IPS ACADEMY- INSTITUTE OF ENGINEERING & SCIENCE, INDORE

(A UGC Autonomous Institute, affiliated to RGPV)

Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal

Scheme of Examination as per AICTE Flexible Curricula

VII Semester Bachelor of Technology (B.Tech.)

[Fire Technology & Safety Engineering]

S. No	Course Type	Course Code	Subject Name	Maximum Marks Allotted					Total Marks	Contact Hours per week			Total Credits
				Theory			Practical						
				End Sem	Mid Sem. Exam.	Quiz/ Assignment	End Sem	Term work / Lab Work & Sessional		L	T	P	
1	PCC	FT17	Fire Fighting Installation	60	25	15	-	-	100	2	1	-	3
2	PCC	FT18	Electrical Fire Safety	60	25	15	-	-	100	2	1	-	3
3	PCC	FT19	Hazardous Material Management	60	25	15	-	-	100	2	1	-	3
4	PEC	FT01	Departmental Elective-I	60	25	15	-	-	100	3	-	-	3
5	PEC	FT02	Departmental Elective-II	60	25	15	-	-	100	3	-	-	3
6	LC	FT17(P)	Fire Fighting Installation	-	-	-	60	40	100	-	-	2	1
7	SBC	FT05(P)	Fire Fighting Drills	-	-	-	60	40	100	-	-	2	1
8	PROJ	FT02	Project Phase -I	-	-	-	60	40	100	-	-	8	4
9	PROJ	FT01	*Evaluation of Internship Completed in Sixth Semester*	-	-	-	60	40	100	-	-	4	2
			Total	300	125	75	240	160	900	12	3	16	
Total Academic Engagement and Credits										31			23

Departmental Elective-I, PEC-FT 01 (Any One Course): ** This can be either offered by the department or online MOOC Course

(a) Safety In Nuclear Facility
(b) Safety in Petrochemical Industry
(c) Safety In Textile Industry
(d) Fire Protection, Services & Maintenance Management of Building

Departmental Elective-II, PEC-FT 02 (Any One Course)

(a) Process Safety & Risk Assessment
(b) Safety and Risk Analytics
(c) Environment Protection & Waste Management
(d) Structural Fire Safety

PCC-FT17	Fire Fighting Installation	2L:1T:0P (03 hrs)	03 Credits

Course Objective:

1. To describe and design the water based hydrant system in different types of occupancies.
2. To explain the relevant code of practice and design the automatic sprinkler system for a given Occupancy.
3. To learn about the foam based fire fighting systems at different applicable fire desirous sites.
4. To solve the problem of fire loss due to water and foam by applying clean extinguishing agent at precious locations.
5. To learn about the special dry chemical and their systems applicable to highly reactive metals.

Course Content:

Module 1 **(08 Hrs)**

WATER BASED FIRE PROTECTION: Fire water demand calculation, water storage tank capacity, water storage tank equipment and accessories, relationship of air pressure and volume in tanks, calculating fire flow rates by Insurance service office method (ISO), Iowa state university method (ISU), fire flow duration, factors affecting water requirement. Hydrant System- Definition and basic components, Pressure and discharge requirement, spacing between hydrant post, pipe material and size.

Module 2 **(08 Hrs)**

AUTOMATIC SPRINKLER SYSTEM: Fundamental of performance- Fire suppression Analogy, Design Consideration, Response time Index, Thermal sensitivity and temperature rating. Sprinkler System layout- Sprinkler system zoning, tree system, looped system, gridded system, placement of mains and branch lines, Sprinkler system spacing, maximum area permitted for protection, spacing between branch lines and sprinklers. Hydraulic calculation and back flow protection. Sprinkler system type- wet pipe system, dry pipe system, pre-action system and deluge system.

Module 3 **(08 Hrs)**

FOAM BASED FIRE PROTECTION: System types –Fixed, Semi fixed and mobile foam systems. Fixed cone roof, external floating roof and internal floating roof protection with foam-water sprinkler system. Diked and non diked area protection. Medium and high expansion foam systems, mobile foam apparatus and their application, Foam Fire Fighting at fixed sites- Size of fire, type of fuel, depth of fuel and application rate. Storage tank fire tactics for cone roof, floating roof and horizontal tanks.

Module 4 **(08 Hrs)**

GAS BASED FIRE PROTECTION: Halogenated Agents and System- Chemical mechanism, chemical composition, Classification and Properties, Toxic and irritant effect, application systems, flooding system, design consideration- NFPA-12A and NFPA-12B, Halon Replacement agents and systems- Extinguishing Mechanism, Halocarbon agents and Inert Gas agents Ozone depletion, Clean agent system design, Agent quantity and discharge time. Carbon Dioxide Application System- Concentration for extinguishment, life safety consideration NFPA-12, methods of application total flooding, local application, hand hose lines, stand pipe systems and mobile supply, components of carbon dioxide system- Carbon dioxide storage, piping system, valves and operating devices, discharge nozzles, system controls, control panels, alarms. Quantity and venting requirements for different system, use and limitation of systems.

