving safety on roads.
CO4	Analyze the causes of road accidents.
CO5	Relate road safety to road and vehicles features and administer a driver safety program.

Course Code	**:**	**ME675**
Course Title	**:**	**Safety in mines**
Type of Course	**:**	PE
Prerequisites	**:**	NIL
Contact Hours	**:**	4 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Hazards, occupational diseases and control measures specific to mines.
CLO2	Health and safety measures, statutory and regulatory requirements applicable formines.
CLO3	Developing and implementing emergency response plans to effectively manage accidents and minimize their impact in mines.
CLO4	Protecting human life and health by implementing robust safety protocols and promoting a strong safety culture across mining and tunnelling industries.
CLO5	Adhering to regulatory standards and best practices for safe and sustainable mining and tunnelling.

Course Content

OPENCAST MINES

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

Development of comprehensive safety assessment and improvement plan.

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.

Comprehensive Safety Management in Underground Mines.

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.

Case studies and discussion on advanced techniques in risk assessment and management.

ACCIDENT ANALYSIS AND MANAGEMENT

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

References

1	Karmis, M. (ed.), 2001. *Mine Health and Safety Management*. Littleton, CO: SME.
2	Kejiriwal, B.K., 2001. *Safety in Mines*. Lovely Prakashan, Dhanbad.
3	Ministry of Labour, 2002. *DGMS Circulars*. Dhanbad: Government of India Press/ Lovely Prakashan.
4	Marcus, J.J. ed., 1997. *Mining environmental handbook: effects of mining on the environment and American environmental controls on mining*. World Scientific.

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Examine the causes and identify preventive measures to avoid accidents in opencast mines.
CO2	Recognize the occupational hazards associated with underground mining and tunneling operations.
CO3	Demonstrate the appropriate usage of personal protective equipment in mining.
CO4	Predict the extent of risks by carrying out risk assessments, compute accident occurrence, formulate accident investigation, employ measures for improving safety in mines.
CO5	Administer emergency preparedness and disaster management activities.

Course Code	**:**	**ME676**
Course Title	**:**	**Dock safety**
Type of Course	**:**	PE
Prerequisites	**:**	NIL
Contact Hours	**:**	4
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

The objective of this course is to imbibe knowledge on:

CLO1	Major Hazards and control measures specific to harbor and docks.
CLO2	Health and safety measures to be followed in harbor and docks.
CLO3	Statutory and regulatory requirements applicable for harbor and docks.
CLO4	Different types of equipments for transporting, construction and maintenance in harbor and docks.
CLO5	Emergency action plan to be followed in case of any mishap.

Course Content

HISTORY OF SAFETY LEGISLATION

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

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

WORKING ON BOARD THE SHIP

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

LIFTING APPLIANCES

Different types of lifting appliances – construction, maintenance and use, various methods of rigging of derricks, safety in the use of container handling/lifting appliances

like portainers, transtainer, top lift trucks and other containers – testing and examination of lifting appliances – portainers – transtainers – toplift trucks – derricks in different rigging etc.

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

TRANSPORT EQUIPMENT

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

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

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

EMERGENCY ACTION PLAN AND DOCK WORKERS

(SHW) REGULATIONS 1990

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

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

Case studies and discussion on spill response and management.

References

1	Wadsworth, E., Bhattacharya, S. and Walters, D., 2015. Representing workers on arrangements for occupational safety and health in a global industry: Dock-Workers experiences in two countries. *Policy and Practice in Health and Safety*
2	Taylor, D.A., 1996. *Introduction to marine engineering*. Elsevier.
3	Srinivasan, R. and Bhavsar, R.C., 1983. *Harbour, Dock and Tunnel Engineering*. Charotar Publishing House.

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Understand the legislation related to dock safety.
CO2	Enumerate the responsibilities of different agencies for safety, health and welfare involved in dock work.
CO3	Recognize hazards and risks involved in working on a ship and administer safety measures.
CO4	Demonstrate safety in the use of handling and lifting appliances.
CO5	Select suitable testing, examination and inspection procedures for handling and lifting appliances.

Course Code	**:**	**ME677**
Course Title	**:**	**Safety in engineering industry**
Type of Course	**:**	PE
Prerequisites	**:**	NIL
Contact Hours	**:**	3 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Workplace hazards in a manufacturing engineering industry.
CLO2	Appropriate control of hazards and usage of proper personal protective equipment.
CLO3	Safety procedures for finishing, inspection, and testing, including heat treatment and pressure testing.
CLO4	Safety standards for operating machines, including zero mechanical state and hazard guards.
CLO5	Safety rules and proper machine guards to prevent accidents with various machines.

