

**UNIVERSITY DEPARTMENTS**  
**ANNA UNIVERSITY :: CHENNAI 600 025**  
**REGULATIONS - 2013**

**I TO IV SEMESTERS CURRICULUM AND SYLLABI (FULL TIME)**  
**M.TECH. INDUSTRIAL SAFETY AND HAZARDS MANAGEMENT**

**SEMESTER I**

COURSE CODE	COURSE TITLE	L	T	P	C
<b>THEORY</b>					
IH8101	Computer Aided Hazards Analysis	3	0	0	3
IH8102	Computer Programming and Software Tools	3	1	0	4
IH8103	Safety in Chemical Industry	3	0	0	3
MA8159	Probability and Reliability	3	1	0	4
	Elective I	3	0	0	3
	Elective II	3	0	0	3
<b>TOTAL</b>		<b>18</b>	<b>2</b>	<b>0</b>	<b>20</b>

**SEMESTER II**

COURSE CODE	COURSE TITLE	L	T	P	C
<b>THEORY</b>					
IH8201	Environmental Pollution Control and Industrial Hygiene	3	0	0	3
IH8202	Industrial Safety and Hazards Management	3	0	0	3
IH8203	Process Simulators	3	0	0	3
IH8204	Regulation for Health, Safety and Environment	3	0	0	3
IH8205	Safety in Engineering Industry	3	0	0	3
	Elective III	3	0	0	3
<b>PRACTICAL</b>					
IH8211	Industrial Safety Lab	0	0	3	2
IH8212	Seminar	0	0	3	1
<b>TOTAL</b>		<b>18</b>	<b>0</b>	<b>6</b>	<b>21</b>

**SEMESTER III**

COURSE CODE	COURSE TITLE	L	T	P	C
<b>THEORY</b>					
	Elective IV	3	0	0	3
	Elective V	3	0	0	3
<b>PRACTICAL</b>					
IH8311	Practical Training	0	0	0	1
IH8312	Project Work (Phase I)	0	0	12	6
<b>TOTAL</b>		<b>6</b>	<b>0</b>	<b>12</b>	<b>13</b>

## SEMESTER IV

COURSE CODE	COURSE TITLE	L	T	P	C
<b>PRACTICAL</b>					
IH8411	Project Work (Phase II)	0	0	24	12
<b>TOTAL</b>		<b>0</b>	<b>0</b>	<b>24</b>	<b>12</b>

## LIST OF ELECTIVES

### M.TECH. INDUSTRIAL SAFETY AND HAZARDS MANAGEMENT

COURSE CODE	COURSE TITLE	L	T	P	C
IH8001	Advanced Transport Phenomena	3	0	0	3
IH8002	Design of Air Pollution Control System	3	0	0	3
IH8003	Electrical Safety	3	0	0	3
IH8004	Fire Engineering and Explosive Control	3	0	0	3
IH8005	Industrial Noise and Vibration Control	3	0	0	3
IH8006	Modelling and Simulation of Chem. Engg. Systems	3	0	0	3
IH8007	Principles of Technical Analysis	3	0	0	3
IH8008	Process Safety Management in Industry	3	0	0	3
IH8009	Safety in Construction	3	0	0	3
IH8010	Safety in Material Handling	3	0	0	3
IH8011	Safety in On and Off Shore Drilling	3	0	0	3
IH8012	Safety Management	3	0	0	3

PROGRESS THROUGH KNOWLEDGE

Attested

  
**DIRECTOR**

**OBJECTIVE**

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

**UNIT I HAZARD, RISK ISSUES AND HAZARD ASSESSMENT 10**

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 8**

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 8**

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 9**

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 10**

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.

**TOTAL: 45 PERIODS**

**REFERENCES**

1. Loss Prevention in Process Industries-Frank P. Less Butterworth-Hein UK 1990 (Vol.I, II & III)
2. Methodologies for Risk and Safety Assessment in Chemical Process Industries, Commonwealth Science Council, UK
3. Hazop and Hazon, by Trevor A Klett, Institute of Chemical Engineering.
4. Quantitative Risk assessment in Chemical Industries, Institute of Chemical Industries, Centre for Chemical process safety.
5. Guidelines for Hazard Evaluation Procedures, Centre for Chemical Process safety, AIChE 1992.

