## SEMESTER I

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**TOTAL CREDITS TO BE EARNED FOR THE AWARD THE DEGREE = 66**

# LIST OF ELECTIVES

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MA  PROBABILITY AND RELIABILITY  L T P C  3 1 0 4

OBJECTIVE
To provide basic concepts of Probability and Reliability.

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

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

UNIT III
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.

UNIT IV
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.

UNIT V

REFERENCES
1. BOWKER and LIBERMAN, Engineering Statistics, Prentice-Hall.
2. GUPTA, S.C. and KAPOOR, V.K., Fundamentals of Mathematical

TOTAL: 60 PERIODS
OBJECTIVE

To train in computer programming and use of software tools for solving chemical engineering problems.

PART - A

DEVELOPMENT OF COMPUTER PROGRAMS

1. Simple problems
2. Mathematical series (Taylor series), random number generation
3. Solution of equation of states for non-ideal gas mixtures (van der Waals, Virial and RKS equations)
4. Solution of thermodynamic equilibrium (UNIQUEAC, UNIFAO, NRTL) models
5. Solution of conductive heat transfer through composite walls
6. Solution of diffusive mass transfer through a stagnant gas film

PART – B

USE OF SOFTWARES

7. Determination of Laplace transform
8. Solution of algebraic equations
9. Solution of ordinary differential equations (ODE)
10. Numerical integration
11. Regression analysis
12. Design of CSTR and PFR
13. Design of double pipe heat exchanger
14. Design of binary distillation column

REFERENCES


TOTAL: 45 PERIODS
OBJECTIVE

To ensure that safety in chemical industry.

UNIT I SAFETY IN PROCESS DESIGN AND PRESSURE SYSTEM DESIGN  10

Design process, conceptual design and detail design, assessment, inherently safer design chemical reactor, types, batch reactors, reaction hazard evaluation, assessment, reactor safety, operating conditions, unit operations and equipments, utilities. Pressure system, pressure vessel design, standards and codes- pipe works and valves- heat exchangers- process machinery- over pressure protection, pressure relief devices and design, fire relief, vacuum and thermal relief, special situations, disposal- flare and vent systems failures in pressure system.

UNIT II PLANT COMMISSIONING AND INSPECTION  8

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.

UNIT III PLANT MAINTENANCE, MODIFICATION AND EMERGENCY PLANNING  10

Management of maintenance, hazards- preparation for maintenance, isolation, purging, cleaning, confined spaces, permit system- maintenance equipment- hot works- tank cleaning, repair and demolition- online repairs- maintenance of protective devices- modification of plant, problems- controls of modifications. Emergency planning, disaster planning, onsite emergency- offsite emergency, APELL

UNIT IV STORAGES AND TRANSPORTATION  12

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

Operating discipline, operating procedure and inspection, format, emergency procedures hand over and permit system- start up and shut down operation, refinery units- operation of fired heaters, driers, storage- operating activities and hazards- trip systems- exposure of personnel. Specific safety consideration for Cement, paper, pharmaceutical, petroleum, petro- chemical, rubber, fertilizer and distilleries.

TEXT BOOK


TOTAL: 45 PERIODS
OBJECTIVE

To provide comprehensive knowledge on PHA, HAZOP, Thermal analysis and BAM testing.

UNIT I HAZARD, RISK ISSUES AND HAZARD ASSESSMENT

Introduction, hazard, hazard monitoring-risk issue - Hazard assessment, procedure, methodology; safety audit, checklist analysis, what-if analysis, safety review, preliminary hazard analysis (PHA), hazard operability studies (HAZOP)

UNIT II INSTRUMENTATION

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

UNIT III TESTING

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.