Course Content

SAFETY IN MACHINERY AND MACHINE GUARDING

General safety rules and principles, Maintenance and inspection of turning, drilling, milling, grinding, and CNC machines. Machine operation safety principles. Design and types of machine guarding, including Zero Mechanical State (ZMS). Guard construction, opening standards, and hazard protection at the point of operation.

SAFETY IN WELDING AND GAS CUTTING

Gas welding, oxygen cutting, resistance welding, arc welding and cutting. Common hazards, personal protective equipment (PPE), and safety precautions in brazing, soldering, and metalizing. Safe generation, distribution, and handling of industrial gases. Color coding, flashback arrestors, leak detection, pipeline safety, and gas cylinder storage/handling.

SAFETY IN COLD FORMING AND HOT WORKING OF METALS

Cold working, power press safety, and point of operation safeguarding. Safety in hot working processes such as forging, hot rolling, and hot bending, along with hazard control measures. Safety in gas furnace operations, foundry health hazards, work environment, material handling, and foundry processes like cleaning and finishing.

SAFETY IN FINISHING, INSPECTION AND TESTING

Safety in heat treatment, electroplating, painting, and blasting operations. Inspection and testing processes - Hydro testing, radiography safety, Indian Boilers Regulation.

DIGITAL ASPECT OF SAFETY IN ENGINEERING INDUSTRY

Basics of Industry 4.0 and relevant technologies. Application of data analytics, video analytics, and IoT in safety. Use of Augmented Reality (AR), Virtual Reality (VR), and Digital Twin for safety training, monitoring, and simulations. Remote interlocking and collaborative robots. Creation and visualization of safety databases (hazard, risk, incident, inspection, and behavioral data). Cutting-edge technologies in safety.

References

1	*Accident Prevention Manual*,1982 National Safety Council (NSC), Chicago
2	John V. Grimaldi and Rollin H. Simonds,1989 *Safety Management*, All India Travelers Book seller, New Delhi.
3	N.V. Krishnan,1996 *Safety in Industry*, Jaico Publisher House.
4	*Indian Boiler acts and Regulations*, Government of India.
5	Blunt J. and Balchin N.C. 2002 *Health and safety in welding and allied processes*. Woodhead Publishing Ltd.

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Identify and interpret the hazards present in metal working machinery, wood working machinery, welding, gas cutting, hot and cold metal working operations.
CO2	Demonstrate safe practices in heat treatment operations.
CO3	Formulate safe operating procedures in hazardous inspection processes.
CO4	Select and use suitable personal protective equipment.
CO5	Design appropriate guards for machines to protect humans from mechanical hazards.

Course Code	**:**	**ME678**
Course Title	**:**	**Environmental pollution control**
Type of Course	**:**	PE
Prerequisites	**:**	NIL
Contact Hours	**:**	3 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Principles of environmental pollution control.
CLO2	Control of various pollutants within the permissible limits.
CLO3	Principles and requirements of ISO 14001 standard based environmental management system.
CLO4	Effects of air, water pollutants and hazardous wastes on the environment.
CLO5	Appropriate tools and techniques to collect and measure environmental pollutants.

Course Content

Air Pollution

Biosphere, Biogeochemical Cycles, Classification and properties of air pollutants – Particulate Matter – types, Pollution sources – Effects of air pollutants on human beings, Vegetation and Materials, Scavenging Mechanisms, Electromagnetic Radiation- ultra violet radiation, infrared radiation, radiation from sun-hazards due to depletion of ozone - deforestation-ozone holes, –Chloro Fluoro Carbon(CFC). Air quality monitoring-Ambient and Stack monitoring.

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

Water Pollution

Classification of water pollutants-health hazards; Basics of water quality standards – physical, chemical and biological parameters; BoD and CoD analysis, sampling and analysis of water-water treatment- primary, secondary, tertiary - different industrial effluents and their treatment and disposal –advanced wastewater treatment - effluent quality standards and laws. Water Pollution Control Board-laws.

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.