**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 (UNIQUAC, UNIFAQ, 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

**TOTAL : 60 PERIODS****REFERENCES**

1. Finlayson B.A., "Introduction to Chemical Engineering Computing", Wiley.2006.
2. Chapra S.C. and Canale R.P., "Numerical Methods for Engineers", 5<sup>th</sup>Ed., Tata McGraw-Hill.2006.
3. Elnashaie S. and Uhlig F., "Numerical techniques for Chemical and Biological Engineers using MATLAB – A Simple Bifurcation Approach", Springer.2007.
4. Attaway S., "MATLAB: A Practical Introduction to Programming and Problem Solving", Elsevier.2009.
5. White R.E., "Computational Mathematics – Models, Methods and Analysis with MATLAB and MPI", CRC Press.2004.
6. Beers K.J., "Numerical Methods for Chemical Engineering – Application in MATLAB" Cambridge University Press.2007.

**OBJECTIVE**

To impart the necessary skills and knowledge about handling hazardous chemicals and safety auditing.

**UNIT I CONCEPT OF SAFETY AND SAFETY AUDITING 4**

Introduction to the concept of safety- safety scenario-need for awareness creations and sensitising workers-safety audit and its importance.

**UNIT II HAZARDOUS CHEMICALS-PRECAUTIONS IN HANDLING 12**

Handling hazardous chemicals-pyrophoric nature of chemicals-methods of extinguishing chemical fires-precautions to be observed in handling alkali metals- Explosives – causative factors of explosions-need to monitor temperature during nitrations-handling ether-necessity to remove peroxides-preparation of thiophene free benzene-precautions to be observed.

**UNIT III TOLERANCE LIMITS OF INDUSTRIAL EMISSIONS 10**

Poisonous gases –their ill effects on the health-tolerance limits of various industrial emissions-first aid procedures-for acid , alkali and mercury poisoning- antidotes for various poisons-plumbosolvency, Paints-hazardous nature of lead containing paints-safe alternatives

**UNIT IV CARCINOGENS-HEALTH HAZARDS OF INSECTICIDES 10**

Carcinogenic nature of chemicals- potential carcinogens-dangers of exposure to high ionizing radiations-ill effects on health's-chemical pesticides and their health hazards-dangers of using phosphorus containing insecticides-introduction to biofertilizers and biopesticides-concepts of eco-friendly organic farming-preparation of a biopesticides-detailed methodology

**UNIT V DRINKING WATER STANDARDS 9**

Drinking water standards-permissible levels of various substances in drinking water as W.H.O-concept of biological oxygen demand and chemical oxygen demand-method of reducing biological oxygen demand.

**TOTAL : 45 PERIODS****REFERENCES**

1. Om Prakash Kharbanda, E.A. Stallworthy, Safety in the Chemical Industry: Lessons from Major Disasters, G P Courseware publishers, May 1988
2. J. Whiston, Safety in Chemical Production, Publisher: Wiley, John & Sons, 1991.
3. Daniel A. Crowl, Joseph F. Louvar, Chemical Process Safety: Fundamentals with Applications, Publisher: Pearson education, 2<sup>nd</sup> edition, 2001

**OBJECTIVE**

To provide basic concepts of Probability and Reliability.

**UNIT I 10**

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

Attested

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<b>UNIT II</b>	<b>15</b>
Special distributions – Uniform, Geometric, Exponential, Gamma, Weibull and Beta distributions – Mean, Variance, Raw moments from moment generating functions of respective distributions.	
<b>UNIT III</b>	<b>15</b>
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.	
<b>UNIT IV</b>	<b>10</b>
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.	
<b>UNIT V</b>	<b>10</b>
Basics concepts of reliability - Failure rate analysis – Reliability of systems – Series, Parallel – Maintenance - Preventive and corrective – Maintainability equation – Availability – Quality and Reliability.	

**TOTAL : 60 PERIODS**

**REFERENCES**

1. Bowker and Liberman, Engineering Statistics, Prentice-Hall.
2. Gupta, S.C. and Kapoor, V.K., Fundamentals of Mathematical
3. Spiegel, Murray R., Probability and Statistics, Schaum's series. Statistics, Sultan Chand and Sons.
4. Spiegel, Murray R., Statistics, Schaum's series.
5. Trivedi K.S., Probability and Statistics with Reliability and Queuing and Computer Science Applications, Prentice Hall of India.

