



IPS Academy, Institute of Engineering & Science
(A UGC Autonomous Institute, Affiliated to RGPV, Bhopal)
Fire Technology & Safety Engineering Department

Minor in Fire Prevention & Protection

(To be offered to students of other departments excluding FT&SE)

S. No.	Semester	Subject Name	Contact Hours per week			Total Credits
			L	T	P	
1.	V	Fundamentals of Fire and Safety	4	0	0	4
2.	VI	Fire Investigation and Loss Control	3	1	0	4
3.	VII	Explosion Hazards & Control	3	1	0	4
4.	VIII	Fire Prevention & Protection Measures	2	0	2	3
		Total	12	2	2	15
		Total Academic Engagement and Credits	16			15



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	Fundamentals of Fire and Safety	4L:0T:0P (04 hrs)	04 Credits
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Course Objective:

To understand and learn the basic essentials fundamentals in fire technology & safety engineering discipline.

Module 1 (08 Hrs)

BASICS OF FIRE AND FIRE SCIENCE: Chemistry and Physics of Fire, Theory of Fire Extinguishment, combustion process, extinguishment with water, extinguishment with aqueous foams, extinguishment with water mist, extinguishment with inert gases, extinguishment with halogenated agents,

Module 2 (08 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 3 (08 Hrs)

FIRE DYNAMICS: Introduction- temperature, heat, specific heat, flash point, fire point, ignition, combustion; Ignition pilot ignition, spontaneous ignition, ignition sources; Types of combustion- rapid, spontaneous, explosion; Product of combustion-flame, heat, smoke, fire gases. Development of fire-incipient, smoldering, flame and heat stages; Diffusion flames-zones of combustion, smoldering combustion, characteristics of diffusion flame; Premixed flames-burning velocity, limits of flammability, explosion and expansion ratios, deflagration and detonation, characteristics of premixed flame.

Module 4 (08 Hrs)

FUNDAMENTALS OF FIRE DETECTION- simplified fire development, fire signatures, characteristics of fire signatures, aerosol signatures, energy release signatures, gas signatures, other fire signatures, basics of passive fire protection, stages of fire development, flame spread, Smoke and Toxicity.

Module 5 (08 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 Outcomes:

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

1. Apply fundamental concepts of fire and its extinguishment.
2. Understand the fundamentals of fire detection & interpret in fire detection system design.
3. Understand various types of fire fighting installation.
4. Know about industrial labour legislation.
5. Understand accident investigation and reporting process .

List of Text/Reference Books:

1. Heinrich H.W. Industrial Accident Prevention McGraw - Hill Company, New York,1980.
2. Krishnan N.V. Safety Management in Industry Jaico Publishing House, Bombay,1997.
3. Lees, F.P., Loss Prevention in Process Industries Butterworth publications, London, 2nd edition, 1990.
4. John Ridley, Safety at Work, Butterworth and Co., London, 1983.
5. Fred Stowell, Principles of Foam Fire Fighting International Fire Service Training Association.
6. Robert M Gagnon, Designer's Guide to Automatic Sprinkler Systems, NFPA-2005.
7. Operation of Fire Protection System NFPA Special Edition.
8. Tariff Advisory committee, Fire Protection Manual- Hydrant System.



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	Fire Investigation and Loss Control	3L:1T:0P (04 hrs)	04 Credits
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Course Objectives:

1. To teach the significance of salvage and smoke movement in fire investigation process.
2. To learn the fundamental of compartment fire and its application in fire investigation process.
3. To calculate the fire loss by different methodology and application of data in identification of fire trends.
4. To understand the evacuation process with different models of evacuation.
5. To learn the role of insurance agency in legal and claim aspect

Course Content:

Module 1

(08 Hrs)

SALVAGE AND SMOKE CONTROL: Concept of salvage, salvage operation, equipments, apparatus and methodology used in salvage operations, case studies in different types of occupancies. Mass flow rate, temperature, soot protection. Smoke generation, smoke flow & dispersion, prediction of smoke flow patterns, scaling of smoke proportion, smoke impact in visibility, smoke control system, pressure differences in ventilation system, calculation of discharge rate of air blowers, smoke extraction.

Module 2

(06 Hrs)

FIRE LOSS INVESTIGATION: Fire Risk analysis methods, Quantitative Deterministic methods, Quantitative probabilistic methods, Monte Carlo Technique, Safety Index Method, Ranking method, Fire Risk Index Method, Initial observation and Examination of the Scene, Use of Fire Incident data, Approaches to fire data analysis, top down & topic driven analysis, analysis by fire causes and property type, Analysis of small data sets, application of data trends identification.