Module 5 **(08 Hrs)**

DRY CHEMCIAL BASED FIRE PROTECTION SYSTEM: Method of application, system design NFPA-17, storage of chemical and expellant, system actuation and distribution system. Quantity and application rate of dry chemical. Inspection, testing and maintenance procedures for chemical systems. Listed agents for metal fires MET-L-X powder, Na-X powder, other combustible metal extinguishing agent, non proprietary combustible metal extinguishing agents.

Course Outcome:

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

1. Describe and design water based fire protection system for a given occupancy.
2. Design and estimates the sprinkler system for a given occupancy.
3. Explain and evaluate the foam based fire protection systems for class-B liquid fires.
4. Justify the use of gaseous based fire protection inside the precious locations.
5. Plan chemical powder based fire fighting systems and able to estimate the cost of the system.

List of Text/Reference Books:

1. Fred Stowell, Principles of Foam Fire Fighting International Fire Service Training Association.
2. Robert M Gagnon, Designer's Guide to Automatic Sprinkler Systems, NFPA-2005.
3. Operation of Fire Protection System NFPA Special Edition.
4. Tariff Advisory committee, Fire Protection Manual- Hydrant System.
5. Tariff Advisory committee, Manual for Water Spray System.
6. Fire Service Manual, Fire Service Technology Equipment and media Fire Fighting Foam Technical
   Volume-1.
7. Arthur E. Cote, P.E., Fire Protection Handbook, Section-10 and 11, National Fire Protection Association.

PCC-FT18	Electrical Fire Safety	2L:1T:0P (03 hrs)	03 Credits

Course Objective:

1. To learn about electrical hazards and electrical safety.
2. To learn about fire hazards and safety measures in generation systems.
3. To learn about fire hazards and safety measures in Transmission systems.
4. To learn about fire hazards and safety measures in distribution systems and transformers.
5. To learn about electrical safety equipments and its use in preventing fire hazards

Course Content:

Module 1 **(08 Hrs)**

INTRODUCTION TO ELECTRICAL FIRE: Electrical hazards and electrical safety, Protection Against Direct Contact, Insulation of Live Parts, Additional Protection by Residual Current Devices, Protection Against Indirect Contact, Protection by Automatic Disconnection of Supply, Protection Without Automatic Disconnection of Supply, Non-electrical causes, nature of electrical injuries, Types of injury, Electric shock, Body resistance, The limits of safety, Effect of frequency, Fractures and torn Muscles, Burns and side effects, Protection against electrical Injuries, electrical current effect in the human body.

Module 2 **(08 Hrs)**

FIRE HAZARDS IN GENERATION SYSTEMS: Generation: - Different types of Generating Stations, Thermal, Hydro electric, their equipments, Nuclear power station, Nuclear fission, Radioactivity, Reactor designs, Safety philosophy, Periodical electrical safety reviews, Safety concept and design, electrical underlying standards, Partial safety concept, Fire resistance, Possible Faults and fire outage, Protection and safety measures.

Module 3 **(08 Hrs)**

FIRE HAZARDS IN TRANSMISSION SYSTEMS: Transmission: - Transmission lines, types of transmission lines, their equipments, Main components of over head lines, Conductor materials, Line supports, insulators, Types of insulators, Ground wires, Possible Faults and fire outage, Protection and safety measures.

Module 4 **(08 Hrs)**

FIRE HAZARDS IN DISTRIBUTION SYSTEM AND TRANSFORMERS: Distribution system and their equipments, Substation and their equipments, Possible Faults and fire hazards, their protection and safety measures. Transformer: Their types, Working Principal, Applications, Possible faults and fire hazards, Protection and Safety measures.

Module 5 **(08 Hrs)**

ELECTRICAL SAFETY EQUIPMENTS: Fuses and its types and construction, Requirement of relays, Primary & backup protection, Types of relay protection, Over current, Over Voltage relays, Circuit Breaker, Arc Voltage, Arc Interruption, Classification of Circuit Breakers, Oil, SF6, Vacuum Circuit Breakers, Earthing- Their method and applications, Insulators – Their types and applications, fire detection system, smoke detector, Photo electric smoke detector, Air sampling type smoke detectors.

Course Outcome:

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

1. Describe electrical hazards and electrical safety.
2. Understand fire hazards and safety measures in generation systems.
3. Describe fire hazards and safety measures in Transmission systems.
4. Explain fire hazards and safety measures in distribution systems and transformers.
5. Describe and explain electrical safety equipments and its use in preventing fire hazards.

List of Text/Reference Books:

1. W Fordham Cooper, Electrical Safety Engineering**.**
2. B. Ravindran and M Chander, Power System protection and Switchgear, New Age International.
3. J. Cadick, Electrical Safety Handbook, McGraw-Hill.
4. B. Ram, Power System Protection & Switchgear, McGraw Hill

PCC FT19	Hazardous Material Management	2L:1T:0P (03 hrs)	03 Credits

Course Objective:
To learn fundamentals of various hazardous materials exposure with their source and dispersion models, chemical risk analysis, storage and handling consideration..