Pollution Control in Process Industries

Pollution control in process industries like automobile, chemical factory, cement, paper, petroleum and petroleum products, textile-tanneries, thermal power plants, dying and pigment industries, sewage/ effluent treatment plants, nuclear power plants, eco-friendly energy. ISO 14001: 2015 principles and requirements.

Sustainability and ESG

Introduction to Sustainability, Health Safety & Environment, and Environmental Social Governance; ESG Principles; Integrating ESG into HSE Practices; Carbon Neutrality, Zero Discharge, Life Cycle Assessment; Understanding GRI- Global Reporting Initiative and BRSR- Business Responsibility and Sustainability Reporting.

References

1	Rao, C.S., 2018. *Environmental Pollution Control Engineering*. New Age International Publishers.
2	Mahajan, S.P., 2017. *Pollution Control in Process Industries*. McGraw-Hill Education.
3	Brauer, H. and Varma, Y.B., 2011. *Air pollution control equipment*. Springer Science & Business Media.
4	*Municipal Solid Waste Management Manual - Part 1 & 2.* Central Public Health and Environmental Engineering Organisation (CPHEEO), India
5	Essia, U., 2022. Fundamentals of ESG (ESG 101).

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Classify air and water pollutants and hazardous wastes.
CO2	Apply scientific knowledge to propose control strategies for different pollutants from process industries.
CO3	Use relevant information about environmental impacts of air, water pollutants and hazardous wastes to discuss environmental pollution in a given case.
CO4	Recognize and select appropriate environmental pollutant sampling measurement techniques.
CO5	Apply relevant statutory and regulatory requirements concerned with environmental pollution.

Course Code	**:**	**ME679**
Course Title	**:**	**Electrical safety**
Type of Course	**:**	PE
Prerequisites	**:**	NIL
Contact Hours	**:**	3 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Protection systems and devices to protect from electrical hazards.
CLO2	Regulatory and statutory requirements relevant to electrical safety.
CLO3	Safe selection, installation, operation, and maintenance of electrical equipment, considering environmental factors and safety protocols.
CLO4	Basic principles of electrostatics, electromagnetism, and the safe operation of electrical equipment in compliance with Indian and international standards.
CLO5	Selection of appropriate intrinsically safe and explosion-proof electrical apparatus to mitigate risks in dangerous environments.

Course Content

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 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 (NESC/ ANSI).

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

PROTECTION SYSTEMS

Fuse, circuit breakers and overload relays – protection against over voltage and under voltage – safe limits of amperage – voltage – safe distance from lines-capacity and protection of conductor – joints and connections, overload and short circuit protection-no load protection - earth fault protection. FRLS insulation - insulation and continuity test - system grounding - equipment grounding earth leakage circuit breaker (ELCB)-

cable wires - maintenance of ground - ground fault circuit interrupter - use of low voltage - electrical guards-Personal protective equipment – safety in handling hand held electrical appliances tools and medical equipments.

SELECTION, INSTALLATION, OPERATION AND MAINTENANCE

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

HAZARDOUS ZONES

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

References

1	Fordham-Cooper, W., 1998. *Electrical safety engineering*. Elsevier.
2	National Safety Council, 1959. *Accident prevention manual for industrial operations*. National Safety Council.
3	Indian Electricity Act and Rules, Government of India.
4	Power Engineers – Handbook of TNEB, Chennai, 1989.
5	"Controlling Electrical hazard" <https://www.osha.gov/sites/default/files/publications/osha3075.pdf>

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Recognize the extreme importance of observing all safety requirements and practices connected with electricity.
CO2	Demonstrate what to do during an electrical accident.
CO3	Identify the potential hazards and indicate measures to prevent accidents due to electricity.
CO4	Describe basic safety concepts and techniques while handling electricity.
CO5	Choose protection methods for hazardous electrical equipment.

Course Code	**:**	**ME680**
Course Title	**:**	**Human factors and ergonomics**
Type of Course	**:**	PE
Prerequisites	**:**	NIL
Contact Hours	**:**	3 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Elements of man-machine interaction to enhance work place safety.
CLO2	Human behavior and perception to create and promote a safe working culture.
CLO3	Designing displays and controls that are easy to use and minimize user fatigue.
CLO4	Optimizing human-computer interaction by considering cognitive factors and user behaviour.
CLO5	Applying ergonomic principles to create workstations and tools that prevent musculoskeletal disorders.