UNIT IV RISK ANALYSIS QUANTIFICATION AND SOFTWARES

Fault Tree Analysis & Event Tree Analysis, Logic symbols, methodology, minimal cut set ranking - fire explosion and toxicity index (FETI), various indices - Hazard analysis (HAZAN) - Failure Mode and Effect Analysis (FMEA) - Basic concepts of Software on Risk analysis, CISCON, FETI, ALOHA

UNIT V CONSEQUENCES ANALYSIS

Logics of consequences analysis - Estimation - Hazard identification based on the properties of chemicals - Chemical inventory analysis - identification of hazardous processes - Estimation of source term, Gas or vapour release, liquid release, two phase release - Heat radiation effects, BLEVE, Pool fires and Jet fire-Gas/vapour dispersion - Explosion, UVCE and Flash fire, Explosion effects and confined explosion - Toxic effects - Plotting the damage distances on plot plant/layout.

REFERENCES:

3. Hazop and Hazon, by Trevor A Klett, Institute of Chemical Engineering.
4. Quantitative Risk assessment in Chemical Industries, Institute of Chemical Industries, Centre for Chemical process safety.

Total: 45 PERIODS
OBJECTIVE

To provide advanced concepts of EIA and EMS.

UNIT I

UNIT II
Rapid and Comprehensive EIA – Legislative and Environmental Clearance procedure in India – Prediction tools for EIA.

UNIT III

UNIT IV
Socio cultural environment – Public participation – Resettlement and Rehabilitation.

UNIT V
Documentation of EIA – Environmental management plan – Post project monitoring – Environmental Audit- Life cycle assessment – EMS – case studies in EIA.

REFERENCES:


Total: 45 PERIODS
OBJECTIVE

To provide comprehensive knowledge of safety and hazards aspects in industries and the management of hazards.

UNIT I FIRE AND EXPLOSION


UNIT II RELIEF SYSTEMS

Preventive and protective management from fires and explosion-inerting, static electricity passivation, ventilation, and sprinkling, proofing, relief systems – relief valves, flares, scrubbers.

UNIT III TOXICOLOGY

Hazards identification-toxicity, fire, static electricity, noise and dust concentration; Material safety data sheet, hazards indices- Dow and Mond indices, hazard operability (HAZOP) and hazard analysis (HAZAN).

UNIT IV LEAKS AND LEAKAGES

Spill and leakage of liquids, vapors, gases and their mixture from storage tanks and equipment; Estimation of leakage/spill rate through hole, pipes and vessel burst; Isothermal and adiabatic flows of gases, spillage and leakage of flashing liquids, pool evaporation and boiling; Release of toxics and dispersion. Naturally buoyant and dense gas dispersion models; Effects of momentum and buoyancy; Mitigation measures for leaks and releases.

UNIT V CASE STUDIES

Flixborough, Bhopal, Texas, ONGC offshore, HPCL Vizag and Jaipur IOC oil-storage depot incident; Oil, natural gas, chlorine and ammonia storage and transportation hazards.

REFERENCES


**TOTAL: 45 PERIODS**
OBJECTIVE

To train on process simulators and CFD software for solving complex Engineering problems.

1. Introduction to process simulators and CFD software- ASPEN PLUS, HYSYS and FLUENT
2. Simulation of a batch reactor
3. Simulation of a chemostat
4. Simulation of a shell and tube heat exchanger
5. Simulation of a condenser
6. Simulation of a pump/compressor
7. Simulation of a fixed bed absorber
8. Simulation of a staged distillation column
9. Simulation of flow in channels and pipes
10. Simulation of flow in sudden expansion/contraction systems
11. Simulation of flow in a square cavity
12. Process simulation study (flow sheeting)- Production of hydrogen by Stream reforming
13. Process simulation study (flow sheeting)- Production of vinyl chloride monomer flowsheet.
14. Process simulation study (flow sheeting)- Production of nitric acid from anhydrous ammonia

REFERENCES


\textbf{TOTAL: 45 PERIODS}
OBJECTIVE

To ensure that safety in Engineering industry.