Course Content:

Module 1 **(08 Hrs)**
EXPOSURE AND RESPONSE: General Principle of Chemical exposure and toxic response- Chemical exposure and cancer, chemical exposure and hypersensitivity, toxic response of lungs, liver, kidney, skin chemical exposure and health risk assessment.

Module 2 **(08 Hrs)**
DISPERSION MODEL: Toxic release and dispersion models-Design basis, Introduction to Source Models, source model, Flashing Liquids, Liquid Pool Evaporation or Boiling, Conservative Analysis, dispersion model, Pasquill- Gifford model, effect of release momentum, Buoyancy, Dense Gas Dispersion, Toxic Effect Criteria, Release Mitigation.

Module 3 **(08 Hrs)**
CHEMICAL RISK ANALYSIS: Flammability-vapour pressure, limits of flammability, Flash points, auto-ignition temperature. Stability- Experimental methods of determination, classifications of instability risk, quantative approach. Toxicity- Evaluation parameter, level of toxic risk, problem posed by determination of toxicity risk level, Quantative estimation method.

Module 4 **(08 Hrs)**
EXPLOSION HAZARDS: Gas and vapor cloud explosion & means of preventing and mitigating in the process industry, Explosion in clouds of liquid droplets in air (spray/mist explosions), Dust Explosion. Stability and sensitivity tests, Classification of materials with explosive potential, Hazard prediction by thermodynamic calculations, Prevention and control of explosions and detonations- diluting a release, purging and inerting, venting, explosion relief, flame arrestors, explosion suppression.

Module 5 **(08 Hrs)**
STOREAGE AND HANDLING: Types of storage-general considerations for storage layouts- atmospheric venting, pressure and temperature relief- relief valve sizing calculations- storage and handling of hazardous chemicals and industrial gases, safe disposal methods, reaction with other chemicals, hazards during transportation- pipe line transport- safety in chemical laboratories. Safety provisions like level and flow indicators- alarms, colour coding for pipe lines and cylinders.

Course Outcome:

At the end of this course student will be able to:
1. Explain chemicals exposure and their response in human body.
2. Describe various source and dispersion models for any hazardous material leakage.
3. Demonstrate chemical risk analysis for a given environment.
4. Analyze impact of explosions in different conditions.
5. Explain storage and handling requirement of different hazardous material.

List of Text/Reference Books:

1. Chemical process safety, fundamental with application- Daniel A Crowl/ Joseph F Louver
2. Chemical exposure and toxic response- Edited by- Stephen K. Hall, Joana Chakraborty Randall J. Ruch.
3. Chemical Risk analysis- Bernard Martel
4. Explosion hazards in the process industries. - Rolf K. Eckhoff.
5. Chemical process Industries Shreve R.N.
6. Chemical Engineers handbook peoy JHJ & Chitten (Ed)
7. Hazardous materials emergency planning guide-NSC India.
8. Loss prevention in the process Industries F.P. Lees.
9. Technical guidance for hazard analysis - NSC India.
10. Process equipment design - MV Joshi
11. Major hazard control - A practical manual (ILO)
12. Chemical Process safety - Daniel A Crawl, Joseph Flouvar.

PEC FT01	Departmental Elective-I a) Safety in Nuclear Facility	3L:0T:0P (03 hrs)	03 Credits

Course Objectives:

1. To teach basic concept and fundamentals of Radioactivity and its effect.
2. To learn about the special nuclear materials and their fire extinguishing guide lines.
3. To teach different types of reactors and their Engineered Safety Features in Nuclear Power Plant.
4. To learn the Radioactivity dispersion and its absorption with remedial plans.
5. To study the major nuclear power plant accident in past.

Course Content:

Module 1 **(08 Hrs)**

RADIATION TERMS- Radioactivity, Alpha, Beta, Gamma Rays, Ionizing Effect, Radiation Exposure, Biological Effects, Radiation Protection Factors, Radioactive Placard and Label Requirement, Fixed site Storage Vessels for Medical Isotopes, Radiation Monitoring Equipment- Geiger- Muller (GM) Counter, Pocket Chamber Dosimeters, Survey meters, Radiation Detection, Devices..

Module 2 **(08 Hrs)**

SPECIAL NUCLEAR MATERIALS, RADIOACTIVE PYROPHORIC METALS- Uranium, Plutonium, Thorium with Fire Extinguishing guide lines, Radioactive material Emergency Response- Hazard Identification, Action Plan, Zoning, Managing the Incident, Assistance and Termination. .

Module 3 **(09 Hrs)**

NUCLEAR POWER PLANT SAFETY- Overview and brief description of Pressurized Water Reactor (PWR), Boiling Water Reactor (BWR) and Pressurized Heavy Water Reactor (PHWR-CANDU), Components and Equipments, Engineered Safety Features in each Reactors. Nuclear Power Plant Operating States and Accident Classification as per code of federal regulation, Large break LOCA typical sequence in Nuclear Power Plant.

