



# IPS ACADEMY-INSTITUTE OF ENGINEERING & SCIENCE, INDORE

(A UGC Autonomous Institute, Affiliated to RGPV, Bhopal)

Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal

Scheme of Examination

III Semester Master of Technology (M.Tech.)

**[Industrial Safety Engineering]**

S. No.	Subject Code	Subject Name	Maximum Marks Allotted					Total Marks	Contact Hours per week			Total Credits
			Theory			Practical			L	T	P	
			End Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem	Term work Lab Work & Sessional					
1	PSEC** IS301	Program Specific Elective Course-III	60	25	15	-	-	100	3	-	-	3
2	LLC IS301	Liberal Learning Course	60	25	15	-	-	100	1	-	-	1
3	SBC IS301	Dissertation Phase-I	-	-	-	100	100	200	-	-	20	10
		Total	120	50	30	100	100	400	4	-	20	14

\*\* This can be either offered by the department or one online MOOC Course

Program Specific Elective Course (PSEC)- III	Liberal Learning Course (LLC)	Skill Based Course (SBC)-I
PSEC IS301 (A) Chemical Process Safety	LLC IS301 (A) Defense (Study about functioning of Armed Forces)	Dissertation Phase-I
PSEC IS301 (B) Fire Protection, Services & Maintenance Management of Building	LLC IS301 (B) Personality Development	
PSEC IS301 (C) Industrial Safety Engineering	LLC IS301 (C) Business Communication	
PSEC IS301 (D) Explosions and Safety		
PSEC IS301 (E) Safety in Construction		

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<b>PSEC IS301 (A)</b>	<b>Chemical Process Safety</b>	<b>3L:0T:0P (03 hrs)</b>	<b>03 Credits</b>
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**Course Objective:**

To understand and learn the important technical fundamentals of chemical process safety with basics of safety.

**Course Content:**

**Module 1 (06 Hrs)**

**INTRODUCTION :** Safety, Hazards and Risk, Elements of process safety management, Features and characteristics of a management system for process safety, Process Safety, Inherent Safety, Hazard Identification, Risk Assessment, Safety and Accident Loss Statistics, OSHA incidence rate, Fatal accident rate(FAR), Fatality rate.

**Module 2 (08 Hrs)**

**RISK MANAGEMENT AND CONTROL MEASURES:** Hazardous substance rules 1986, Factories Act 1948, EPA rules, Class Label Nature of Accident, Introduction of Four significant disasters of world Flixborough, Seveso, Bhopal, Jaipur Accident Types of Chemical Plant Causes of over pressurization Heat of Reaction Adiabatic Temperature Rise Arrhenius relationship Thermal runaway Phi factor Heat loss (changes with scale) Reagent accumulation Onset temperature (exothermic events) Safety factors (for thermal hazards data) Safety factors and Consideration

**Module-3 (08 Hrs)**

**TOXICOLOGICAL STUDIES:** Toxic, Toxicant and Toxin, Routes and Effects of Exposure Types of Toxic Effect, Entry Routes for Toxicants and Methods for Control, Dose-Response Relationships Dose Versus Response Dose Limit Values Measures of Toxicity: Median Lethal Dose LD50, Median Lethal Concentration LC50, Targeted Organ, Excretion, Metabolism, Biotransformation, Toxicological Disease Process, Modeling Concepts, Selection of Models, Toxic Load response relation, Dose-infection models Hit-Theory Models.

**Module 4 (08 Hrs)**

**SAFETY IN THE STORAGE AND HANDLING OF CHEMICALS AND GASES:** 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, trips- protection and stills, columns and towers from lightening- colour coding for pipe lines and cylinders.

**Module-5 (08 Hrs)**

**SAFETY IN THE OPERATION OF CHEMICAL PROCESS PLANTS :** Properties of Chemicals MSDS Material Safety data Sheet, Operational Activities and Hazards Standard operating procedures, Effects of pressure, temperature, flow rate and humidity on operations Condition monitoring- control valves- safety valves- pressure reducing valves, drains, bypass valves, inert gases. Chemical splashes, eye irrigation and automatic showers.

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**Course Outcomes:**

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

1. Know about elements of process safety management.
2. Understand the risk management and control measures through past accidents.
3. Explain the chemical toxicology with different Disease Process, Modeling.
4. Demonstrates the safety measures in STORAGE and handling of chemicals and gases capacity
5. Explain operational safety in chemical process plant.

**List of Text/Reference Books:**

1. Crowl D.A. and Louvar J.F., Chemical Process Safety: Fundamentals With Applications.
2. Lees F.P. Lee's Loss Prevention in Process industries: Hazard Identification, Assessment and control
3. Kletz T, What Went Wrong - Case Histories of Process Plant Disasters: How They Could Have Been Avoided

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<b>PSEC IS301 (B)</b>	<b>Fire Protection, Services &amp; Maintenance Management of Building</b>	<b>3L:0T:0P (03 hrs)</b>	<b>03 Credits</b>
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**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 in 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, CO<sub>2</sub>, 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 through openings. Zone modeling of pre flashover enclosures fire: Flame & burning object, source 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, Co<sub>2</sub> flooding system, Co<sub>2</sub> 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.

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**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.

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<b>PSEC IS301 (C)</b>	<b>Industrial Safety Engineering</b>	<b>3L:0T:0P (03 hrs)</b>	<b>03 Credits</b>
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**Course Objectives:**

To impart knowledge on different facets and aspects of engineering systems safety, focusing on tools, techniques and methodologies needed for prevention of occurrences of unsafe operations and accidents under different industrial settings.