**IH8201 ENVIRONMENTAL POLLUTION CONTROL AND INDUSTRIAL HYGIENE**

**L T P C**  
**3 0 0 3**

**OBJECTIVE**

To provide advanced concepts of EIA and EMS.

<b>UNIT I</b>	<b>9</b>
Evolution of EIA – Concepts – Methodologies – Screening – Scoping – Mitigation – Matrices – Checklist.	
<b>UNIT II</b>	<b>9</b>
Rapid and Comprehensive EIA – Legislative and Environmental Clearance procedure in India – Prediction tools for EIA.	
<b>UNIT III</b>	<b>5</b>
Assesment of Impact – Air – Water – Soil – Noise- Biological.	
<b>UNIT IV</b>	<b>10</b>
Socio cultural environment – Public participation – Resettlement and Rehabilitation.	

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**UNIT V****12**

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

**TOTAL : 45 PERIODS****REFERENCES**

1. Canter. R. L., Environmental Impact Assessment, McGraw Hill.
2. John G. Rau and David. C. Wooten (Ed)., Environmental Impact analysis hand book, McGraw Hill Book Company.

**IH8202****INDUSTRIAL SAFETY AND HAZARDS MANAGEMENT****L T P C****3 0 0 3****OBJECTIVE**

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

**UNIT I FIRE AND EXPLOSION****10**

Introduction-Industrial processes and hazards potential, mechanical electrical, thermal and process hazards. Safety and hazards regulations, Industrial hygiene. Factories Act, 1948 and Environment (Protection) Act, 1986 and rules thereof. Shock wave propagation, vapour cloud and boiling liquid expanding vapours explosion (VCE and BLEVE), mechanical and chemical explosion, multiphase reactions, transport effects and global rates.

**UNIT II RELIEF SYSTEMS****8**

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****10**

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****12**

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****5**

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

**TOTAL : 45 PERIODS****REFERENCES**

1. Crowl D.A. and Louvar J.F., "Chemical Process Safety: Fundamentals with Applications", 2<sup>nd</sup> Ed., Prentice Hall.2001.
2. Mannan S., "Lee's Loss Prevention in the Process Industries", Vol.I, 3<sup>rd</sup>Ed., Butterworth-Heinemann.2004.



3. Mannan S., "Lee's Loss Prevention in the Process Industries", Vol.II, 3<sup>rd</sup> Ed., Butterworth-Heinemann.2005.
4. Mannan S., "Lee's Loss Prevention in the Process Industries", Vol.III, 3<sup>rd</sup> Ed., Butterworth-Heinemann.2005.

**IH8203**

**PROCESS SIMULATORS**

**L T P C**  
**3 0 0 3**

### **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

**TOTAL : 45 PERIODS**

### **REFERENCES**

1. Lewin D.R., "Using Process Simulators in Chemical Engineering – A multimedia Guide for Core Curriculum", 2<sup>nd</sup> Ed., Wiley. 2003
2. Finlayson B.A., "Introduction to Chemical Engineering Computing", Wiley, 2006
3. Jana A.K., "Process Simulation and Control using ASPEN" Prentice Hall, 2009
4. Froment G.F. and Bischoff K.B., "Chemical Reactor Analysis and Design", 2<sup>nd</sup> Ed., Wiley, 1990.
5. Jana A.K., "Chemical Process Modelling and Computer Simulation" Prentice Hall, 2008.
6. Aris R., "Mathematical Modeling, Vol. 1: A Chemical Engineering Perspective (Process System Engineering)", Academic Press, 1999.



IH8204

**REGULATION FOR HEALTH, SAFETY AND ENVIRONMENT**

**L T P C  
3 0 0 3**

**OBJECTIVE**

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

**UNIT I**

**8**

Factories act and rules; Workmen compensation act.

**UNIT II**

**9**

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

**UNIT III**

**9**

Manufacture, Storage and Import of Hazardous Chemical rules 1989

**UNIT IV**

**10**

Indian Electricity act and rules.