Module 4 **(08 Hrs)**

DISPERSION OF RADIOACTIVITY Releases from Nuclear Power Plant, Phenomena of Releases, Diffusion of Radioactive Plume at different heights and temperature condition. Simple Evaluation Techniques, Special Case of Radioactive Iodine release, Biological Absorption and Remedial Plans.

Module 5 **(07 Hrs)**

MAJOR NUCLEAR POWER PLANT ACCIDENTS: Case Studies, Causes and sequence of events, Consequences & follow up actions in Three Mile Island unit-2 Accident, Chernobyl Accident, Fukushima Station Accident and Davis Basse Accident..

Course Outcome:

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

1. Explain radiation terminology and their measurement.
2. Describe special nuclear materials, radioactive pyrophoric metals.
3. Understand the types of nuclear reactors and their engineered safety features.
4. Demonstrate dispersion of radioactivity through different source models.
5. Analyze major nuclear power plant accidents through case studies.

List of Text/Reference Books:

1. J. Misumi, B. Wilpert And R.Miller, Nuclear Safety: A Human Factors Perspective, Taylor & Francis.
2. Gianni Petrangeli, Nuclear Safety, Elsevier-2006
3. John C. Lee And Morman J. Mccormick, Risk And Safety Analysis Of Nuclear Systems, Wiley-2011
4. Joe Varela, Hazardous Materials Handbook For Emergency Response, International Thomson Publishing.

IPS Academy, Institute of Engineering & Science
(A UGC Autonomous Institute, Affiliated to RGPV, Bhopal)
New Scheme & Syllabus Based on AICTE Flexible Curricula **(B. Tech)**
Fire Technology & Safety Engineering

PEC FT01 (b)	**Departmental Elective-I** **Safety in Petrochemical Industry**	**3L:0T:0P (03 hrs)**	**03 Credits**

Course Objectives:

1. To learn the characteristics of crude oil and classification of petroleum products.
2. To learn about the refining process and its significance in safety.
3. To learn about petrochemical fire and emergency planning in potential fire hazard areas.
4. To teach the statutory provisions pertaining to refineries petrochemical pants and gas terminals

Course Content:

Module 1 **(08 Hrs)**

INTRODUCTION: Crude oil, its properties & Characteristics, Classification of petroleum & its products, MSDS of crude oil, diesel, gasoline, kerosene, LPG, Natural Gas, nylon, Naptha, Ammonia, Benzene, toluene, Acelytene..

Module 2 **(08 Hrs)**

REFINING PROCESSES: Primary Distillation, catalytic cracker, polymerization, reforming, steam cracking, sulphur recovery, Lubricating oil treating. Process units such as desalter, ADU, VDU, FCC, hydrocracker, catalytic reformer etc. Storage tanks & its types. Layout of Refineries - simplified flow diagram of a typical refinery.

Module 3 **(06 Hrs)**

FIRE PROTECTION & EMERGENCY PLANNING: Major fire risks, design criteria for selection of fire water network, fire fighting installations such as hydrant, mobile water monitors, foam pourer, DCP fixed, subsurface injection & steam snuffing systems. Storage tanks protection. Use of various media in petroleum & gas fires such as water, foam, DCP.

Module 4 **(08 Hrs)**

FIGHTING REFINERY & PETROCHEMICAL FIRES: Potential fire hazards, precautionary measures in case of non-ignited releases, oil & gas leaks. Fire fighting facilities for depots, terminals, onshore, off-shore drilling platforms, and pipelines for transportation of petroleum products & Gas. Fighting Gas terminal fires: - Fire fighting & procedures in case of BLEVE, LPG hazards, spillage, vehicles using LPG & CNG as a fuel. Fire fighting facilities at LPG bottling plants. Water Injection into LPG vessel (water bottoming).

Module 5 **(08 Hrs)**

STATUTORY PROVISIONS: Pertaining to refineries, petrochemical plants & gas terminals, Oil Industry Safety Directorate (OISD), Petroleum Act 1934, Petroleum Rules 2002, Petroleum & Natural Gas Regulatory Board (PNGRB) drafts, Explosive Act 1884, Explosive Rules 1983 and Gas cylinders Rules 2004. Application of advance technologies used in refineries & petrochemical plants such as SCADA, SAP and various simulation modeling.

Course Outcome:

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

1. Explain hazardous characteristics of petroleum product and refining process.
2. Apply fire protection systems in potential fire hazards area in oil and gas industry.
3. Present statutory provisions pertaining to refineries, petrochemicals plants and gas terminals.
4. Explain various fire fighting strategies in case of BLEVE, LPG hazards and spillage.
5. Demonstrate the knowledge about statutory provision pertaining to refineries, petrochemical plants and gas terminals.

