

SE 701 HAZARD IDENTIFICATION AND RISK ASSESSMENT

Module I

Hazard and risk, Types of hazards – fire, explosion and toxic gas release, Structure of hazard identification and risk assessment.

Identification of hazards : Inventory analysis, Fire and explosion hazard rating of process plants - The Dow Fire and Explosion Hazard Index, The Mond Index, Plant layout and unit hazard rating, Preliminary hazard analysis, Hazard and Operability study (HAZOP), What If analysis, Case studies.

Module II

Plant availability and process reliability : ways of improving plant availability, MTBF and MTTF, the reliability function, failure rate, bathtub curve, probability relationships, simple reliability estimation.

Estimation of frequency of occurrence of a hazard : The logic tree approach, set theory and Boolean algebra, application to probability, Boolean manipulation.

Fault tree analysis – logic symbols, minimal cut set, logic gates, fault tree quantification.

Event tree analysis – notation, event tree construction, advantages and disadvantages of ETA.

Failure mode and Effect Analysis (FMEA) – methodology, criticality analysis, corrective action and follow-up.

Module III

Consequence modelling :

Source models – discharge rate models, flash and evaporation, dispersion models.

Explosions and fires – vapour cloud explosions, flash fires, physical explosions, BLEVE and fire ball, confined explosions, pool fires, jet fires.

Effect models –dose-response functions, probit functions, toxic gas effects, thermal effects, explosion effects – Software application for effect and damage calculations.

Module IV

Quantification of risk : QRA, Vulnerability analysis, accepted and imposed risk, perception of risk, risk indices, individual risk and societal risk, acceptance criteria for risk, ALARP, Presentation of measures of risk – risk contour, F-N curve. Calculation of individual risk and societal risk.

Human reliability analysis (HRA) : factors leading to human error, characteristics of HRA techniques, Technique for Human Error Rate Prediction (THERP), Accident Sequence Evaluation Program (ASEP), Techniques using expert judgment, Operator Action tree (OAT).

Text Books

AICHE/CCPS, *Guidelines for Hazard Evaluation Procedures* second edition. Centre for Chemical Process Safety, American Institute of Chemical Engineers, New York, 1992.

AICHE/CCPS, *Guidelines for Chemical Process Quantitative Risk Analysis* second edition. Centre for Chemical Process Safety, American Institute of Chemical Engineers, New York, 2000.

References

1. Lees F.P. *Loss Prevention in the Process Industries* second edition. Butterworths, London, 1996.

Type of Questions for University Examination

Q1. Eight short answer questions of 5 marks each with two questions from each of the four modules.

Q2 to Q5 : Two questions A & B of 15 marks from each module with option to answer either A or B.

SE 702 SAFETY IN RAIL AND ROAD TRANSPORT

MODULE I

Railway Engineering: Permanent way- Components: Rails- Functions, requirements, defects, rail joints and fastenings, check and guard rails, coning of wheels, creep of rails; Sleepers- functions, requirements, types, density; Ballast- functions, requirements, types.

Geometric Design- Horizontal curves, Super-elevation, Negative super-elevation in branches, Length of transition curves- Grade compensation on curves- Widening of gauge on curves.

MODULE II

Railway operation & control: Points and crossings- Turn-out - Types of Railway tracks- Points- Station Yards and Marshalling Yards- Signaling and interlocking- Principles of track circuiting- Control of train movement by centralized traffic control system. Railway Accidents & Safety. Rapid Transit Railways-types, merits & demerits.

MODULE III

Classification of highways-Typical cross-section of roads- Definition of various cross-sectional elements- Requirements & factors controlling alignment of roads- Basic geometric design of streets and highways.

MODULE IV

Traffic characteristics- various traffic studies and their applications- Traffic signals- Classification of signals- Carriage-way markings- Traffic islands- Highway intersections- Principles of highway lighting- Accident prevention, investigation and reduction- Road Accidents- Regulatory measures for traffic management- Physical methods of traffic control- Traffic Calming- Safety Audit, Intelligent Transport System.