UNIT I SAFETY IN METAL WORKING MACHINERY AND WOOD WORKING MACHINES

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

UNIT II PRINCIPLES OF MACHINE GUARDING


UNIT III SAFETY IN WELDING AND GAS CUTTING

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

UNIT IV SAFETY IN COLD FORMING AND HOT WORKING OF METALS

Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot-operated presses, power press electric controls, power press set up and die removal, inspection and maintenance-metal sheers-press brakes. Hot working safety in forging, hot rolling mill operation, safe guards in hot rolling mills – hot bending of pipes, hazards and control measures.Safety in gas furnace operation, cupola, crucibles, ovens, foundry health hazards, work environment, material handling in foundries, foundry production cleaning and finishing foundry processes

UNIT V SAFETY IN FINISHING, INSPECTION AND TESTING

Heat treatment operations, electro plating, paint shops, sand and shot blasting, safety in inspection and testing, dynamic balancing, hydro testing, valves, boiler drums and headers,
pressure vessels, air leak test, steam testing, safety in radiography, personal monitoring devices, radiation hazards, engineering and administrative controls, Indian Boilers Regulation. Health and welfare measures in engineering industry-pollution control in engineering industry-industrial waste disposal.

REFERENCES

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

TOTAL: 45 PERIODS
OBJECTIVE

To impart knowledge about regulations for health, safety and environment.

UNIT I

Factories act and rules; Workmen compensation act.

UNIT II

Indian explosive act - Gas cylinder rules - SMPV Act - Indian petroleum act and rules.
Environmental pollution act

UNIT III

Manufacture, Storage and Import of Hazardous Chemical rules 1989

UNIT IV

Indian Electricity act and rules.

UNIT V

Overview of OHSAS 18000 and ISO 14000

REFERENCES:

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

To provide comprehensive knowledge on analyzing instrument.

1. NOISE LEVEL MEASUREMENT AND ANALYSIS


2. VIBRATION MEASUREMENT AND ANALYSIS


3. FRICTION SENSITIVITY TEST


4. IMPACT SENSITIVITY TEST

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

5. THERMAL REACTIVITY TEST

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

6. EXHAUST GAS MEASUREMENT AND ANALYSIS

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

7. BREATHING ZONE CONCENTRATION

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

8. AMBIENT AIR MONITORING

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

Soft computing skills on developing effects of fire & explosion and dispersion: Software – PHAST 1 and ALOHA

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

11. STUDY OF FIRE EXTINGUISHERS

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

TOTAL: 45 PERIODS
OBJECTIVE

To provide a structured management approach to control safety risks in operations. Effective safety management must take into account the organisation’s specific structures and processes related to safety of operations.

UNIT I CONCEPTS


UNIT II TECHNIQUES

Incident Recall Technique (IRT), disaster control, job safety analysis, safety survey, safety inspection, safety sampling, Safety Audit.

UNIT III ACCIDENT INVESTIGATION AND REPORTING


UNIT IV SAFETY PERFORMANCE MONITORING

ANSI (Z16.1) Recommended practices for compiling and measuring work injury experience – permanent total disabilities, permanent partial disabilities, temporary total disabilities - Calculation of accident indices, frequency rate, severity rate, frequency severity incidence, incident rate, accident rate, safety “t” score, safety activity rate – problems.

UNIT V SAFETY EDUCATION AND TRAINING

REFERENCES


Total: 45 PERIODS
OBJECTIVE

To ensure that safety in Construction Industry during material handling, inspection and maintenance.

UNIT I INTRODUCTION


UNIT II FOUNDATION


UNIT III MATERIALS AND STRUCTURES


UNIT IV INSPECTION IN HUGE STRUCTURES

Safety in typical civil structures – Dams-bridges-water Tanks-Retaining walls-Critical factors for failure- Regular Inspection and monitoring.

UNIT V MAINTENANCE

Maintenance – Training- Scheduling- Preventive maintenance-Lock out of Mechanical and Electrical maintenance-ground maintenance-hand tools-Gasoline operating equipment.

REFERENCES:


Total: 45 PERIODS
OBJECTIVE

To provide basic concepts of modeling and simulation of chemical engineering systems.

UNIT I INTRODUCTION

Introduction to process modeling and simulation

UNIT II MODELS

Models, need of models and their classification, models based on transport phenomena principles, scaling, alternate classifications of models, population balance, stochastic, and empirical models. Unit models of simple chemical engineering systems and their block diagrams.

