

**RAJIV GANDHI PROUDYOGIKI VISHWAVIDYALAYA BHOPAL**

*Choice Based Credit System*

**FIRE TECHNOLOGY & SAFETY ENGINEERING, IV-Semester**

**SAFETY MANAGEMENT**

**COURSE OBJECTIVE:**

1. Demonstrate knowledge and skills in the area of Basic Concepts and Techniques of Safety Management.
2. To understand the components of Safety Audit and Audit methodologies with relevant Government Agencies.
3. To understand the fundamentals of Accident Investigation and Reporting with its relevance in Accident Prevention.
4. To familiarize with different Accident Indices for Safety Performance monitoring.
5. To understand the importance of Safety Education and Training needs of an Organization.

**COURSE CONTENT:**

**CONCEPTS AND TECHNIQUES**

History of Safety movement, Evolution of modern safety concept, General concepts of management, Planning for safety for optimization of productivity, Quality and safety, Line and staff functions for safety, Budgeting for safety, Safety policy. Incident Recall Technique (IRT), Disaster control, Job safety analysis, Safety survey, Safety inspection, Safety sampling, Evaluation of performance of supervisors on safety.

**SAFETY AUDIT - INTRODUCTION**

Components of safety audit, Types of audit, Audit methodology, Non conformity reporting (NCR), Audit checklist and report, Review of inspection, Remarks by government agencies, Consultants, Experts, Perusal of accident and safety records, Formats, Implementation of audit Indication, Liaison with departments to ensure coordination, Check list, Identification of unsafe acts of workers and unsafe conditions in the shop floor

**ACCIDENT INVESTIGATION AND REPORTING**

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.

**SAFETY PERFORMANCE MONITORING**

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.

**SAFETY EDUCATION AND TRAINING**

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.

**COURSE OUTCOME**

1. Graduate will able to apply adult learning theory to safety training methodology.
2. Graduate will able to conduct accident investigations and Accident Data Analysis.
3. Graduate will able to anticipate, recognize, evaluate, and develop control strategies for hazardous conditions at work practices.

**EVALUATION**

Evaluation will be continuous an integral part of the class as well through external assessment.

## REFERENCES

- Heinrich H.W. Industrial Accident Prevention McGraw - Hill Company, New York, 1980.*
- Krishnan N.V. Safety Management in Industry Jaico Publishing House, Bombay, 1997.*
- Lees, F.P., Loss Prevention in Process Industries Butterworth publications, London, 2<sup>nd</sup> edition, 1990.*
- John Ridley, Safety at Work, Butterworth and Co., London, 1983.*
- Dan Petersen, Techniques of Safety Management, McGraw- Hill Company, Tokyo, 1981.*
- Relevant India Acts and Rules, Government of India.*
- Relevant Indian Standards and Specifications, BIS, New Delhi.*
- Blake R.B., Industrial Safety Prentice Hall, Inc., New Jersey, 1973.*
- Safety and Good House Keeping, N.P.C., New Delhi, 1985.*
- Accident Prevention Manual for Industrial Operations, N.S.C.Chicago, 1982.*
- Journal by Insurance company surveyors and loss assessors – Mumbai – published by Insurance companies.*

**FIRE TECHNOLOGY & SAFETY ENGINEERING, IV-Semester**

**RESCUE EQUIPMENTS & TECHNIQUES**

**COURSE OBJECTIVE:**

1. To give basic concepts of Rescue in Ordinary as well as special situations in Major Disasters.
2. To Understand the Respiratory and Non Respiratory Personal Protective Equipments used by Rescuer in Emergencies.
3. To learn about various types of Fire Dynamics in Fire Scenario and the basic Fundamentals of Fire Propagation .
4. To give general idea of Electrical hazards and Static Electricity.

**COURSE CONTENT:**

**RESPIRATORY AND NON-RESPIRATORY**

Head protection, Eye & Face Protection, Hand and Arm Protection, Foot and Leg Protection, Body Protection, Safety Belt and Harness, Ear Protection- the IS specification with types and testing procedure for Head protection, Eye & Face Protection, Hand and Arm Protection, Foot and Leg Protection, Body Protection, Safety Belt and Harness, Ear Protection Equipment. General, Selection, Care & Special precaution for respiratory PPE's, Canister type Respirators (IS 8523-1977), Chemical Cartridge Respirators (IS 8522-1977), Filter Type Particulate Respirators (IS 9473- 1980), Compressed Air Line Breathing Apparatus (IS 10245 Part-V -1982), Self Contained Breathing Apparatus (IS 10245 Part-II- 1982)

**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; Explosion- physical explosion, chemical explosion; Special kinds of combustion- Flash fire, Pool fire, Deep seated fire, Spoilover, Boilover, Slopover, Dust explosion, BLEVE, UVCE; Classification of fire based on material.