**UNIT V**

**9**

Overview of OHSAS 18000 and ISO 14000

**TOTAL : 45 PERIODS**

**REFERENCES**

1. The Factories Act 1948, Madras Book Agency, Chennai, 2000
2. The Environment Act (Protection) 1986, Commercial Law Publishers (India) Pvt.Ltd., New Delhi.
3. Water (Prevention and control of pollution) act 1974, Commercial Law publishers (India) Pvt.Ltd., New Delhi.
4. Air (Prevention and control of pollution) act 1981, Commercial Law Publishers (India) Pvt.Ltd., New Delhi.
5. Explosive Act, 1884 and Explosive rules, 1883 (India), (2002), Eastern Book company, Lucknow, 10th Edition
6. The manufacture, storage and import of hazardous chemical rules 1989, Madras Book Agency, Chennai.
7. ISO 9000 to OHSAS 18001, Dr. K.C. Arora, S.K. Kataria & Sons, Delhi

PROGRESS THROUGH KNOWLEDGE

IH8205

**SAFETY IN ENGINEERING INDUSTRY**

**L T P C  
3 0 0 3**

**OBJECTIVE**

To ensure that safety in Engineering industry.

**UNIT I**

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

**5**

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.

*Attested*

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**UNIT II PRINCIPLES OF MACHINE GUARDING 10**

Guarding during maintenance, Zero Mechanical State (ZMS), Definition, Policy for ZMS – guarding of hazards - point of operation protective devices, machine guarding, types, fixed guard, interlock guard, automatic guard, trip guard, electron eye, positional control guard, fixed guard fencing- guard construction- guard opening. Selection and suitability: lathe-drilling-boring-milling-grinding-shaping-sawing-shearingpresses-forge hammer-flywheels-shafts-couplings-gears-sprockets wheels and chains-pulleys and belts-authorized entry to hazardous installations-benefits of good guarding systems.

**UNIT III SAFETY IN WELDING AND GAS CUTTING 8**

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 12**

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 10**

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

**TOTAL : 45 PERIODS**

**REFERENCES**

1. Accident Prevention Manual” – NSC, Chicago, 1982.
2. Occupational safety Manual” BHEL, Trichy, 1988.
3. Safety Management by John V. Grimaldi and Rollin H. Simonds, All India Travelers Book seller, New Delhi, 1989.
4. Safety in Industry” N.V. Krishnan Jaico Publishery House, 1996.
5. Indian Boiler acts and Regulations, Government of India.
6. Safety in the use of wood working machines, HMSO, UK 1992.
7. Health and Safety in welding and Allied processes, welding Institute, UK, High Tech. Publishing Ltd., London, 1989.

**OBJECTIVE**

To provide comprehensive knowledge on analyzing instrument.

**1. NOISE LEVEL MEASUREMENT AND ANALYSIS**

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

**2. VIBRATION MEASUREMENT AND ANALYSIS**

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

**3. FRICTION SENSITIVITY TEST**

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

**4. IMPACT SENSITIVITY TEST**

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

**5. THERMAL REACTIVITY TEST**

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

**6. EXHAUST GAS MEASUREMENT AND ANALYSIS**

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

**7. BREATHING ZONE CONCENTRATION**

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

**8. AMBIENT AIR MONITORING**

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

**9. CONSEQUENCE ANALYSIS**

Soft computing skills on developing effects of fire & explosion and dispersion: Software – 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 (CO<sub>2</sub>), dry chemical powder, halon.

**TOTAL: 45 PERIODS**

**OBJECTIVE**

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

**UNIT I INTRODUCTION****8**

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****10**

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****10**

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****5**

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****12**

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.

**TOTAL : 45 PERIODS****REFERENCES**

1. Bird R.B., Stewart W.E. and Lightfoot E.N., "Transport Phenomena", 2<sup>nd</sup>Ed., 1994.
2. Leal L.G., "Advanced Transport Phenomena: Fluid Mechanics and Convective Transport Processes", Cambridge University Press.2007.
3. Dean W.M., "Analysis of Transport Phenomena", Oxford University Press.1988.
4. Brodkey R.S. and Hershey H.C., "Transport Phenomena – A Unified Approach", Brodkey.2003.

**OBJECTIVE**

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

**UNIT I AIR POLLUTION****10**

Industrial sources of Air Pollution – Emission factors – Regulations – Control Strategies – Policies.