UNIT III MODELING OF CHEMICAL ENGINEERING SYSTEMS

Reactors - fixed bed, fluidized bed and bioreactors (aerobic and anaerobic); Evaporators, cyclone separators, electrostatic precipitators; Stack dispersion modeling; Modeling of safety systems.

UNIT IV PROCESS SIMULATION


UNIT V NUMERICAL SIMULATION

Finite difference approximation of partial differential equations and their solutions.

REFERENCES


TOTAL: 45 PERIODS
OBJECTIVE

To ensure that safety in ergonomics of conveying and hoisting mechanisms and handling of heavy equipments.

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

UNIT II ERGONOMICS OF CONVEYING MECHANISMS
Ergonomic consideration in material handling, design, installation, operation and maintenance of Conveying equipments, hoisting, traveling and slewing mechanisms.

UNIT III ERGONOMICS OF HOISTING MECHANISMS
Ergonomic consideration in material handling, design, installation, operation and maintenance of driving gear for hoisting mechanism – Traveling mechanism

UNIT IV HANDLING OF HEAVY EQUIPMENTS
Selection, operation and maintenance of Industrial Trucks – Mobile Cranes – Tower crane – Checklist - Competent persons.

UNIT V STORAGE OF GOODS AND EQUIPMENTS
Storage and Retrieval of common goods of various shapes and sizes in a general store of a big industry.

REFERENCES:


TOTAL: 45 PERIODS
OBJECTIVE

To provide an understanding of sources of noise and industrial vibration control.

UNIT I INTRODUCTION

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

UNIT II INSTRUMENTATION AND AUDITORY

Sensors used in vibration and measurements – Frequency and spectrum analysers – Weighting networks – Hearing mechanism – relation between subjective and objective sounds – Auditory effects of noise and audiometric testing – Speech interference levels and its importance.

UNIT III SOURCES OF NOISE AND RATINGS

Mechanism of noise generation and propagation in various machinery and machine components, vehicles etc. – Directivity index – Concept of Leq and estimation – Noise ratings and standards for various sources like industrial, construction, traffic, aircraft community etc. – industrial safety and OSHA regulations – Noise legislations and management.

UNIT IV NOISE CONTROL


UNIT V ABATEMENT OF NOISE

Active noise attenuators and scope for abatement of industrial noise.

TEXT BOOK:

OBJECTIVE

To ensure that safety in on and off shore drilling operation, extraction and transportation.

UNIT I PETROLEUM PRODUCTS 10

UNIT II ON AND OFF SHORE OPERATION 10
On and off shore oil operation – Construction of Installation – Pipe line Construction – Maintenance and repair activities – Safety and associated hazards

UNIT III DRILLING 9
Drilling oil – Technique and equipment- Work position – Working condition – safety and associated hazards- lighting and its effects

UNIT IV EXTRACTION AND TRANSPORTATION 9
Petroleum Extraction and transport by sea – Oil field products – Operation – Transport of crude by sea – Crude oil hazards.

UNIT V STORAGE AND CLEANING 7
Petroleum product storage and transport – Storage equipment – Precaution – Tank cleaning

REFERENCES:


TOTAL: 45 PERIODS
OBJECTIVE

To provide electrical protection and maintenance in working environment and ensure that electrical safety.

UNIT I BASIC ELECTRICAL

UNIT II STANDARDS AND REQUIREMENTS
Standards and statutory requirements – Indian electricity acts and rules – statutory requirements from Electrical inspectorate.

UNIT III ELECTRICAL HAZARDS

UNIT IV ELECTRICAL PROTECTION AND MAINTENANCE
Selection of Environment, Protection and Interlock – Discharge rods and earthing device – Safety in the use of portable tools - Preventive maintenance

UNIT V CLASSIFICATION OF HAZARDOUS AREAS
Hazardous area classification and classification of electrical equipments for hazardous areas (IS, API and OSHA standards).