References :

- 1.S.C. Rangwala, *Railway Engineering*
- 2.S.K. Khanna and C.E.G. Justo, *Highway Engineering*
- 3.L.R. Kadiyali, *Traffic Engineering and Transport Planning*.
- 4.Mike Slinn, Peter Guest and Paul Mathews, *Traffic Engineering Design : Principles and Practice*, Butterworth-Heinemann Elsevier.
- 5.R. Agor, *Railway Track Engineering*, Khanna Publishers.

Type of Questions for University Examination

- Q1. Eight short answer questions of 5 marks each with two questions from each of the four modules.
Q2 to Q5 : Two questions A & B of 15 marks from each module with option to answer either A or B.

SE 703 SAFETY IN ENGINEERING INDUSTRY

Module I

Introduction - Classification of Engineering Industry –Manufacturing Processes
Hot Working-Foundry operations-furnace and equipments, health hazard, safe methods of operation. Forging operations , heat radiation, maintenance of machines , shop equipments and hand tools - safe work practice. Operations in hot and cold rolling mills.

Module II

Machinery safeguard-Point-of-Operation , Principle of machine guarding - breakdown of machine guarding - types of guards and devices.
Cold Working-Safety in Power Presses, primary & secondary operations - shearing -bending - rolling – drawing. Metal Cutting- safety in turning , boring , milling, planning and grinding. Maintenance of machine tools - health hazards and prevention.

Module III

Welding and Cutting-Safety Precautions of Gas welding and Arc Welding, Cutting and Finishing. Gas Cylinders and Equipments. Heat Treatment- Furnaces and Salt baths-operations and maintenance -safety in handling and storage of salts- disposal of effluents - health precautions, exposure to hazardous fumes, source of fumes, ventilation and fume protection.

Module IV

Material Handling-Classification-safety consideration- manual and mechanical handling. Handling assessments and techniques- lifting, carrying, pulling, pushing, palletizing and stocking. Material Handling Equipments-operation & maintenance. Maintenance of common elements-wire rope, chains slings, hooks , clamps .

Reference

1. *Accident Prevention Manual for Industrial Operations* : National Safety Council, Chicago
2. Roland P. Blake, *Industrial Safety*
3. N C Balchin, *Health and Safety in Welding and Allied process*, Jaico Publishers
4. N. Srinivasan, *Safety in Engineering Industry*, Vijay Consultant Services, Chennai
5. S. Kalpakjian and S.R. Schmid, *Manufacturing Engineering and Technology*, Pearson Education Asia

Type of Questions for University Examination

- Q1. Eight short answer questions of 5 marks each with two questions from each of the four modules.
Q2 to Q5 : Two questions A & B of 15 marks from each module with option to answer either A or B.

SE 704 FIRE ENGINEERING IV

MODULE- I

Process of emergency evacuation - special features of personnel movement. Parameter characteristics of the movement of people-practical methods of designing evacuation passages and exits. Evacuation exits and routes - stages of evacuation; Exit Requirements- Planning of evacuation routes and exits - Seating arrangement - Passages and corridors; Smoke control during building design; Mechanical Ventilation; Compartment fires and tactical ventilation.

MODULE- II

Classification of building based on occupancy; Fire zone; classification of type of construction according to fire resistance; General fire safety requirements applicable to all individual occupancies. Sitting of detectors as per relevant standards (ISI); Selection and planning of alarm system as per relevant standards (ISI). General requirements and guidelines for the installation of fire detection and alarm system in buildings of different occupancy classification.

MODULE- III

General exit requirements as per NBC; Internal staircases; Pressurisation of stair staircases; horizontal exits; fire tower; ramps; fire lifts; external fire escape ladders; Planning of location and calculation of capacity, number and width of exit as per NBC for different occupancy classification.