**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.

**CHEMISTRY AND PHYSICS OF FIRE**

Principles of Fire, Heat Measurement and Heat Transfer, Fire Growth, Heat Release Rate, Fuel Loading, Classification of Fire, Theory of Fire Extinguishment with Water, Foam, DCP, Inert Gases and Halogenated Agents, Special Case of Fire Extinguishment.

**ELECTRICAL HAZARDS & ITS PREVENTION**

Hazards of electrical energy, Safe limits of amperages, voltages, Safe distance from lines, Capacity and protection of conductor, Joints and connections, Means of cutting off power, Overload and short circuit protection, No load protection, Earth fault protection, Earth insulation and continuity tests, Earthing Standards, Protection against surge and voltage fluctuation, Hazards arising out of 'borrowed' neutrals, Others precautions, Types of protection for electrical equipment in hazardous atmosphere, Electrical area classification, Criteria in their selection, installation, maintenance and use. Introduction, Electro-Static charging - where charging can occur contact electrification, Electro Static discharges (sparks), Electro Static hazards and their control, Earthing and bonding, Recommended, Earthing resistance for control of electricity. Primary & Secondary Electric Shock,

AC Shock v/s DC Shock, Severity of Electric Shock, Prevention of Shock, Total Earthing System in Electrical Installations, Substation/ Electric plant, Types of Grounding, Safety Clearness and Creepage, Distance in Electrical Plant and Equipment.

### **COURSE OUTCOME**

1. Graduate will be able to demonstrate Rescue Operations by means of Special and unusual type.
2. Graduate will be able to apply the proper use of Respiratory and Non Respiratory Personal Protective Equipments in Emergencies.
3. Graduate will be able to know Fire Physics and Chemistry, Fire Propagation and Fire Dynamics.
4. Graduate will have general idea of Electrical hazards and Static Electricity.

### **LABORATORY**

Experiments as suggested by the course coordinator.

### **EVALUATION**

Evaluation will be continuous an integral part of the class as well through external assessment.

### **REFERENCES**

*AERB Safety Guideline for Personal Protective Equipments (Govt. of India)*  
*Fire Protection Handbook Vol.I Section-I Basics of Fire and Fire Scenario*  
*Elementary principles of rescue by Govt. Of India, ministry of Home Affairs*  
*Relevant ISI special appliances and equipments*  
*Gupta R.S., A Hand Book of Fire Technology,*  
*Raymond Friedman Principles of Fire Protection chemistry, National Fire Protection Association, 1996*  
*S. Rao and H.L. Saluja, Electrical Safety, Fire Safety Engineering and Safety Management, Khanna Publisher.*  
*A.A. Hattangadi, Electrical Fires and Failures, Tata McGraw Hill.*  
*John Cadick , Electrical Safety Hand Book, Tata McGraw Hill.*  
*J. Maxwell Adams, Electrical Safety a Guide to the causes and prevention of electrical hazards, The Institution of Fire Engineers.*

**FIRE TECHNOLOGY & SAFETY ENGINEERING, IV-Semester**

**FIRE FIGHTING & FIELD TRAINING-I**

**COURSE OBJECTIVE:**

1. To perform the position of Attention, Stand at Ease, Stand Easy, Sizing, Right dress, Dismiss, Step forward/backward March and Side step.
2. To understand the tricks of Parade Inspection, how & whom to salute and perform the position of Saluting.
3. To understand the fundamental of incident command system in fire service.
4. To understand the Fire Fighting strategy and various function of fire service.