Module 3

(08 Hrs)

PYROLYSIS: Importance of Pyrolysis in Fires, Pyrolysis process, Physico Chemical Description of Pyrolysis Process, Pyrolysis of Cellulose, Pyrolysis of Hemicellulose, Pyrolysis of Lignins, Pyrolysis of Wood, Characteristics and location of fire causalities, nature of Injuries, causality rate per fire, Process of emergency evacuation, Evacuation modeling, model-1 EXIT, model-2 EGRESS, model-3 SIMULEX.

Module 4

(08 Hrs)

INSURANCE AND RISK MANAGEMENT: Introduction to risk, Nature & types of risks, Risk Management Process, Risk and its relation with Insurance, General principles of Insurance, Insurance Terminology, Insurance Application and Acceptance Procedure.

Module 5

(08 Hrs)

ECONOMICS AND INSURANCE: Computation of Loss, Fire Insurance Claims, Legal provisions for Fire Loss, Economics of Loss Prevention, Cost of Losses, Cost of Prevention, Level of Loss Prevention Expenditure, Insurance of Process Plant, Damage Insurance, Business Interruption Insurance, Other Insurance Aspects.,

Course Outcome:

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

1. Demonstrate salvage equipments and apparatus with evaluation of smoke control parameter in occupancy.
2. Design compartment fire zone and formulate the fire dynamics of given problem.
3. Explain fire loss investigation process and prepare fire investigation report.
4. Prepare evacuation plan of a given occupancy.
5. Explain the role of insurance agency in fire loss.

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. Fire protection handbook volume-I section-III, NFPA.
4. Fire protection handbook volume-II section-IX, NPFA
5. Fundamental of fire fighting skills, NFPA
6. Scand Power. Handbook for Fire calculation and fire risk assessment in the process industry, AS Sintef-NBL.



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	Explosion Hazards & Control	3L:1T:0P (04 hrs)	04 Credits
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Course Objectives:

To understand and learn simple modeling of blast waves derived from energy release in explosions, predictions for the damage caused by explosions and methods of ensuring safety.

Course Content:

Module 1 (08 Hrs)

INTRODUCTION: Loud Bang and Disruption Blast Wave in an Explosion; Prediction from Dimensional Considerations Typical Examples of Explosions and Classification Theory of Blast Waves Shock Hugoniot and Rayleigh Line Properties behind Constant Velocity Shock Blast waves; Concentration of Mass at Front, Snow Plow Approximation.

Module 2 (08Hrs)

BLAST WAVE IMPACT : Characteristics of Blast Waves Decay of a Blast Wave, Sach's Scaling Overpressure and Impulse in the near and Far Field Missiles, Fragments and Shrapnel, Craters Interaction of Blast with Objects and Structures Reflection and Transmission of Blast Waves, Impedance Amplification of Reflected Blast waves, Spall, Damage to Organs, Mushroom Cloud.

Module 3 (08 Hrs)

EXPLOSION ENERGY: Energy Release in an Explosion Energy Release in a Chemical Reaction, Standard Heats of Formation Stoichiometry, Equivalence Ratio and Heat Release in Fuel-rich and Oxidizer-rich Compounds Energy release calculations, Higher and Lower Calorific Values, Internal Energy of Formation Rate of Energy Release Concentration, Activation Energy, Energy Release Profile Thermal Theory of Explosions Application of Thermal Theory and Inferences.

Module 4 (08 Hrs)

EXPLOSION MODELING: Modeling of Rate of Energy Release Role of Chain carriers in an explosion Fire and Combustion Combustion and Explosions Case Histories of explosions involving Volatile Liquids Detonations Introduction to Detonations Structure of Detonation Realizable States in a Detonation One Dimensional Model of a Detonation Case Histories of explosions Involving Detonation or Quasi-Detonation.

Module 5 (08 Hrs)

EXPLOSION TYPES: Different Types of Explosions Explosions in Confined and Unconfined Geometries Dust Explosion I Dust Explosion II Physical Explosions Rupture of Cryogenic Storage Vessels and Pressure Vessels Condensed Phase Explosions Condensed Phase Explosives based on Hydrocarbons Condensed Phase explosives and their Properties TNT Equivalence and Yield of an Explosion Quantification of damages in an Explosion.

Course Outcome:

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

1. Know concept of blast wave belongs to different types of explosions.
2. Calculate the impact of blast wave on objects and building structure.
3. Understand the fundamentals of explosion energy and rate of energy release.
4. Develop one dimensional model of a detonation involving volatile liquids.
5. Have knowledge of explosion types and their properties.