MODULE- IV

Selection and distribution of portable extinguishers (for class A and B fires) and other fire protection equipments and systems for different occupancy classification as per NBC; Planning of fixed fire fighting installation for different occupancy classification- sprinkler system; total flooding system; CO₂ system; foam system; Fire training and education- Arson - Fire safety audits - Risk assessment - Fire insurance. Fire Investigation

Text Books

1. Roytman M. Ya., “Principles of Fire Safety Standards for Building Construction”, Amerind Publishing Co. Pvt. Ltd., New Delhi, 1975
2. E.Gorden Butcher E. G. and Parnell A. C., “Designing of fire safety”, John Wiley and Sons Ltd., New York, U.S.A., 1983.
3. BIS, “NBC Part 4- Fire and Life safety”, Bureau of Indian Standards, New Delhi, 2005.

Reference Books

1. Marchant E.W., “A Complete Guide to Fire and Building”,
2. Adam and Charles Black, “Fire safety in Buildings”,

Type of Questions for University Examination

Q1. Eight short answer questions of 5 marks each with two questions from each of the four modules.
Q2 to Q5 : Two questions A & B of 15 marks from each module with option to answer either A or B.

SE 705 (A) AUTOMOBILE ENGINEERING & SAFETY

Module I

Types of automobiles. Limiting Dimensions as per Central Motor Vehicles Rules. Engines – Classification, Construction, Materials of engine components. Prototype Testing as per Central Motor Vehicles Rules.

Fuel System – Fuel tank, Fuel filter, Types of Fuel system. Carburetor – Simple and Modern, Fuel injection System. Emission Standards as per CMV Rules.

Module II

Electrical System – Storage Battery Operations and Maintenance. Ignition System – Coil and Magneto Ignition System. Starting System, Lighting System, Horn System – Wind Shield Wiper Motors, Fans, Heaters, Traficators. Automobile air conditioning. Central Motor Vehicles Rules regarding Lighting, Windshields, Wipers.

Module III

Transmission System – Clutches – operation and fault finding of clutches, Fluid Flywheel, Gear Box-types, Steering Systems, Chassis Springs, Suspension. Differential, Dead and Live axles, Rims, Tyre etc. Brakes – Types, construction and fault finding. CMV Rules – Brakes, Steering & Tyre.

Module IV

Lubrication Systems – Types, Components, Lubricating oil, Cooling system – Details of components, Study of Systems, Types. Miscellaneous – Special gadgets and accessories for fire fighting vehicles. Automobile accidents. CMV Rules regarding Safety devices for drivers, passengers.

References :

- 1) William H. Crouse, *Automobile Chassis and Body Construction, Operation and Maintenance.*
- 2) William H. Crouse, *Automobile Machines –Principles & Operations.*
- 3) GBS Narang, *Automobile Engineering*
- 4) Kirpal Singh, *Automobile Engineering*
- 5) Joseph Heitner, *Automotive Mechanics-Principles & Practices*
- 6) P. L. Kohli, *Automotive Electrical Equipments.*
- 7) *The Central Motor Vehicles Rules, 1989*

Type of Questions for University Examination

Q1. Eight short answer questions of 5 marks each with two questions from each of the four modules.

Q2 to Q5 : Two questions A & B of 15 marks from each module with option to answer either A or B.

SE 705 (B) SAFETY IN PETROLEUM & PETROCHEMICAL INDUSTRIES

Module – I

Simplified flow diagrams of a typical refinery – distillation unit, catalytic cracker, reformer, treating unit (hydro forming, gas purification, Sulphur recovery, lubricating oil unit) Simplified flow diagrams of Petrochemical Industry – steam cracking, butadiene extraction, ethane recovery, butyl rubber polymerization.

Module – II

Potential fire hazards in petroleum and petrochemical industries (ignition by local sources, spark, flame, hot surface, ignition of oil mists and fumes.). Storage tank farms of petroleum and petrochemical industries – Identification of Hazards, Type of Tanks, Design, Layout, Fire prevention measures including lightning protection. Fire protection arrangements in large tank farms, Design concepts of various fixed fire protection systems like Foam- Water Systems, Halogen & DCP systems. Lock out procedures. Salient features of codes / standards : NFPA, API, OISD and SHELL.