**Course Content:**

**Module 1 (06 Hrs)**

**INTRODUCTION:** Key concept- Hazard, System, Accident, Safety and Risk. System Safety Concept, Objectives System as Design Parameters System Life Cycle- Concept, Phases-Defination, Development, Production and Deployment

**Module 2 (08 Hrs)**

**SYSTEM SAFETY IMPLEMENTATION:** Policy and Procedures, Product Assurance Organization, System Safety Program Plan (SSPP), Elements of System Safety Program Plan, System Interfacing, Human Engineering-Design of Work Places, Causes of Errors, Procedural Safety Guards.

**Module 3 (06 Hrs)**

**SAFETY EVALUATION TOOL:** Probability laws, Measures of Central Tendency and Dispersion, Methods of Safety Analysis-Correlation, Regression, Analysis of Variance, Contingency Table.

**Module 4 (08 Hrs)**

**HAZARD ANALYSIS:** Elements of Hazard Analysis-Hazard Severity, Hazard Likelihood, Hazard Probability, Hazard Control, Hazard Index, Hazard Control Design Criteria, Preliminary Hazard Analysis, System Hazard Analysis.

**Module 5 (06 Hrs)**

**FAULT TREE ANALYSIS:** Fault Tree Symbology -Event and Logic Symbol, Fault Tree Synthesis, Cut Set Development, Fault tree Quantification-Fault Rate, Mean down Time, Un Reliability, Common Cause Analysis

**Course Outcome:**

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

1. Know key concept and terminology of system safety.
2. Develop system safety program plan for a given system.
3. Calculate probability as safety evaluation tool for a given sample of accident data.
4. Explain hazard analysis techniques and its application for a given system.
5. Apply fault tree analysis technique to given set of parameters for assessment of accident root cause.

**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.

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4. Industrial Accident Prevention, Heinrich et al., McGraw Hill, 1980.
5. Techniques for safety management - A systems approach, Petersen D, ASSE 1998.

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<b>PSEC IS301 (D)</b>	<b>Explosions and Safety</b>	<b>3L:0T:0P (03 hrs)</b>	<b>03 Credits</b>
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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.



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**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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<b>PSEC IS301(E)</b>	<b>Safety in Construction</b>	<b>3L:0T:0P (03 hrs)</b>	<b>03 Credits</b>
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**Course Objectives:**

To learn and understand the latest safety and health regulations and the Indian Standards applicable to the construction industry.

**Course Content:**

**Module 1**

**(08 Hrs)**

**BASIC PHILOSOPHY:** Building Bye laws for Residential Area, Cinemas, Theatres, Multiplex, Auditorium etc., Drive-in-Cinemas, Gasoline Filling Station, Basic Philosophy and parameters governing in construction such as site planning and layout, safe access and good housekeeping, safety in use of construction machinery, structural soundness, structural safety, accident causes and its effect.

**Module 2**

**(08 Hrs)**

**WORKING AT HEIGHT:** Fall protection in construction, OSHA 3146, Requirement for working at height, Work permit system, Height pass, Salient Features of safety and health in the Building & other Construction Workers (Regulation of employment and conditions of service) Act. 1996 and Central Rules 1998 IS & NB codes)

**Module 3**

**(06 Hrs)**

**SAFETY IN DEMOLITION OPERATIONS:** Planning & permit, Precautions prior to demolition, Protection of public, Precautions during demolition. Sequence of demolition operations from safety point of view, Safety measures with respect to building materials including cement, lime, timber, steel, glass, paints, varnishes, and petroleum products

**Module 4**

**(08 Hrs)**

**SAFETY IN CONSTRUCTION OPERATIONS I :** Underground works Excavation, drilling & blasting, trenching, strutting, piling & safety in using and operation machinery and equipment relating to above components. Above ground works, Scaffolding, Centering, Frame work, Ladders, Concreting wall and floor openings, staircases and railings. Structural steel work including welding, cutting erection, Safety in use of related machinery equipments,

**Module 5**

**(08 Hrs)**

**SAFETY IN CONSTRUCTION OPERATIONS II :** Under water operations, River draining, well sinking, Caissons, under water concreting, Cofferdams & special operation connected with irrigation works, Use of related machinery and equipments, Movement of Materials & personnel, Heavy/Long items, Railway wagons, Motor trucks, Vehicles and Hazardous materials, High rise building, bridges, roads, railways, asphaltting, pneumatic caissons, electrical, installations & lifts, safety in prevention and protection at work site including collapsing of structures

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**Course Outcome:**

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

1. Understand philosophy and parameters governing in construction Industry.
2. Demonstrates the working at height operation and apply applicable rules and act in Indian scenarios.
3. Explain safety in demolition operations involved with construction industry.
4. Understand safety in construction operation specifically underground works excavation.
5. Understand safety in construction operation specifically under water operations.

**List of Text/Reference Books:**

1. Hinze, J.W. (1997) Construction Safety, Prentice Hall
2. Mac Collum, D.V. (1995) Construction Safety Planning, John Wiley & Sons
3. Reese, C.D. & Eidson, J.V. (2006) Handbook of OSHA Construction Safety and Health, Taylor & Francis.
4. Lingard, H. & Rowlinson, S. (2005) Occupational health and Safety in Construction Project Management, Spon Press.
5. Holt, A.S.J. (2005) Principles of Construction Safety, Wiley-Blackwell Publishers
6. MacCollum, D.V. (2007) Construction Safety Engineering Principles, McGraw Hill Publishers
7. Bhattacharjee, S.K. (2011) Safety Management in Construction, Khanna Publishers
8. Li, R.Y.M. & Poon, S.W. (2013) Construction Safety, Springer Publishers Few IS Codes & journal papers
9. Fulman, J.B., 1979 Construction Safety, Security & Loss Prevention, John Wiley and Sons,