List of Text/Reference Books:

1. Fire Service Manual (Volume 2) Fire Service Operations - Petrochemical Incidents
2. Manual of Firemanship, Part 6-A by H.M.S.O.
3. Oil Industry Safety Directorate (OISD) Norms & Rules
4. Petroleum & Natural Gas Regulatory Board (PNGRB) drafts
5. Loss prevention in Process of Industries, Vol 1,2, & 3, Frank P. Lees.
6. Relevant NFPA Codes and Indian Acts.

PEC FT01 (c)	Departmental Elective-I Safety In Textile Industry	3L:0T:0P (03 hrs)	03 Credits

Course Objective:
To understand and identify the hazards associated in textile industry with their safety management system.

Course Content:

Module 1 **(10 Hrs)**

INTRODUCTION: Introduction to process flow charts of short staple spinning, long staple spinning, viscose rayon and synthetic fibre, manufacturer, spun and filament yarn to fabric manufacture, 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.

Module 2 **(08 Hrs)**

TEXTILE HAZARDS I: Accident hazards, sizing processes- cooking vessels, transports of size, hazards due to steam, Loom shed shuttle looms and shuttless looms, knitting machines, non-wovens.

Module 3 **(06 Hrs)**

TEXTILE HAZARDS II: Scouring, bleaching, dyeing, punting, mechanical finishing operations and effluents in textile processes.

Module 4 **(08 Hrs)**

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

Module 5 **(06 Hrs)**

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

Course Outcome:
At the end of this course, student will be able to:
1. Understand major process associated with textile industry.
2. Identify the hazards associated with steam shuttless looms and knitting machines with preventive measures.
3. Identify the hazards associated with major textile process with preventive measures.
4. Understand occupational diseases and PPEs for preventing in specific hazardous work environments.
5. Familiar with factory act provisions and applicable rules in textile industry..

List of Text/Reference Books:
1. 100 Textile Fires – Analysis, Findings And Recommendations Lpa
2. Groover And Henry Ds, Hand Book Of Textile Testing And Quality Control
3. Quality Tolerances For Water For Textile Industry, Bis
4. Shenai, V.A,. A Technology Of Textile Processing, Vol.I, Textile Fibres
5. Little, A.H.,Water Supplies And The Treatment And Disposal Of Effluent
6. Safety In Textile Industry Thane Belapur Industries Association, Mumbai.

PEC FT01 (d)	**Departmental Elective-I** **Fire Protection, Services & Maintenance Management of Building**	**3L:0T:0P (03 hrs)**	**03 Credits**

Course Objective:
To understand types of buildings, services and maintenance management with basic fire fighting installation using different extinguishing medias.

Course Content:

Module 1 **(10 Hrs)**

BUILDING STUDIES: Basic Terminology, Elements of Structure, Fire Test, Standard time, Temperature relationship, Non combustibility test, Ignitibility test, Fire Propagation test, Performance criteria for fire resistance, Fire resistance rating of structural elements, Type of Building construction, Classification of building based on occupancy, Fire zones.

Module 2 **(08 Hrs)**

MODEL FIRE AND LIFE SAFETY REQUIREMENT: Residential buildings, Educational buildings, Institutional buildings, Assembly buildings, Business buildings, Industrial buildings, Storage buildings and Hazardous buildings, Life Safety requirement in Underground structure, Basement protection, Fire Protection is Building under construction, Fire Control Room.

Module 3 **(06 Hrs)**

FIRE PROPAGATION: Spread of flames in solids and liquids, linear and three dimensional fire propagation; Smoke, Constituents of smoke, quantity and rate of production of smoke, quality of smoke, smoke density, Visibility in smoke, principles of spreading quantity of smoke, smoke movement; Pressurization modeling of smoke movement; Toxicity of smoke- effect of harmful agents preventing escape and causing injury or death - CO, CO2, Nitrogen oxide, Sulphur dioxide.

Module 4 **(08 Hrs)**

COMPARTMENT FIRE: Stage of fire development, fire induced flows, compartment flow dynamics, single room fire analysis, Model of enclosures fires, theory & concepts of zone models, Dynamics of enclosure fire: Heat release, fire generated flows, heat transfer & flow trough openings. Zone modeling of pre flashover enclosures fire: Flame & burning object, sources terms, fire plume source terms. Hot layer source terms, product of combustion source terms one zone modeling of pool flash fire

Module 5 **(06 Hrs)**

FIRE FIGHTING INSTALLATION: Water Based Fire Protection, Hydrant system, Automatic Sprinkler System, High Velocity Water spray system, Foam Based Fire Protection, Gas Based Fire Protection, Co2 flooding system, Co2 local application system, Dry Chemical Based Fire Protection System, DCP fixed installation and local application system.

Course Outcome:
At the end of course, student will be able to:
1. Understand types of buildings and classification of occupancy.
2. Explain fire and life safety requirements in each type of building/ occupancy.
3. Have knowledge of fire propagation and spread within the enclosed building.
4. Develop models on compartment fire in different category and scenarios.
5. Have knowledge of fire fighting installation based on extinguishing medias.