Course Content

INTRODUCTION

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

HUMAN BODY AS A MECHANICAL SYSTEM

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

ANTHROPOMETRY AND WORKSTATION DESIGN

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

Anatomy of human posture, Fundamental aspects of standing and sitting, effective workstation design, visual, postural and temporal requirements, holding times for static postures, footrests and foot rails, ergonomics of seated work, dynamic postures, visual

display terminals, guidance for office workstation design, work surface design, static work-risk assessment, rapid entire body assessment of working posture using composite risk zone ratings.

REPETITIVE RISK ASSESSMENT AND DESIGN OF MANUAL HANDLING

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

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

DISPLAY, CONTROLS AND VIRTUAL ENVIRONMENTS

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

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

References

1	R S Bridger. 2017 *Introduction to Human Factors and Ergonomics*. CRC Press.
2	E J McCormick, Mark S Sanders 1992 *Human Factors in Engineering and Design.* McGraw-Hill Education.
3	K.H.E. Kroemer. 2001 *Ergonomics: How to Design for Ease and Efficiency*. 2nd edn. Prentice Hall International Series in Industrial and Systems Engineering.
4	Wickens C.D., Lee, J.D., Liu, Y. and Gordon Becker S. 2004 *An Introduction to Human Factors in Engineering*. 2nd edn. Prentice Hall International Series in Industrial and Systems Engineering.
5	Jan Dul and Bernard Weerdmeester. 2008 *Ergonomics for Beginners: A Quick Reference Guide*. 3rd edn. CRC Press

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Identify musculoskeletal disorders in the work environment and behavioral aspects of work place posture.
CO2	Apply anthropometry in designing work stations.
CO3	Analyze the ergonomic aspects of repetitive work and thereby prevent work-related musculoskeletal disorders.
CO4	Relate human sensory, cognitive, physical capabilities and limitations and suitably design work place displays and controls.
CO5	Design effective displays and controls for visual perception, attention, and cognitive load.

Course Code	**:**	**ME681**
Course Title	**:**	**Industrial noise and vibration control**
Type of Course	**:**	PE
Prerequisites	**:**	NIL
Contact Hours	**:**	3 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Concepts of vibration and noise, including their causative factors.
CLO2	Measurement and control of vibration and noise in industrial environments.
CLO3	Noise generation mechanisms and rating standards across different environments.
CLO4	Techniques for controlling and minimizing noise through various methods and materials.
CLO5	Active noise attenuation techniques and strategies for reducing industrial noise.

Course Content

INTRODUCTION

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

INSTRUMENTATION AND AUDITORY

Sensors used in vibration and measurements – Frequency and spectrum analysers Weighting networks – Hearing mechanism – relation between subjective and objective sounds – Auditory effects of noise and audiometric testing – Speech interference levels and their 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 legislation 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. Active noise attenuators and scope for abatement of industrial noise.

References

1	Irwin, J.D. and Graf, E.R., 1979. *Noise and Vibration Control*. Prentice Hall Inc., New Jersey.
2	Crandall, I.B., 1974. *Theory of Vibrating Systems and Sound*. D. Van Nostrand Company, New Jersey.
3	Harris, C.M., 1971. *Handbook of Noise Control*. McGraw Hill Book Company, New York
4	White, R.G. and Walker, J.G., 1982. *Noise and Vibration*. John Wiley and Sons, New York.

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Explain the basic concepts of vibration.
CO2	Interpret the working of musculoskeletal system and applications of anthropometry.
CO3	Evaluate mechanical work capacity.
CO4	Describe the established biomechanical models and their intervention with health and safety systems.
CO5	Describe the implications of whole body and segmental vibrations in the work environment.

Course Code	**:**	**ME682**
Course Title	**:**	**Work study and ergonomics**
Type of Course	**:**	PE
Prerequisites	**:**	NIL
Contact Hours	**:**	3 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Principles, need and application of work study in organizations.
CLO2	Man-machine interface to create a safe and sustainable work environment.
CLO3	Ergonomic principles to enhance worker comfort, reduce strain, and optimize workspace design.
CLO4	Safe and efficient processes and equipment, focusing on machine safety, layout, and maintenance.
CLO5	Interaction between humans and machines, focusing on risk factors, control systems, and performance enhancement.

Course Content

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 andsupervision – hazards and prevention.