**COURSE CONTENT:**

**INTRODUCTION:** Aim of drill, The Principle of good Instructions, Words of command, Timing and Techniques for Instructions. Review and Practices of Position- Attention, Stand at Ease, Stand Easy, Practice for Turning, Dressing, Numbering, Sizing & Inclining. **POSITION:** Attention, Stand at ease, Stand easy, Turning and Inclining, Dressing, Forming up in Three ranks, Numbering, Open and Close order March, Sizing. Practice of Marching in slow and quick time, Saluting & Changing, Saluting at the Halt, Saluting on the March, Stepping out & stepping short, Side Pace, Paces Forward and Rear, Wheeling. Practice for word of command, Correction of Faults, Inspection and Handling a Squad, Application of Instruction Techniques, Organizing Instructional Periods. **MARCHING:** Length of pace and time of marching, Marching in quick time, Elementary instruction, Regular pace, Halt, Marching in slow time, Position in marching, Changing step in slow march, changing step in quick march, breaking into slow march, breaking into quick march, turning and Diagonal march in slow time and quick time, forming squad on the march in slow and quick time, marching of in single file, reforming in three ranks.

**KNOT FORMATION:** Over Hand Know, Figure of Eight Knot, Reef Knot, Chair Knot, Half Hitch, Clove Hitch, Rolling Hitch, Timber Hitch, Black Wall Hitch, Water Mains Hitch. Slippery Hitch, Draw Hitch, Fishermen Bend, Single Sheet Bend, Double Sheet Bend, Carrick Bend, Sheep Shank, Bow Line, Running Bow Line, Ropes and Lines, Rope Making Terms.

**MANAGING INCIDENTS:** Incident command developed, strategic level, Building Incident Management system, Post incident review, Sizing of the incident, Determining fire flow, Incident action plan development, General structures fire consideration, Fire patterns, Determination of fire causes, Fire causes classification, Indicators of fires, Legal consideration.

**FUNCTION IN FIRE SERVICE:** Management function and responsibility, Personnel Management, Productivity, Organization structure of fire department, Fire officer responsibilities, Fire department function related to fire prevention, Training as management function, Training design, Management of learning and learning experience.

**STRATEGY OF FIRE FIGHTING:** Strip mall fires, Interior & Exterior fire spread, Venting, Common roof space, Strategy summary, High rise residence fires, Communication systems, Evacuation plan, Stair and door marking, Heavy Timber Factory fire, First and Second attack hose line, Size up consideration, Exposure protection.

**COURSE OUTCOME**

1. Graduate will able to conduct Squad Drill of Fire Fighting Crew in an Organization.
2. Graduate will able to trained Fire Fighting crew in different Squad Drills.
3. Graduate will able to perform different function in fire service.
4. Graduate will able to mange fire incident with different fire fighting strategy.

## LABORATORY

1. To Study the Aim, Principle, Instruction Method of Drill
2. To perform the position of Attention, Stand at Ease, Stand Easy, Sizing, Right dress, Dismiss, Step forward/backward March and Side step.
3. To perform the position of March and pace, Turning by numbers, Mark Time, The Halt, Marching in squad, Quick March and The Halt (on the move).
4. To perform the position of 'Right (or Left) ---Turn', Changing direction by wheeling and Changing steps on the March, Forming File from Single File and Forming Single File from File.
5. To study the tricks of Parade Inspection, how & whom to salute and perform the position of Saluting.

## EVALUATION

Evaluation will be continuous an integral part of the class as well through external assessment.

## REFERENCES

*Drill manual for Fire Services of India by Govt. of India.*

*Fire Fighters Skill drill manual by NFPA.*

*Fire officer principles and practice, NFPA, Jones and Bartlett Publishers.*

*Management in the fire service, NFPA Harry R.Carter, Ph.D and Erwin Rausch.*

*Strategy of Fire Fighting Vincent Dunn, Pennwell Corporation.*

**FIRE TECHNOLOGY & SAFETY ENGINEERING, IV-Semester**

**FLUID MECHANICS**

**COURSE OBJECTIVE:**

To be familiar with all the basic concepts of fluids and fluid flow phenomenon, conservation equations and their applications to fluid flow problems.

**COURSE CONTENT:**

**Fluid Static's:** Review of Basic concepts & properties of the fluid . Pressure at a point, pressure variation in static fluid, Absolute and gauge pressure, manometers, Forces on plane and curved surfaces ; buoyant force, Stability of floating and submerged bodies, Relative equilibrium.

**Kinematics of Flow :** Types of flow-ideal & real , steady & unsteady, uniform & non-uniform, one, two and three dimensional flow, path lines, streak-lines, streamlines and stream tubes; continuity equation for one and three dimensional flow, rotational & irrotational flow, circulation, stagnation point, separation of flow, sources & sinks, velocity potential, stream function, flow net & its applications , method of drawing flow nets.