**UNIT II PARTICULATE POLLUTANTS AND CONTROL****12**

Particulate pollutant control: Settling chambers – Laminar and Turbulent flow - Filtration – Interception – Impaction – Convective diffusion – Collection of particles by fibers and Granular beds – Electrostatic precipitation – Cyclones – Wet Collectors.

**UNIT III GASEOUS POLLUTANTS AND CONTROL****8**

Gaseous Pollutant control: Gas absorption in tray and packed towers – Absorption with / Without chemical reaction – Removal of SO<sub>2</sub> – Absorption in fixed blades- Breakthrough.

**UNIT IV TOXIC POLLUTANTS REMOVAL****8**

Removal of HCs / VOCs – NO<sub>x</sub> removal – Wet scrubbers.

**UNIT V AIR POLLUTION CONTROL****7**

Integrated Air pollution control systems.

**TOTAL : 45 PERIODS****REFERENCES**

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

**OBJECTIVE**

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

**UNIT I BASIC ELECTRICAL****12**

Review of Electrical concept, Electrostatic – Electro magnetism – Stored energy – Working principle of major electrical equipment – Typical supply situation.

**UNIT II STANDARDS AND REQUIREMENTS****10**

Standards and statutory requirements – Indian electricity acts and rules – statutory requirements from Electrical inspectorate.

Attested



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<b>UNIT III</b>	<b>ELECTRICAL HAZARDS</b>	<b>9</b>
Electrical Hazards – Energy leakage – Clearance and insulation – Excess energy – Current surges – Electrical causes of fire and explosion – National electrical Safety code.		
<b>UNIT IV</b>	<b>ELECTRICAL PROTECTION AND MAINTENANCE</b>	<b>8</b>
Selection of Environment, Protection and Interlock – Discharge rods and earthing device – Safety in the use of portable tools - Preventive maintenance		
<b>UNIT V</b>	<b>CLASSIFICATION OF HAZARDOUS AREAS</b>	<b>6</b>
Hazardous area classification and classification of electrical equipments for hazardous areas (IS, API and OSHA standards).		

**TOTAL : 45 PERIODS**

**REFERENCES**

1. Fordham Cooper W., Electrical Safety Engineering, Butterworths, London, 1986.
2. Accident Prevention Manual for Industrial Operations, NSC, Chicago, 1982.
3. www.osha.gov

<b>IH8004</b>	<b>FIRE ENGINEERING AND EXPLOSION CONTROL</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

**OBJECTIVE**

To provide basic concepts of fire engineering and explosion control.

<b>UNIT I</b>		<b>8</b>
Fire chemistry – Dynamics of fire behavior – Fire properties of solid, liquid and gas – Fire spread – Toxicity of products of combustion		
<b>UNIT II</b>		<b>7</b>
Industrial fire protection systems – Sprinkler – Hydrants- Stand pipe- Special fire suppression system like deluge and emulsifier.		
<b>UNIT III</b>		<b>10</b>
Building evaluation for fire safety – Fire load –Fire resistance materials and fire testing – Structural Fire protection – Exits and egress.		
<b>UNIT IV</b>		<b>8</b>
Explosion protection systems – Explosion parameters – Explosion suppression system based on CO2 and Halon – Hazards in L.P.G handling.		
<b>UNIT V</b>		<b>12</b>
Statutory Rules and Techniques of fire fighting - Indian Explosive acts and rules – Techniques of fire fighting and demonstration.		

**TOTAL : 45 PERIODS**

**REFERENCES**

1. James, D., Fire Prevention Handbook, Butterworths, London, 1986.
2. Gupta R.S., Handbook of Fire Technology, Orient Longman, Bombay, 1997.

Attested  
  
**DIRECTOR**  
 Centre For Academic Courses  
 Anna University, Chennai-600 025.



**OBJECTIVE**

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

**UNIT I INTRODUCTION****10**

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****10**

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****10**

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****10**

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.

**UNIT V ABATEMENT OF NOISE****5**

Active noise attenuators and scope for abatement of industrial noise.