Module – III

Fire protection facilities in Oil Refineries, Depots & Terminals- Transportation of petroleum and petrochemical products (safety considerations, statutory considerations). Design and Construction requirements for cross country hydrocarbon pipelines. Liquefied Petroleum Gas (LPG) Bottling Plant Operations. Design Philosophies. Operating Practices- Safety and Fire Protection in bottling plants. Internal Safety Audits in (Procedures and Checklist) Transportation of Bulk Petroleum Products. Storage and Handling of Bulk Liquefied Petroleum Gas.

Module – IV

On- Shore and Off- shore drilling. Classification of wells. Drilling method. Rotary drilling. Drilling equipment. Ground and offshore structures for drilling. Offshore platforms and drilling vessels. Drilling mud – functions, classification and properties. Blow-off, well kicks, Blow out preventer. Shallow gas. Directional drilling. Well killing procedure., Emergency shut down, Methods of Rescue & Fire Fighting.

References:

1. Frank P Lees : *Loss prevention in Process Industries – Vol. I, II & III*, Butter worth – Heinemann Publishing Company, UK.
2. *Manuel of Fireman ship – Vol. I to XIII*, HMSO, London.
3. *Fire Protection Hand book*.
4. *OISD guidelines*.

Type of Questions for University Examination

Q1. Eight short answer questions of 5 marks each with two questions from each of the four modules.
Q2 to Q5 : Two questions A & B of 15 marks from each module with option to answer either A or B.

SE 705 (C) FOOD AND BIOSAFETY

Module I

Quality attributes of foods, size and shape, colour and gloss, texture – visual and objectively measurable attributes. Aroma of foods – Introductory ideas, formation and chemistry. Introduction to sensory evaluation of foods and beverages.

Food safety, food additives and food contaminants, their chemical, technological and toxicological aspects, Food laws – development and enforcement. Prevention of Food Adulteration Act and Food Regulations. ISO 9000 series and HACCP. Codex Alimentarius protocols for export.

Module II

Principles of food commodity storage, Insect pests – their biology and food preference. Effects of pests on food communities. Pesticide classification and chemistry. Pesticide formulations. Pesticide appliances. Insect growth regulators, biopesticides and grain protectants. Fumigants, Sanitation in food processing / handling units. Ballooning techniques. Irradiation and other physical methods of control. Pesticide and health hazards. Safety devices, pesticide residues in foods, residue analysis and decontamination. Concept of organic foods.

Module III

The legal and socio-economic impacts of biotechnology – Public education of the processes of biotechnology involved in generating new forms of life for informed decision making – Biosafety regulation and national and international guidelines. r-DNA guidelines – Challenges for the Indian biotechnological research and industries – Ethical implications of biotechnological products and techniques.

Module IV

Experimental protocol approvals – Levels of containment – Environmental aspects of biotech applications – Use of genetically modified organisms and their resistance in environment – Special procedures for r-DNA based product production – Social and ethical implications of biological weapons – Good safety practices – GLP standards – Lab contaminants – PI, PII, PIII guidelines.

References

- 1) P.K. Gupta, *Elements of Biotechnology*
- 2) H.D. Kumar, *A Textbook on Biotechnology*
- 3) Sasson A, *Biotechnologies and Development*
- 4) P. Fellows, *Food Processing Technology : Principles and practice*

Type of Questions for University Examination

Q1. Eight short answer questions of 5 marks each with two questions from each of the four modules.

Q2 to Q5 : Two questions A & B of 15 marks from each module with option to answer either A or B.

SE 705 (D) FAULT DETECTION AND DIAGNOSIS

MODULE I

Introduction to Fault Detection and Diagnosis: Scope of FDD:- Types of faults and different tasks of Fault Diagnosis and Implementation - Different approaches to FDD: Model free and Model based approaches. Classification of Fault and Disturbances- Different issues involved in FDD- Typical applications.