**Dynamics of Flow:** Euler's equation of motion along a streamline and derivation of Bernoulli's equation, application of Bernoulli's equation, energy correction factor, linear momentum equation for steady flow; momentum correction factor. The moment of momentum equation, forces on fixed and moving vanes and other applications. Fluid Measurements: Velocity measurement ( Pitot tube, current meters etc.); flow measurement (orifices, nozzles, mouth pieces, orifice meter, nozzle meter, venturi-meter, weirs and notches).

**Dimensional Analysis :** Dimensional analysis, dimensional homogeneity, use of Buckingham-pi theorem, calculation of dimensionless numbers Introduction to boundary layer, Boundary layer development on a flat plate and its characteristics - Boundary layer thickness, displacement thickness, momentum thickness, energy thickness. Momentum equation for boundary layer by Von karman, drag on flat plate, boundary layer separation and its control. Aerofoil theory, lift and drag coefficients, streamlined and bluff bodies.

**Flow through Pipes :** Reynolds experiment & Reynolds number, laminar & turbulent flow, Introduction to Navier Stokes' Equation, relation between shear & pressure gradient, laminar flow through circular pipes, friction factor, laminar flow between parallel plates, hydrodynamic lubrication.

**COURSE OUTCOME**

At the completion of this course, students should be able to .

1. understand the properties of the fluid.
2. understand and solve the fluid flow problems.
3. understand the mathematical techniques of practical flow problems.
4. understand the energy exchange process in fluid machines.

**FIRE TECHNOLOGY & SAFETY ENGINEERING, IV-Semester**

**Auto CAD**

**COURSE OBJECTIVE:**

1. To understand how to use AutoCAD as a draughting tool to produce 2D & 3D working drawings.
2. To perform how to create a new drawing, edit an existing drawing.
3. To perform how to plot a drawing to a suitable printer or plotter.
4. To understand how to draw Isometric drawing and setup drawing environment and customize screen layout to suit their own preferences.

**COURSE CONTENT:**

STARTING A NEW DRAWING/OPENING AN EXISTING DRAWING: Setting up a drawing starting from scratch, Setting up a drawing using a Wizard, Using and creating a template file, Opening an existing drawing, Screen layout, Pull-down menus, Screen icons, Command line, status bar, Dialogue boxes

DRAWING COMMANDS: Lines, Ray, Construction Line, Multiline and polylines, Rectangles, Arc, Circle and Ellipse, Polygon, Spline, Co-ordinate input methods, (directive, and absolute, relative and polar)

MODIFY COMMANDS: Erase, Trim, Move, Copy, Mirror, Offset, Fillet and Chamfer, Array, Extend, Stretch, Rotate, Break, Scale and Explode.

CONSTRUCTION OF PLANE AND COMPLEX GEOMETRICAL FIGURES: Angles, Triangles, Rhombus, Quadrilaterals, Polygons, Angle Bisectors, Line divided in equal parts, Construction of Curves and Helix, Principles of Projections, Projections of Straight Lines and Solids, Section of Solids

DRAWING SETTINGS AND AIDS: Layers, Load Line types, Match properties, World UCS and User-defined, UCS, Drawing limits and units, Blocks, Attributes, individual project drawings of Hydrant post, Sprinkler head, Branch pipe, water monitor, fire extinguisher, hose fittings and Breathing Apparatus.

**COURSE OUTCOME**

1. Graduate will able to use Auto CAD Software in designing the fire protection system.
2. Graduate will able to create new and edit existing drawing.
3. Graduate will able plot a drawing to a suitable printer or plotter.
4. Graduate will able draw Isometric drawing and setup drawing environment and customize screen layout to suit their own preferences.

**REFERENCES**

*Auto CAD Manual*



**FIRE TECHNOLOGY & SAFETY ENGINEERING, IV-Semester (Mathematics-III)**

**(Applicable to ME/AU/CM/FT/IP/Mining Branches)**

**COURSE OBJECTIVE-** The objective of this course is to fulfill the needs of Engineers to understand the Applications of Fourier Series, Different Transforms, Complex Analysis & numerical methods in order to enable young technocrats to acquire Mathematical thinking of Formulating, Analyzing and Solving a wide range of Practical Problems Appearing in Science & Engineering.