List of Text/Reference Books:

1. V.K. Jain. Fire Safety in Buildings.Taylor & Francis
2. D.J. Rasbash. Evaluation of Fire Safety, Willey
3. Gupta R.S., A Hand Book of Fire Technology,
4. T.W.MEVER Building Services Design.
5. R.LEE Building Maintenance Management.

IPS Academy, Institute of Engineering & Science
(A UGC Autonomous Institute, Affiliated to RGPV, Bhopal)
New Scheme & Syllabus Based on AICTE Flexible Curricula **(B. Tech)**
Fire Technology & Safety Engineering

PEC FT02 (a)	Departmental Elective-II Process Safety & Risk Assessment	3L:0T:0P (03 hrs)	03 Credits

Course Objective:
To understand the concept of risk assessment in design and operation with evaluation of threat zone observed during consequence modeling.

Course Content:

Module 1 **(08 Hrs)**
CONCEPT OF RISK: Definition, Accepted & Imposed risk, perception and qualification of risk, ALARP, cost Benefit analysis.

Module 2 **(08 Hrs)**
BASIC QUANTITATIVE RISK ASSESSMENT (QRA): The logic tree Approach, principles of QRA, fault tree analysis, probability Theory, Combination of Frequencies, Event Tree analysis (ETA)

Module 3 **(08 Hrs)**
SAFETY IN DESIGN AND OPERATION: Safety in Design safety assurance in design, safety in operation, maintenance, organizing for safety, Accident Investigation and reporting.

Module 4 **(08 Hrs)**
HAZOP: Introduction to HAZOP, conducting a HAZOP study, computerized reporting systems. HAZOP of batch process, Extensions of HAZAOP, Failure Mode & Effect Analysis (FMEA): Methodology of FMEA, criticality analysis, corrective action and followup

Module 5 **(08 Hrs)**
CONSEQUENCE MODELING: Gas dispersion, Toxicity, Explosions and fires, fires. Human Factors:- The role of the operator, control room design, Human Error Assessment Methods, Application of HAZOP to human reliability, date on operator reliability.

Course Outcome:
At the end of this course student will be able to:
1. Know the basic concept of risk.
2. Describe QRA , ETA, FTA and other safety methodologies.
3. Understand safety in design and operation.
4. Understand HAZOP and its application in risk assessment.
5. Evaluate threat zone in consequence modeling.

List of Text/Reference Books:

1. Process safety analysis An introduction by Bob Skelton.
2. An introduction to Risk Analysis by Robert E. Megill.
3. Risk Assessments Questions and Answers a practical approach by Pat Perry.
4. Safety sharing the experience - BP Process Safety Series- by www.icheme.org.
5. Fire Safety Risk Assessment- HM Government

PEC FT02 (b)	**Departmental Elective-II** **(b) Safety and Risk Analytics**	**3L:0T:0P (03 hrs)**	**03 Credits**

Course Objective: The objective of this course is to impart students with a holistic view of safety and risk analytics applied to systems life cycle through advanced analytics and reporting techniques and technologies.

PRE-REQUISITES: Basic probability and statistics

BASICS OF SAFETY AND RISK: Introduction to Safety and Risk Management, Hazard Triangle Safety Ontology Qualitative Risk Assessment, Quantitative Risk Assessment, Hazard and Risk Data – I, Hazard and Risk Data – II, Incident Investigation Data, Inspection and Audit Data, Behavioral and Organizational Safety Data, Data Dimensions and Information Quality, Missing Data Handling.

CREATION OF SAFETY DATABASE: Data Transformation – I, Data Transformation – II, Data Reduction I, Data Reduction II, Probability Distribution, Sample and Statistics, Safety Data Visualization Tools – I, Safety Data Visualization Tools – II, Safety Data Exploration, Leading and Lagging Indicators for Measuring Safety, Performance Control Charts for Safety Performance Evaluation and Monitoring

DESCRIPTIVE SAFETY ANALYTICS: Safety Capability Analysis I, Safety Capability Analysis I, Safety Reports and Use of Text Analytics, Preprocessing of Text Data – I, Preprocessing of Text Data – II, Document Classification using KNN, Topic Modeling - Latent Dirichlet Allocation, Bow-Tie Construction, Bow-Tie Quantification – I, Bow - Tie Quantification - II : Accident Scenarios/Paths, Tie Quantification III : Accident Path Quantification, Tie Quantification - IV : Probabilistic Approach using Monte Carlo Simulation, Consequence Modeling and Risk Distribution

PREDICTIVE SAFETY AND RISK ANALYTICS: Introduction to Predictive Safety and Risk Analytics, Logistic Regression, Application of Logistic Regression, Classification and Regression Tree (CART). Classification and Regression Tree (CART): Case Study Support Vector Machine, Support Vector Machine (Contd.), Application of Support Vector Machine, Association Rule Mining, Application of Association Rule Mining,