Analytical Redundancy Concepts: Introduction- Mathematical representation of Fault and Disturbances: Additive and Multiplicative types – Residual Generation: Detection, Isolation, Computational and stability properties – Design of Residual generator – Residual specification and Implementation.

MODULE II

Design of Structured Residuals: Introduction- Residual structure of single fault Isolation: Structural and Canonical structures- Residual structure of Multiple fault Isolation: Diagonal and Full Row canonical concepts – Introduction to parity equation implementation and alternative representation.

MODULE III

Design of Directional structured Residuals: Introduction – Directional Specifications: Directional specification with and without disturbances – Parity Equation Implementation – Linearly dependent column.

MODULE IV

Advanced level issues and design involved in FDD: Introduction of Residual generation of parametric fault – Robustness Issues –Statistical Testing of Residual generators – Application of Neural and Fuzzy logic schemes in FDD – Case study.

Text Books:

1. Janos J. Gertler “ *Fault Detection and Diagnosis in Engineering systems*” – 2nd Edition, Macel Dekker, 1998.

Reference Books:

1. Sachin. C. Patwardhan, “*Fault Detection and Diagnosis in Industrial Process*” – Lecture Notes, IIT Bombay, February 2005.
2. Rami S. Mangoubi, “*Robust Estimation and Failure detection*”. Springer-Verlag-London 1998.

Type of Questions for University Examination

- Q1. Eight short answer questions of 5 marks each with two questions from each of the four modules.
Q2 to Q5 : Two questions A & B of 15 marks from each module with option to answer either A or B.

SE 706 FIRE ENGINEERING LAB

1. Determination of flash Point, fire point and pour point of hydrocarbons.
2. Tests on Dry Chemical Powder
 - a. Apparent Density Test
 - b. Hygroscopicity Test
 - c. Caking Test
 - d. Water Repellency Test
 - e. Heat Test
 - f. Efficient Fluidity Test
 - g. Fire Knocking Down Property Test
 - h. Foam Compatibility Test
3. Performance Tests on Portable DCP Fire Extinguishers (Cartridge Type)
4. Performance Tests on Portable and Trolley mounted Fire Extinguishers CO₂ Type.
5. Tests on Foam
 - a. pH value
 - b. Sludge content
 - c. Specific Gravity
 - d. Miscibility
 - e. Freezing Point
 - f. Film Formation Test
 - g. 25% Drainage Time
 - h. Burn- back Resistance
 - i. Fire Extinguishing Property
6. Test of non-combustibility of Building Materials.
7. Study of fire fighting equipments and accessories.

Note : 50 % marks is earmarked for continuous evaluation, and 50 % marks for end semester examination to be assessed by two examiners. A candidate shall secure a minimum of 50 % marks separately for the two components to be eligible for a pass in that subject.

SE 707 INDUSTRIAL HYGIENE LAB

- 1 Demonstration and calibration of Air sampling equipment
- 2 Sampling and estimation of gases in work environment by calorimetric method
- 3 Sampling and estimation of solvent vapours in work environment
- 4 Sampling and estimation of dust-gravimetric method
- 5 Noise level measurement - Sound level meter, Octave filter set
 - a) Measurement of sound pressure level in db A and db linear
 - b) Frequency analysis of noise
- 6 Measurement of illumination level
- 7 Study of lungs models
- 8 Study of occupational diseases with photographic models
- 9 Demonstration of medical laboratory equipments
- 10 Thermal stress analysis.

Note : 50 % marks is earmarked for continuous evaluation, and 50 % marks for end semester examination to be assessed by two examiners. A candidate shall secure a minimum of 50 % marks separately for the two components to be eligible for a pass in that subject.

SE 708 SEMINAR

Students shall individually prepare and submit a seminar report on a topic of current relevance related to the field of Safety and Fire Engineering. The reference shall include standard journals, conference proceedings, reputed magazines and text books, technical reports and URLs. Each student shall be evaluated by a team of internal experts comprising of 3 teachers based on style of presentation, technical content, adequacy of references, depth of knowledge and overall quality of the seminar report.