MAN-MACHINE SYSTEMS

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

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

References

1	International Labour Organization (ILO), 1991. *Introduction to Work Study*. Oxford and IBH Publishing Company, Bombay
2	National Productivity Council, 1995. *Work Study*. National Productivity Council, New Delhi
3	McCormick, E.J. and Sanders, M.S., *Human Factors in Engineering and Design*. TMH, New Delhi
4	Accident Prevention Manual for Industrial Operations", NSC Chicago, Third Edition, 2008.

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Employ and conduct work study in organizations.
CO2	Apply the principles of ergonomics in industrial work environment.
CO3	Apply the process of inherently safer design.
CO4	Practice the procedures for procurement, storage, inspection and testing of personal protective equipments.
CO5	Relate the interaction between man and machine to improve safety levels in industrial environment.

Course Code	**:**	**ME683**
Course Title	**:**	**Safety in textile industry**
Type of Course	**:**	PE
Prerequisites	**:**	NIL
Contact Hours	**:**	3 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Hazards, occupational diseases and control measures specific to textile industries.
CLO2	Health and safety measures applicable for textile process industries.
CLO3	Accident hazards in various textile processes, including sizing, weaving, knitting, and non-woven fabric production.
CLO4	Process flows and safety measures in textile manufacturing.
CLO5	Relevant safety regulations, including the Factories Act, and manage effluent treatment and waste disposal in the textile industry.

Course Content

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 shuttles loom iii) knitting machines iv) non-wovens. Scouring, bleaching, dyeing, punting, mechanical finishing operations and effluents in textile processes.

HEALTH AND WELFARE

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

SAFETY STATUS

Relevant provisions of the Factories Act and rules and other statutes applicable to the textile industry – effluent treatment and waste disposal in the textile industry.

References

1	Safety in Textile Industry" Thane Belapur Industries Association, Mumbai.
2	Quality tolerances for water for textile industry", BIS.
3	Groover and Henry DS, "Handbook of textile testing and quality control".
4	Shenai, V.A., 1985. *Technology of Textile Processing*, Vol. I, Textile Fibres.
5	Little, A.H., 1975. "Water supplies and the treatment and disposal of effluent".

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Recognize the hazards present in textile processing activities.
CO2	Interpret the accident hazards, guarding of machinery and safety precautions for textile industry.
CO3	Identify the occupational hazards and associated diseases in the textile industry.
CO4	Choose appropriate personal protective equipment relevant to textile industry.
CO5	State relevant provisions of acts and rules applicable to safety in textile industry.

Course Code	**:**	**ME684**
Course Title	**:**	**Sensitivity measurements and evaluation of energetic material**
Type of Course	**:**	PE
Prerequisites	**:**	NIL
Contact Hours	**:**	3 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Explosion and sensitivity characteristics of energetic materials.
CLO2	Mechanism of explosion of various explosive materials.
CLO3	Mechanical and thermal sensitivity tests for various energetic materials.
CLO4	Kinetics of unstable energetic materials, including reaction rates and activation energy.
CLO5	Theoretical methods to evaluate explosive properties and understand ignition mechanisms.

Course Content

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, thermal 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

References

1	Mohamed-Suceska, B., 2017. *Test Methods for Explosives*. Springer.
2	Bement, L.J. and Schimmel, M.L., 1995. *A Manual for Pyrotechnic Design, Development, and Qualification*. Wiley.
3	Center for Chemical Process Safety (CCPS) of the American Institute of Chemical Engineers, 1995. *Guidelines for Chemical Reactivity Evaluation and Application to Process Design*. Wiley.
4	Haines, P. (ed.) (2002) *Principles of Thermal Analysis and Calorimetry*. Cambridge: RSC Paperbacks.

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Describe the combustion and detonation mechanisms of energetic materials.
CO2	Outline the various mechanical and thermal sensitivity test methods for energetic materials.
CO3	Appraise the kinetics of thermal decomposition and methods to measure kinetic parameters.
CO4	Analyze the influence of physical and chemical characteristics on the behaviour of pyrotechnics, propellants, and explosives.
CO5	Evaluate methods for determining explosive properties, including oxygen balance and initiation mechanisms.

Course Code	**:**	**ME685**
Course Title	**:**	**Safety in powder handling**
Type of Course	**:**	PE
Prerequisites	**:**	NIL
Contact Hours	**:**	3 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Powder classification, handling methods, and the behaviour of charges on powders.
CLO2	Production, characterization, safety, and industrial applications of metal powders.
CLO3	Causes, characteristics, testing, and prevention of dust explosions in industrial settings.
CLO4	Equipment and processes involved in dust handling, along with the associated electrostatic hazards and safety measures.
CLO5	Assessment and management of dust hazards, focusing on control strategies, worker protection, and environmental safety.