REFERENCES

3. www.osha.gov

TOTAL: 45 PERIODS
OBJECTIVE

To ensure that potential hazards are identified and mitigation measures are in place to prevent accidents. Also to know how to monitor the safety performance importance of training.

UNIT I CONCEPTS 5

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

UNIT II TECHNIQUES 8

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

UNIT III ACCIDENT INVESTIGATION AND REPORTING 12

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

UNIT IV SAFETY PERFORMANCE MONITORING 10

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.

UNIT V SAFETY EDUCATION AND TRAINING 10

REFERENCES


TOTAL: 45 PERIODS
OBJECTIVE

To provide comprehensive knowledge on design of air pollution control system.

UNIT I AIR POLLUTION

UNIT II PARTICULATE POLLUTANTS AND CONTROL

UNIT III GASEOUS POLLUTANTS AND CONTROL
Gaseous Pollutant control: Gas absorption in tray and packed towers – Absorption with / Without chemical reaction – Removal of SO2 – Absorption in fixed blades- Breakthrough.

UNIT IV TOXIC POLLUTANTS REMOVAL
Removal of HCs / VOCs – NOx removal – Wet scrubbers.

UNIT VAIR POLLUTION CONTROL
Integrated Air pollution control systems.

REFERENCES:


Total: 45 PERIODS
OBJECTIVE

To provide basic concepts of fire engineering and explosion control.

UNIT I
Fire chemistry – Dynamics of fire behavior – Fire properties of solid, liquid and gas – Fire spread – Toxicity of products of combustion

UNIT II
Industrial fire protection systems – Sprinkler – Hydrants- Stand pipe- Special fire suppression system like deluge and emulsifier.

UNIT III
Building evaluation for fire safety – Fire load – Fire resistance materials and fire testing – Structural Fire protection – Exits and egress.

UNIT IV
Explosion protection systems – Explosion parameters – Explosion suppression system based on CO2 and Halon – Hazards in L.P.G handling.

UNIT V

REFERENCES:


Total: 45 PERIODS
OBJECTIVE

To provide advanced concepts of momentum, mass and heat transfer operations.

UNIT I INTRODUCTION

Review of basic principles and equations of change in transport of momentum, heat and mass; Viscosity, thermal conductivity and diffusivity; Shell balance for simple situations to obtain shear stress, velocity, heat flux, temperature, mass flux and concentration distributions.

UNIT II EQUATIONS OF CHANGE

Equations of continuity, motion, mechanical energy, angular momentum, energy, and equation of continuity for multi component mixture. Use of the equations of change in solving problems of momentum, heat and mass transport, dimensional analysis of the equation of change.

UNIT III DISTRIBUTIONS WITH MORE THAN ONE INDEPENDENT VARIABLE

Unsteady state flow, heat and mass transfer problems, creeping flow around a sphere, flow through a rectangular channel, unsteady heat conduction in slabs with and without changing heat flux, heat conduction in laminar in compressible flow, potential flow of heat in solids, unsteady state diffusive mass transport, steady state transport of mass in binary boundary layers.

UNIT IV TRANSPORT OF MASS, MOMENTUM AND HEAT UNDER TURBULENT FLOW CONDITIONS

Velocity, temperature and concentration distributions in smooth cylindrical tubes for incompressible fluids, empirical equations for various transport fluxes and momentum.

UNIT V INTERPHASE TRANSPORT IN ISOTHERMAL AND NON-ISOTHERMAL MIXTURES

Definitions of friction factor and heat and mass transfer coefficients; Heat and mass transfer in fluids flowing through closed conduits and packed beds; Mass transfer accompanied with chemical reaction in packed beds; Combined heat and mass transfer by free and forced convection; Transfer coefficients at high net mass transfer rate. Macroscopic Balances-Momentum, heat and mass balances and their application, use of macroscopic balances in steady and unsteady state problems; Cooling and heating of a liquid in stirred tank, start-up of a chemical reactor.
REFERENCES


TOTAL: 45 PERIODS