BEHAVIORAL SAFETY ANALYTICS AND INJURY EPIDEMIOLOGY: Statistical Measures of Safety Program Effectiveness – I, Statistical Measures of Safety Program Effectiveness – II, Statistical Measures of Safety Program Effectiveness – III, Intervention Design, Risk Based Decision Making-I, Risk Based Decision Making-II, Risk Based Maintenance-I, Risk Based Maintenance-II, Introduction to Behavioral Safety, Behavioral Safety Data Collection and Preliminary Analysis, Causal Modelling – I, Causal Modelling - II : Application of Path Model, Injury Epidemiology, Occupational Safety, Health and Working Conditions Code, 2020

Course Outcome:

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

1. Know types, sources and characteristics of safety data and their integration for organization-wide safety centric data model.
2. Describe safety data visualization and exploration.
3. Evaluate safety performance and monitoring techniques.
4. Justify the use of behavioral safety analytics.
5. Know safety related decision making at work places.

List of Text/Reference Books:

1. System Safety Engineering Management, Harilde.Roland and Brain Moriarty, John Willey & Sons.
2. Safety Analysis, Lars Harms-Ringdahl CRC Press.
3. Probabilistic Risk Assessment for Engineering and Scientists, Komamoto and Henley, IEEE Press, 1995.
4. Industrial Accident Prevention, Heinrich et al., McGraw Hill, 1980.
5. Techniques for safety management - A systems approach, Petersen D, ASSE 1998.

PEC FT02 (c)	**Departmental Elective-II Environment Protection & Waste Management**	**3L:0T:0P (03 hrs)**	**03 Credits**

Course Objectives

To learn the various engineering techniques and management approaches for the prevention and control of air pollution, water pollution and pollution due to urban solid waste and hazardous waste.

Course Content:

Module I **(08 Hrs)**

AIR POLLUTION MANAGEMENT: Air Pollution, Air pollution Measurement, Air quality monitoring, Air pollution modeling, Air pollution control Technology & method, Equipment Selection, Equipment design, Particulate emission control, Sources corrective methods, Air quality management concept.

Module II **(08 Hrs)**

WATER POLLUTION MANAGEMENT: Concept of water pollution, characteristic of waste water, standards of pollution parameters methodology of waste water treatment, Water Treatment process, Sedimentation, coagulation and flocculation, Filtration, Advanced Water Treatment processes, Industrial Water pollution management.

Module III **(08 Hrs)**

SOLID HAZARDOUS WASTE MANAGEMENT: Sources, Classification and composition of MSW (Municipal Solid Waste), Waste Minimization of MSW, Thermal Treatment (Combustion) of MSW, Hazardous Waste Transport & treatment facilities, Treatment systems for hazardous waste & handling of treatment plant residues.

Module IV **(08 Hrs)**

ENVIRONMENTAL MANAGEMENT: Principles and requirements of ISO 14001 EMS, Environmental auditing and Auditing of waste minimization. Environment Impact Assessment, Environment Management Plan. EIA, EMP and Environmental Auditing Environmental impact assessment, base line for existing data collection and identification of impact, prediction of impacts, Evaluation of impacts.

Module V **(08 Hrs)**

HEALTH CARE WASTE: Handling storage and transportation of health care waste, Waste segregation packaging on site collection Transport & storage of waste treatment and disposal of health care waste. Incineration chemical infection wet and dry thermal treatment, microwave irradiation, land disposal, winterization treatment and disposal method from pharmaceutical & chemical waste; Training for health care personal and waste management operators.

Course Outcome:

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

1. Attain ability to choose the most suitable technique for air pollution monitoring and control technique for a given application.
2. Describe suitable techniques for water treatments and control technique for water pollution management.
3. Identify the techniques for the disposal and management of urban solid wastes and hazardous wastes
4. Demonstrate the ability to recognize the tools for environmental management in industries.
5. Demonstrate an ability to recognize the type of health care waste and processes involved in Transport & storage of waste treatment and disposal of health care waste.

List of Text/Reference Books:

1. Environmental Management Handbook by Marcel Dekker.
2. Environmental Management Handbook for Hydrocarbon Processing Indus.; James B. Wall.
3. Environmental Safety and Health Engineerings by Gayle wood side and Dianna Koeurek.
4. Waste Management by Rajiv K. Sinha.
5. Hazardous Waste Management by J.M. Dewan.
6. Perspectives in Nuclear Toxic and Hazardous Waste by Kadambari Sharma.
7. Water Pollution, Causes Effects & Control by P.K. Goel.
8. A to Z of Environmental Audit, A. Mehrotra.
   Elements of Biotechnology -P.K. Gupta

PEC- FT02 (d)	Departmental Elective-II Structural Fire Safety	3L:0T:0P (03 hrs)	03 Credits

Course Objectives:
To learn and understand the burning building collapse due to failure of structures at elevated temperature during fire.

Course Content:

Module 1 **(08 Hrs)**

CONSTRUCTION TERMS OF BUILDING DESIGN AND TYPES OF LOADS: General collapse information, General causes of collapse and its types, Constructive terms of building design-Arch, Beam and its types, Buttress, Deck, Façade, Fire cut beam, Girder gusset plate, types of wall, Lintel joist, suspended ceiling and braced frame construction. Types of loads and methods of application, Hierarchy of structural framing and zone of danger.