Course Content

INTRODUCTION

Powder classification-physical, chemical and other properties powders-other non-metallic powders-handling methods, 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, flow rate – testing.

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

DUST EXPLOSION

Industrial dust, dust explosion accidents – explosibility characteristics, minimum explosive concentration, minimum ignition energy, explosion pressure characteristics, maximum permissible oxygen concentration, spontaneous ignition-explosibility tests, Hartmann vertical tube apparatus, horizontal tube apparatus, inflammatory apparatus, Godbert and Greenward furnace. Explosibility

classification – Hybrid test – gas mixtures – Dust ignition sources – Dust explosion prevention – Dust explosion protection – Dust explosion venting, vent coefficient, various methods of design – venting of ducts and pipes – dust fire.

DUST HANDLING PLANTS AND ELECTROSTATIC HAZARDS

Grinding mills, conveyors, bucket elevators, dust separators, dust filters, cyclones, driers, spraydriers, silos, grain elevators, typical applications, and hazards.

Electrostatic charges - energy released - type of discharge - spark- corona - 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 – the 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	Martin Glor 1988, *Electro Static Hazard in Powder Handling,* Research Studies Press Ltd, England.
2	International Labour Office 1988, *Major Hazard Control.*
3	Seminar on "*Hazard recognition and prevention in the workplace-airborne dust*" Vol.1and 2, SRMC, Chennai, 4/5, Sept.2000.
4	G.F Vander Voort 2004, *ASM Handbook Powder Metallurgy Vol 9,* ASM International.

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Classify the powders based on their sensitivity.
CO2	Understand and discuss the techniques for screening and cleaning metals.
CO3	Identify the various tests and apparatus used in the evaluation of dust explosion.
CO4	Recognize hazardous materials and their safe handling.
CO5	Describe the procedures and control measures for particulates.

Course Code	**:**	**ME686**
Course Title	**:**	**Nuclear engineering and safety**
Type of Course	**:**	PE
Prerequisites	**:**	NIL
Contact Hours	**:**	3 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Elements of nuclear engineering, safe design and operation of nuclear equipment.
CLO2	Control measures to mitigate the release of radiation and safe disposal of radioactive materials.
CLO3	Design and operation of nuclear reactors, focusing on different reactor types and their components.
CLO4	Regulatory requirements and standards governing nuclear reactor operation and safety.
CLO5	Influence of human factors on nuclear safety, including operator training, human-machine interfaces, and error prevention.

Course Content

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 andmonitoring – 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 – environmentalreleases.

REFERENCES:

1	Wakil, M.M.E.L., 1986. *Nuclear Power Engineering*. McGraw-Hill Inc., US.
2	Mannan, S., 2012. *Lees' Loss Prevention in the Process Industries: Hazard Identification, Assessment and Control*. Butterworth-Heinemann, UK.
3	Wakil, M.M.E.L., 1982. *Nuclear Energy Conversion*. Amer Nuclear Society.
4	Murray, R.L., 1961. *Introduction to Nuclear Engineering*. Prentice Hall.
5	Sri Ram, K., 1990. *Basic Nuclear Engineering*. South Asia Book.
6	Loffness, R.L., 1979. *Nuclear Power Plant*. Van Nostrand Publications.

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Describe the elements of nuclear engineering.
CO2	Illustrate control requirements in design of nuclear equipment.
CO3	Identify various types of nuclear reactor.
CO4	Demonstrate the safe design and operations of nuclear reactors.
CO5	Apply control measures for radioactivity release and radiation release.

Course Code	**:**	**ME687**
Course Title	**:**	**Disaster management**
Type of Course	**:**	PE
Prerequisites	**:**	NIL
Contact Hours	**:**	3 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Principles and elements of disaster management and emergency preparedness.
CLO2	Control measures to mitigate the effects of industrial disasters.
CLO3	Effective disaster preparedness plans, including risk assessment, resource allocation, and community education. .
CLO4	Processes involved in post-disaster recovery and rehabilitation, including damage assessment, rebuilding efforts, and psychological support for affected populations.
CLO5	The role of technology in disaster management, including the use of geographic information systems (GIS), early warning systems, and data analysis tools.