**TOTAL : 45 PERIODS****TEXT BOOKS**

1. Irwin, J.D and Graf, E. R, Noise and Vibration Control, Prentice Hall Inc. New Jercey, 1979.
2. Irwing B Crandall, Theory of Vibrating Systems and Sound, D. Vannostrand Company, New Jercey, 1974.
3. Cyril M. Harris, Hand Book of Noise Control, McGraw Hill Book Company, New York, 1971.
4. White R. G. Walker J. G, "Noise and Vibration", John Wiley and sons New York, 1982.



**OBJECTIVE**

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

**UNIT I INTRODUCTION 5**

Introduction to process modeling and simulation

**UNIT II MODELS 8**

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 10**

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 12**

Techniques of digital simulation. Lumped parameter systems, stability, model analysis, discretization and discrete to continuous systems. Newton's and globally convergent methods for set of nonlinear equations; Use of Runge-Kutta and Gear's methods for solution of staged separation problems.

**UNIT V NUMERICAL SIMULATION 10**

Finite difference approximation of partial differential equations and their solutions.

**TOTAL : 45 PERIODS****REFERENCES**

1. Denn M.M., "Process Modeling", Longman.1986.
2. Luyben W.L., "Process Modeling, Simulation and Control for Chemical Engineers", 2<sup>nd</sup>Ed., McGraw Hill.1990.
3. Najim K., "Process Modeling and Control in Chemical Engineering", CRC Press.1990.
4. Aris R., "Mathematical Modeling, Vol. 1: A Chemical Engineering Perspective (Process System Engineering)", Academic Press.1999.

**OBJECTIVE**

The elective is aimed to instill in the students a good grasp of the fundamentals and generalizations underlying technical analysis

**UNIT I QUANTITATIVE ESTIMATION - PRINCIPLE 8**

Types of Analysis- Principles underlying Quantitative estimation- Purity of simple sugars- Principle underlying BERTRAND'S method- Estimation of percentage purity of phenol (By tribromo phenol formation method)- Estimation of percentage purity of glycerol- Principles underlying above estimations.

<b>UNIT II</b>	<b>ANALYSIS OF COAL AND FERTILIZER</b>	<b>8</b>
Analysis of Coal- Suitability for thermal power plants- Proximate and ultimate analysis of coal - underlying principles- Correlation between thermal energy and fixed carbon- Estimation of nitrogen in ammonical fertilizers and soil- Principles underlying Kjeldahl's method.		
<b>UNIT III</b>	<b>STANDARD AND RAPID METHODS OF ANALYSIS OF CEMENT</b>	<b>10</b>
Types of analysis of cement- Standard and rapid methods- Fundamentals generalizations underlying the above estimations- Quality assessment of Cement.		
<b>UNIT IV</b>	<b>PURITY INDEX OF OIL</b>	<b>9</b>
Estimation of freshness and purity of a vegetable oil- Principles underlying estimation of free acid value, Saponification value and iodine value- Causative factors of rancidity of oil.		
<b>UNIT V</b>	<b>QUALITY STANDARDS OF DRINKING WATER</b>	<b>10</b>
Estimation of Chloride, Sulphate, Total Dissolved Solids and Dissolved Oxygen in the given sample of water- Principles underlying estimation of chemical oxygen demand (COD) - Principles underlying water purification strategies- World Health Organization prescribed standards of drinking water.		

**TOTAL : 45 PERIODS**

#### REFERENCES

1. Commercial methods of Analysis by Fosterdee Snell and Frank Moody Bifeen- Chemical Publishing House, Page 11 – 37, 596 – 603 and 654- 662.
2. Technical Analysis Lab Manuals- Volume I and II by Dr.K.Srinivasan and Dr.P.Gnanasundaram, Anna University, Chennai.

<b>IH8008</b>	<b>PROCESS SAFETY MANAGEMENT IN INDUSTRY</b>	<b>L T P C</b> <b>3 0 0 3</b>
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#### 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.

<b>UNIT I</b>	<b>CONCEPTS</b>	<b>5</b>
Evolution of modern safety concept- Safety policy - Safety Organization - line and staff functions for safety- Safety Committee- budgeting for safety.		

<b>UNIT II</b>	<b>TECHNIQUES</b>	<b>8</b>
Incident Recall Technique (IRT), disaster control, Job Safety Analysis (JSA), safety survey, safety inspection, safety sampling, Safety Audit.		

<b>UNIT III</b>	<b>ACCIDENT INVESTIGATION AND REPORTING</b>	<b>12</b>
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.		