**Course Contents**

**Fourier Series:** Fourier Series for Continuous & Discontinuous Functions, Expansion of odd and even periodic functions, Half-range Fourier series, Complex form of Fourier Series,

**Integral Transforms:**

**Fourier Transform-**Complex Fourier Transform, Fourier Sine and Cosine Transforms, Applications of Fourier Transform in Solving the Ordinary Differential Equation. **Laplace Transform-** Introduction of Laplace Transform, Laplace Transform of elementary Functions, Properties of Laplace Transform, Change of Scale Property, First and Second Shifting Properties, Laplace Transform of Derivatives and Integrals. Inverse Laplace Transform & its Properties, Convolution theorem, Applications of Laplace Transform in solving the Ordinary Differential Equations.

**Functions of Complex Variables:** Analytic functions, Harmonic Conjugate, Cauchy-Riemann Equations, Line Integral, Cauchy's Theorem, Cauchy's Integral Formula, Singular Points, Poles & Residues, Residue Theorem, Application of Residues theorem for Evaluation of Real Integrals.

**Numerical Solution of Ordinary Differential equations:** Picard's Method, Taylor's Series, Euler's Method, Modified Euler's Method, Runge-Kutta methods, Milne's and Adam's Bashforth Methods.

**COURSE OUTCOMES-** The curriculum of the Department is designed to satisfy the diverse needs of students. Coursework is designed to provide students the opportunity to learn key concepts of Fourier Series, Different Transforms, Complex Analysis & Numerical Methods for Solving Ordinary Differential Equations of First Order.

**EVALUATION-** Evaluation will be continuous, an integral part of the class as well as through external assessment.

**References:**

1. Erwin Kreyszig: Advanced Engineering Mathematics, Wiley India.
2. H C Taneja: Advanced Engineering Mathematics, I.K. International Publishing House Pvt. Ltd.
3. B.S. Grewal: Higher Engineering Mathematics , Khanna Publication.
4. S S Sastri: Engineering Mathematics, PHI
5. Ramana: Advance Engg. Mathematics, TMH New Delhi
6. Engineering Mathematics By Samnta Pal and Bhutia, Oxford Publication

**FIRE TECHNOLOGY & SAFETY ENGINEERING, IV-Semester**

**Systems Engineering**

**COURSE OBJECTIVE**

This course in systems engineering examines the principles and process of creating effective systems to meet application demands. The course is organized as a progression through the systems engineering processes of analysis, design, implementation, and deployment with consideration of verification and validation throughout.

**COURSE CONTENT**

What is System Engineering, Origin, Examples of Systems requiring systems engineering, Systems Engineer Career Development Model, Perspectives of Systems Engineering, Systems Domains, Systems Engineering Fields, System Engineering Approaches.

Structure of Complex Systems, System Building Blocks and Interfaces, Hierarchy of Complex Systems, System Building Blocks, The System Environment, Interfaces and Interactions, Complexity in Modern Systems.

Concept Development and Exploration, Originating a New System, Operations Analysis, Functional Analysis, Feasibility, System Operational Requirements, Implementation of Concept Exploration.

Engineering Development, Reducing Program Risks, Requirements Analysis, Functional Analysis and Design, Prototype Development as a Risk Mitigation Technique, Development Testing, Risk Reduction.

Integration and Evaluation, Integrating, Testing, And Evaluating The Total System, Test Planning And Preparation, System Integration, Developmental System Testing, Operational Test And Evaluation, Engineering For Production, Transition From Development To Production, Production Operations.

**COURSE OUTCOME**

After successful completion of the course, students would be able to Plan and manage the systems engineering process and examine systems from many perspectives (such as software, hardware, product, etc.) Students can distinguish critical functions, diagnose problems, and apply decoupling strategies and judge the complexity of production and deployment issues.

**EVALUATION**

Evaluation will be a continuous and integral process comprising classroom and external assessment.

**REFERENCES:**

1. Alexander Kossiakoff, William N Sweet, "System Engineering Principles and Practice, Wiley India
2. Blanchard Fabrycky, Systems engineering and analysis, Pearson
3. Dennis M. Buede, William D. Miller, "The Engineering Design of Systems: Models & Methods" Wiley India
4. Jeffrey L. Whitten, Lonnie D Bentley, "System Analysis and Design Methods"
5. Richard Stevens, Peter Brook, "System Engineering – Coping with complexity, Prentice Hall