Course Content

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-Software's on emergency controls-Monitoring devices for detection of gases in the atmosphere-Right to know act.

Introduction to Sustainable Development-Biodiversity-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-theimmune 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.	Masters, G.M. and Ela, W.P., 2015. *Introduction to Environmental Engineering and Science*. Pearson Education India
2.	Miller, G.T., 2010. *Environmental Science*. Brooks/Cole.
3.	Miller, G.T., 2000. *Environmental Science: Working the Earth*. Wadsworth Publishing Co Inc
4.	Vilas, B., 2006. *Principles of Environmental Science and Engineering*. Prentice Hall India Learning Private Limited
5.	Sivakumar, R., 2005. *Principles of Environmental Science and Engineering*. Vijay Nicole Imprints.

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Describe the elements of disaster management practices.
CO2	Develop on-site and off-site emergency plans for hazardous industries and coordinate the implementation of the same.
CO3	Conduct environmental impact assessment for sustainable development.
CO4	Conduct detailed risk assessments and develop effective strategies to mitigate disaster impacts on vulnerable communities.
CO5	Design and implement comprehensive disaster preparedness and response strategies for various disaster scenarios.

Course Code	**:**	**ME688**
Course Title	**:**	**ISO 45001 and ISO 14001**
Type of Course	**:**	PE
Prerequisites	**:**	NIL
Contact Hours	**:**	3 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	ISO 45001 Standard Development and Structure
CLO2	Creating and Implementing Effective OH&S Policies and Plans.
CLO3	Operational Planning, Control, and Emergency Preparedness.
CLO4	Monitoring, Checking, and Continual Improvement of OH&S Performance.
CLO5	Integrating Environmental Management Systems (EMS) with ISO 45001.

Course Content

ISO 45001 STANDARD

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

ISO 45001 POLICY, PLANNING, SUPPORT AND OPERATION

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

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

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

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

IMPLEMENTATION AND OPERATION, CHECKING AND REVIEW

Guidelines for structure and Responsibilities, Top Management, middle level management, Co-ordinator and employees - Developing procedures, identifying 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 14001 based EMS, steps in ISO 14001.

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

ENVIRONMENT IMPACT ASSESSMENT

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

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

References

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-14001:2015, ISO 45001:2018.

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Explain the development and structure of the ISO 45001 standard.
CO2	Develop and implement effective Occupational Health and Safety (OH&S) policies.
CO3	Formulate and execute operational and emergency planning and control measures.
CO4	Design and manage training and communication programs.
CO5	Conduct performance measurement, monitoring, and reviews of OH&S systems.

Course Code	**:**	**ME689**
Course Title	**:**	**Safety in refrigeration and cryogenics**
Type of Course	**:**	OE
Prerequisites	**:**	NIL
Contact Hours	**:**	3 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Fundamental principles of refrigeration and cryogenics.
CLO2	Impact of refrigerants and cryogenic fluids on the environment.
CLO3	Safety measures applicable for refrigeration and cryogenics.
CLO4	Properties and handling of cryogenic fluids, mitigating potential hazards and environmental risks.
CLO5	Safe operation and maintenance of refrigeration and air conditioning systems, including those using alternative refrigerants.

Course Content

INTRODUCTION TO FUNDAMENTALS

Basics of thermodynamic processes, Thermodynamic Laws, Introduction to Refrigeration, Air-conditioning and cryogenics, Vapor compression systems: Ideal and actual cycles.

REFRIGERANTS AND THEIR IMPACT ON ENVIRONMENT

Refrigerants and its classification – Need of alternate refrigerants, Flammability of the alternate refrigerants, methods for identifying the safe zone of operation, Measuring the financial and environmental impact of leakage of refrigerants on the environment, Refrigerant hazards.

SAFETY IN REFRIGERATION AND AIR - CONDITIONING

Safety and risk assessment of alternative refrigerants, System design using alternative refrigerants, Leak detection of alternative refrigerants, Maintenance and repair of alternative refrigerant systems, and Retrofitting existing systems.

SAFETY IN CRYOGENICS

Introduction to Cryogenic fluids and their properties, behaviour of cryogenics fluids, production of cryogenic fluids, safety measures to handle cryogenic fluids, environmental impact of cryogenic fluids on the environment, cold related illness and injuries – wind chill temperature index.