Module 2 **(08 Hrs)**

FIRE EFFECTS ON BUILDING: Effect of Fire, Natural ventilation, Smoke movement in buildings, Smoke movement in tall buildings, Stack effect, Wind effects, Influence of openings in tall buildings, Smoke shaft, Smoke control during building design, Control of smoke spread, Mechanical ventilation, Pressurization system and their types, Design of smoke control pressurization system for a building**.**

Module 3 **(06 Hrs)**

ANALYSIS OF STRUCTURAL DAMAGE: Wall collapse- Masonry wall, Concrete wall and wood frame walls. Roof collapse- Sloping peak roof, Timber truss roof, Flat roof and steel roof, Stairway collapse, Floor collapse-Terrazzo floor, wooden I beam, Precast concrete slabs, Column collapse.

Module 4 **(08 Hrs)**

POST FIRE ANALYSIS: Post fire analysis and fire protection to buildings Rain roof, Fire Retarding compartmentation, fire fact sheet, the fire diagram and fire photographic documentation, Fire planning and design, Confinement of fire site planning access to fire fighting appliances, Contribution of external walls and roof covering, Aspects of internal planning, reduction of fire spread, Concept of compartments and types, Construction of compartments, Space and circulation, Principles and types of fire and roof venting, Effect of wind on roof vent, Industrial building ventilation.

Module 5 **(08 Hrs)**

BUILDING CONSTRUCTION AND HAZARDS: Five standard types of building construction and their collapse hazards. Time temperature grading curves, Head balance for an enclosure during a fire, Fire severity and factors controlling fire severity, Thermal properties of wall fixtures & geometrical properties of a room compartment, Thermal insulation heat transfer and radiation, Calculation of fire resistance of a compartment, fire spread within, outside and between the buildings, Flames outside buildings, Reduction of risk of fires explosions.

Course Outcome:

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

1. Identify the constructive terms of building design and general causes of collapse.
2. Describe effect of fire, smoke movement and smoke control pressurization system for a buildings.
3. Analyze structural damage for different load bearing and non load bearing elements..
4. Distinguish between post fire analysis and planning/design for reduction of fire spread.
5. Explain types of building construction with their collapse hazard.

List of Text/Reference Books:

1. Vincent Dunn, Collapse of Burning Buildings: A guide to fire ground safety, Penn well corporation.
2. Howard J. Hill, Failure Point: How to determine Burning building stability, Penn well corporation.
3. Glenn. P corbeti, Builidng construction for the fire service, Jones & Barl.
4. T Z Harmathy, Fire Safety Design and Concrete, Longman Group UK Limited.
5. Bernard J. “Ben” Klaene, Structural Fire Fighting, National Fire Protection Association.
6. J.A. Purkiss, Fire Safety Engineering Design of Structures, Butterworth Heinemann

LC FT17 (P)	**Fire Fighting Installation**	**0L:0T:2P (02 hrs)**	**01 Credits**

List of Experiment:

1. To draw the suction and delivery arrangement of main, standby and jockey pump for a given sample of pump house and calculate the fire water demand.
2. To summarize the Sprinkler system components and draw the sprinkler installation for a given sample of an occupancy.
3. To recognize the major components of hydrant system and draw the hydrant system installation for a given sample of an occupancy.
4. To plan the foam based fire protection system and design for medium and high expansion foam system inside a given sample of flammable liquid tank.'
5. To analyze and evaluate the inert gas fire protection system drawing for a given sample of an occupancy.
6. To draw the major components of dry chemical based fire protection system in a given sample of hazardous location.
7. To draw and analyze the components of water spray system in a given sample of LPG bullet storage facility.
8. To draw and describe the components water mist/emulsify system for a given sample of transformer model.

SBC-FT05 (P)	**Fire Fighting Drills**	**0L:0T:2P (02 hrs)**	**01 Credit**

Course Objectives:
To understand and command aim, principle and instruction method of squad drill and fire fighting drills.

Course Content:

1. Introduction
2. Aim of Drill
3. Basic Principles
4. Squad Drills
5. Appliance Drills
    - Hose drill
    - Hydrant drill
    - Pump drill
    - CFT drill
    - Ladder drill
    - Ambulance drill
6. Miscellaneous Drills
    - Knots
    - Rescue Techniques
7. Emergency Evacuation Drills
8. Fitness Training
    - Yoga
    - Meditation
    - Physical training
9. Emergency Communications

Course Outcome:
At the end of this course student will be able to:
1. Conduct and command squad drill of fire fighting crew in an organization.
2. Trained fire fighting crew in different squad drills and fire fighting drills.

List of Text/Reference Books:

1. AFS – Drill Manual
2. Drill manual for Fire Services of India by Govt. of India.
3. Fire Fighters Skill drill manual by NFPA.