List of Text/Reference Books:

1. Baker, W.E., Explosions in Air, University of Texas Press, Austin, 1973
2. Ramamurthi, K. Explosions and Explosion Safety, McGraw Hill, New Delhi, 2011
3. Crowl, D. A. and Louvar, J.F., Chemical Process safety, Prentice Hall, NJ, 2002
4. Stull, D.R., Fundamentals of Fire and Explosion, AIChE Monograph Series, Vol. 73, No. 10,1977
5. Kinney G. F. and Graham K. J., Explosive Shocks in Air, Springer, Berlin, 1985
6. Cooper P. W. and Kurowski S.R., Introduction to the Technology of Explosives, Wiley-VCH, New York, 1966



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	Fire Prevention & Protection Measures	2L:0T:2P (04 hrs)	03 Credits
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Course Objectives:

- To learn about the fundamentals of buildings and their classifications.
- To teach about the evacuation procedure and means of escape during emergency in tall structures.
- To learn about automatic fire and gas detection in different types of occupancy.
- To teach about first aid fire fighting equipments, their working principles and periodic maintenance.
- To learn about ideal fire and life safety requirement based on different types of buildings.

Course Content:

Module 1

(08 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

(09 Hrs)

MEANS OF ESCAPE: General requirements for evaluation facilities, Principle factors for design consideration, evacuation time, Occupancy load, Occupancy, Travel distance, Design for evacuation routes, evacuation route quantification, requirement of stairs ways, phased evacuation in tall buildings, Life Safety Consideration refuse area, Exit Route, Assibilate of fire fighting approach evacuation facility or disable people, use of lifts & air lifting, safe evacuation time.

Module 3

(08 Hrs)

FIRE AND GAS DETECTION: Fire Alarm system basic, classification of fire alarm system, Basic consideration for instation, Automatic fire detectors, heat detector, Smoke detector, Gas sensing fire detector, Radiant energy sensing fire, detectors, detector installation, maintenance & testing, Inspection, Testing & maintance shuetuting for Fire alarm system & its component gas & vapour fixed detection system, Sensors portable gas mainting instrument.

Module 4

(10 Hrs)

FIRE EXTINGUISHMENT: Basic concept of fire fighting with water, carbon dioxide, dry chemical powder, foam and inert gases, Extinguishing Properties of Water, Droplet size, Smoothing, Heat absorbing capacity, Surface tension and waiting agent additives and its limitations, Properties of inert gases as extinguishing agent, properties of foam, Expansion, Concentration, bubbles size, Extinguishing properties of Dry chemical powder, Composition, Particle size, Radiation shielding, Chain breaking mechanism, Description, working principle and Operation methods of portable Fire Extinguishers, Care inspection and maintenance of portable Fire Extinguisher, Performance criteria of different types of Fire Extinguisher as per relevant Indian Standard.

Module 5

(06 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.

Course Outcome:

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

1. Explain fire resistance rating of different structural elements and fire resistance test on building material.
2. Design evacuation routes and performed evacuation in tall buildings.
3. Design fire alarm system with fire and gas detection apparatus in different types of occupancy.
4. Demonstrate first aid fire fighting appliances and performed periodic care and maintenance for the same.
5. Present model fire and life safety requirement in different type of buildings. .

List of Text/Reference Books:

1. Barendra Mohan Sen, Fire Protection And Prevention The Essential Handbook, Ubs Publishers.
2. Dr. Than Singh Sharma, Fundamentals In Building Design.
3. Lon H. Ferguson, Fundamentals Of Fire Protection For The Safety Professional, The Scarecrow Press, Inc.
4. National Building Code Of India Part-Iv.
5. Fire Protection Hand Book Volume-Ii Section-Ix.

List of Experiment:

1. To measure the operating performance requirement for effective discharge time, fire rating suitability of water type fire Extinguisher on Class A Fire.
2. To measure the operating performance requirement for effective discharge time, fire rating suitability of Foam type Gas Cartridge fire Extinguisher on Class B Fire
3. To measure the burn back resistance time for different foam concentrates using film formation test apparatus.
4. To assess the effective time of film formation at fire surface for different foam concentrates using film formation test apparatus.
5. To Perform the Caking test on given sample of Dry Chemical Powder using procedures given in IS 4308.
6. To determine the moisture content for regular dry chemical powder using procedures given in IS 4308.
7. Determination of calorific value of diesel, petrol and LPG/Kerosene.
8. To determine the water repellency for regular dry chemical powder using water repellency test apparatus.