References

1	Arora, R.C.,2010. *Refrigeration and Air Conditioning*, PHI Learning Pvt. Ltd.
2	Arora, C.P.,2017. *Refrigeration and Air Conditioning*, 3rd Edition, Tata McGraw-Hill.
3	Randall F.,1985. *Barron, Cryogenic Systems*, McGraw-Hill.
4	NPTEL: *Cryogenics Engineering* by Prof. M. D. Atrey, IIT Bombay <https://archive.nptel.ac.in/courses/112/101/112101004/>

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Interpret the hazards and safety precautions in refrigeration and cryogenics.
CO2	Choose appropriate refrigerant by keeping application and environmental safety into account.
CO3	Articulate and administer safety measures specific to refrigerants
CO4	Understand the properties and hazards of cryogenic fluids, implement safe handling procedures, and mitigate environmental impact.
CO5	Gain comprehensive understanding of refrigeration, air conditioning, and cryogenics systems, emphasizing safety, environmental responsibility, and efficient operation.

Course Code	**:**	**ME690**
Course Title	**:**	**Biomechanics and human body vibration**
Type of Course	**:**	OE
Prerequisites	**:**	NIL
Contact Hours	**:**	3 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Concepts of biomechanical systems and human body vibration.
CLO2	Biomechanical models to enhance occupational health and safety.
CLO3	Use of different biomechanical static and dynamic body movements for various applications.
CLO4	Understanding vibration concepts, including exciters, control systems, and sensors used to measure and control vibration.
CLO5	Assessment of the effects of whole-body and segmental vibration on human health and apply exposure criteria to manage vibration risks.

Course Content

INTRODUCTION

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

MUSCULOSKELETAL 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.

References

1	De Silva, C.W. ed., 2005. *Vibration and shock handbook*. CRC press.
2	Don B. Chaffin, Gunnar B. J. Andersson, Bernard J. Martin, 2006. Occupational biomechanics. John wiley & sons.
3	Winter, D. A. (2009). *Biomechanics and motor control of human movement*. John wiley & sons.
4	NPTEL: "Principles of Vibration Control" by Prof. Bishakh Bhattacharya" IIT Kanpur <https://archive.nptel.ac.in/courses/112/104/112104211/>

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Explain the basic concepts of vibration.
CO2	Interpret the working of the musculoskeletal system and applications of anthropometry.
CO3	Evaluate mechanical work capacity.
CO4	Describe the established biomechanical models and their intervention with health and safety systems.
CO5	Illustrate the implications of whole body and segmental vibrations in work environment.

Course Code	**:**	**ME691**
Course Title	**:**	**Safety in on and off shore drilling**
Type of Course	**:**	OE
Prerequisites	**:**	NIL
Contact Hours	**:**	3 hrs.
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives

The objective of this course is to imbibe knowledge on:

CLO1	Hazards and risks prevailing in petrochemical industries and emergency preparedness of petrochemical industries.
CLO2	Measures to improve health and safety in petrochemical industries statutory and regulatory requirements of petrochemical industries.
CLO3	Analysing the environmental impact of petroleum operations and explore mitigation strategies.
CLO4	Offshore and onshore oil operations, including drilling, extraction, transportation, and storage safety.
CLO5	Potential hazards associated with the petroleum industry and implement safety measures.

Course Content

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	International Labour Organisation, 1985. *Encyclopaedia of Occupational Health and Safety*, vol. II. Geneva: International Labour Organisation.
2	Sutton, I. (2013). *Offshore safety management: Implementing a SEMS program*. William Andrew.
3	Khalique, A. (2015). *Basic Offshore Safety: Safety induction and emergency training for new entrants to the offshore oil and gas industry*. Routledge.
4	Lyons, William. *Working guide to drilling equipment and operations*. Gulf professional publishing, 2009.

Course Outcomes (CO)

At the end of the course, student will be able to:

CO1	Describe the health and safety issues involved in the processing of petroleum products.
CO2	Interpret the hazards associated with oil and petroleum extraction and employ control measures to ensure safe working environment.
CO3	Practice standard operating procedures for safe handling and storage of petroleum products.
CO4	Gain knowledge on oil exploration, extraction, transportation, and storage processes, emphasizing safety protocols and environmental considerations.
CO5	Assess and mitigate risks associated with petroleum operations, including emergency response and prevention.