*Attested*

*Sobhan*  
**DIRECTOR**

Centre For Academic Courses  
Anna University, Chennai-600 025.

**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**

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

**TOTAL : 45 PERIODS**

**REFERENCES**

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

**IH8009**

**SAFETY IN CONSTRUCTION**

**L T P C  
3 0 0 3**

**OBJECTIVE**

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

**UNIT I INTRODUCTION 10**

General safety consideration – analyzing construction jobs for safety – Contract document – Safety certificate for statutory authorities for old building and construction.

**UNIT II FOUNDATION 8**

Excavation, foundation and utilities – Cordoning – Demolition – Dismantling –Clearing debris – Types of foundations – Open footings.

**UNIT III MATERIALS AND STRUCTURES 8**

Safety in Erection and closing operation - Construction materials –Specifications – suitability – Limitations – Merits and demerits – Steel structures –Concrete structure.

**UNIT IV INSPECTION IN HUGE STRUCTURES 10**

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

**UNIT V MAINTENANCE 9**

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

**TOTAL : 45 PERIODS**

**REFERENCES**

1. Accident Prevention Manual for Industrial Operations, NSC, Chicago, 1982.
2. Fulman, J.B., Construction Safety, Security, and Loss Prevention, John Wiley and Sons, 1979.

**OBJECTIVE**

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

**UNIT I MATERIAL HANDLING 8**

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

**UNIT II ERGONOMICS OF CONVEYING MECHANISMS 10**

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

**UNIT III ERGONOMICS OF HOISTING MECHANISMS 8**

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

**UNIT IV HANDLING OF HEAVY EQUIPMENTS 9**

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

**UNIT V STORAGE OF GOODS AND EQUIPMENTS 10**

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

**TOTAL : 45 PERIODS****REFERENCES**

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

**OBJECTIVE**

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

**UNIT I PETROLEUM PRODUCTS 10**

Petroleum and Petroleum products – Fuels- Petroleum solvents – Lubricating oils – Petroleum wax, greases – Miscellaneous product

**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

<b>UNIT III</b>	<b>DRILLING</b>	<b>9</b>
Drilling oil – Technique and equipment- Work position –Working condition – safety and associated hazards- lighting and its effects		
<b>UNIT IV</b>	<b>EXTRACTION AND TRANSPORTATION</b>	<b>9</b>
Petroleum Extraction and transport by sea – Oil field products – Operation – Transport of crude by sea – Crude oil hazards.		
<b>UNIT V</b>	<b>STORAGE AND CLEANING</b>	<b>7</b>
Petroleum product storage and transport –Storage equipment –Precaution –Tank cleaning		

**TOTAL : 45 PERIODS**

**REFERENCE**

1. Encyclopedia of Occupational Health and Safety, Vol. II, International Labour Organisation, Geneva, 1985 & I.

<b>IH8012</b>	<b>SAFETY MANAGEMENT</b>	<b>L T P C</b> <b>3 0 0 3</b>
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**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.

<b>UNIT I</b>	<b>CONCEPTS</b>	<b>8</b>
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History of Safety movement –Evolution of modern safety concept- general concepts of management – planning for safety for optimization of productivity -line and staff functions for safety- budgeting for safety- safety policy.

<b>UNIT II</b>	<b>TECHNIQUES</b>	<b>5</b>
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Incident Recall Technique (IRT), disaster control, job safety analysis, safety survey, safety inspection, safety sampling, Safety Audit.

<b>UNIT III</b>	<b>ACCIDENT INVESTIGATION AND REPORTING</b>	<b>12</b>
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Concept of an accident, reportable and non reportable accidents, reporting to statutory authorities – principles of accident prevention – accident investigation and analysis – records for accidents, departmental accident reports, documentation of accidents – unsafe act and condition – domino sequence – supervisory role – role of safety committee –cost of accident.

<b>UNIT IV</b>	<b>SAFETY PERFORMANCE MONITORING</b>	<b>10</b>
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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.

<b>UNIT V</b>	<b>SAFETY EDUCATION AND TRAINING</b>	<b>10</b>
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Importance of training-identification of training needs-training methods – programmes, 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.

**TOTAL : 45 PERIODS**

### **REFERENCES**

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

