

## SE 801 HUMAN FACTORS ENGINEERING

### MODULE I

Human factors - objectives and approach. Systems thinking - human –machine systems, characteristics of systems, system reliability. Human beings as information processors- information theory, displaying information, coding of information, characteristics of good coding system, compatibility, types of compatibility, perception, memory, decision making, attention, age and information processing, mental workload and its measurement.

### MODULE II

Process of seeing, visual capabilities, accommodation, visual acuity, contrast sensitivity, factors affecting visual acuity and contrast sensitivity, adaptation, colour discrimination, perception. Design of hard copy and VDT screens. Graphic representations – symbols, objectives and criteria for selection, perceptual principles of symbolic design. Codes – dimension, colour.

Design of dynamic information displays, uses of dynamic information, design of quantitative visual displays, design of qualitative visual displays, design of signal and warning lights, recommendations regarding signal and warning lights, representational displays, head-up displays.

Hearing, nature and measurement of sound, complex sound, anatomy of ear, conversion of sound waves to sensations, masking. Auditory displays, detection of signals, relative discrimination and absolute identification of auditory signals, sound localization, principles of auditory display, cutaneous senses, tactual displays, substitutes for hearing and seeing, olfactory senses and displays.

### MODULE III

Physical work - muscle physiology, work physiology, measures of physiological strain, physical work load, work efficiency, energy consumption, grades of work, factors affecting energy consumption, controlling energy expenditure, strength and endurance, measurement of strength, factors affecting strength. Manual materials handling – lifting tasks, carrying tasks, pushing tasks, limits of MMH tasks, reducing risks of MMH overexertion.

Motor skills – biomechanics of human motion, types of body movements, range of movements, classes of motor movements, Speed of movements – reaction time, movement time, accuracy of movements.

Human control of systems – compatibility, spatial compatibility, movement compatibility. Supervisory control. Controls devices – functions of control, factors in control design.

Principles of hand tool and device design.

### MODULE IV

Workplace design – anthropometry, static dimensions, dynamic dimensions, principles in the application of anthropometric data. Work spaces - work-space envelopes for sitting and standing personnel, out-of-reach and clearance requirements. Design of work surfaces. Science of seating - general principles of seat design. VDT workstations.

Arrangement of components within a physical space – principles of arranging components, methodologies for arranging components, types and uses of various data, link diagrams, general location of various controls and displays within work space, specific arrangements of controls and displays within work space, spacing of control devices. General guidelines in designing individual workplaces.

### TEXT BOOK & REFERENCE

Sanders, M.M. & McCormick, E.J, *Human Factors in Engineering & Design*  
7th ed. McGraw-Hill International Edition, 1993.

Martin Helander, *A Guide to Ergonomics of Manufacturing*, TMH, 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 802 DISASTER MANAGEMENT

### MODULE 1

Importance of disaster management for chemical industry - Types of emergencies – major industrial disasters – causes and consequences of major industrial disasters like Flixborough, Seveso and Bhopal. Components of a major hazard control system – identification of major hazard control installations – purpose and procedures – safe operation of major hazard installations – mitigation of consequences – reporting to authorities. Implementation of major hazard control systems – group of experts – training – checklists – inspection – evaluation of major hazards – information to the public – manpower requirements – sources of Information

### MODULE 2

Emergency planning – on-site and off-site emergency plan – need of plan – possible approach – objectives of emergency plan.

On-site emergency planning – formulation of the plan and emergency services – Identification of resources – actions and duties – emergency procedure – mock drills. Off-site emergency planning – objectives and elements of off-site plan – role of administrative machinery – role of major hazard works management – role of the local authority. Emergency preparedness at local level – Awareness and preparedness for emergencies at local level (APELL) – The process and its partners.

### MODULE 3

Requirements of emergency plan as per Indian legislations like Factories Act, Manufacture, Storage and Import of Hazardous Chemicals Rules, Chemical Accidents (Emergency planning, Preparedness and Response) Rules.

Emergency planning and preparedness in international standards like ISO 14001, OHSAS 18001 and OSHA's Process Safety Management System, Emergency Planning in Seveso II directive – elements of emergency planning in IS : 18001 – Hazardous Materials / Spills Emergencies – contingency plans for road transportation of hazardous chemicals – contingency plans for oil spills in marine environment.

### MODULE 4

Natural Hazards – potentially hazardous natural phenomena – earthquakes – landslides – flooding – cyclones – hazards in arid and semi-arid areas – nature of the hazard – hazard management activities – disaster mitigation – natural hazard prediction – emergency preparedness – disaster, rescue and relief – post disaster rehabilitation and reconstruction – education and training activities – vulnerable elements to be considered in the development planning for natural hazard management – applications of remote sensing and GIS in disaster management.

### REFERENCES:

1. ILO, Geneva : *Major Hazard Control – a Practical Manual.*
2. UNEP, Paris : *APELL - A Process for responding to technological accidents , A Handbook, Industry & Environment Office., 1998*
3. *Accident Prevention Manual for Business and Industry, Vol. I* – National Safety Council, USA.
4. *Oil spill Response : The National Contingency Plan* - Institute of Petroleum, London
5. Petak, W.J and Atkisson, A.A.: *Natural Hazard Risk Assessment and Public Policy : Anticipating the Unexpected*
6. U.R. Rao : *Space Technology for Sustainable Development*

### 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 803 ADVANCED SAFETY ENGINEERING AND MANAGEMENT

### Module I

Domino incident investigation – technique, logic diagram, input requirements, output, example.

Unavailability analysis of protective systems – technique, logic diagram, input requirements, example.

Reliability analysis of automatic control systems - PES safety system development logic diagram , system analysis, calculation of fractional dead time, application, strengths and weaknesses.

Introduction to MORT analysis, IFAL analysis, Markov processes and application of Markov modeling to safety instrumented systems, Sneak analysis.

### Module II

Environmental risk assessment – Human health risk assessment (HHRA), Ecological risk assessment (EcRA), Receptor, stressor and exposure. Steps in EcRA – identification of potential sites, identification and characterization of stressors, identifying receptors, identification of potential ecological effects, selection of assessment and measurement end points , developing a conceptual model and risk hypotheses, approach for risk assessment.

### Module III

Security for chemical process industries - Assessments and regulatory environment, methods for assessing security vulnerability, emerging security regulations, government development and industry activities that relate to security for process facilities. Strategies and counter measures – prevention of intentional releases and theft of chemical releases at process facilities.

Site security for process industries – Essential elements – threat analysis, security counter measures, mitigation and emergency response. Specific security measures – information security, cyber security, physical security, policies and procedures, training, mitigation and response, inherently safer processes. Case study.

### Module IV

Safety Management Systems : SHEMS, OHSAS 18001 and OSHA's PSM – Policy, planning, training, implementation, management control and review.

Layer of Protection Analysis (LOPA) – Overview of relevant standards and guidelines, risk tolerance criteria. Preparation of LOPA – LOPA methodology, the LOPA team. Scenario development – components, inherently safe considerations. Initiating causes / effects – identification, estimation of frequencies. Independent protection layers – IPL criteria, allocation of IPL credit – basic process control systems, operator response, pressure relief device, safety instrumented system, safety instrumented function. Safety integrity level (SIL) assignment, Interpreting LOPA results and making recommendations.

### Text Books and References

1. Centre for Chemical Process Safety, AIChE : *Guidelines for Chemical Process Quantitative Risk Analysis*, second edition, 2000.
2. ACC : *Site Security Guidelines for the U.S Chemical Industry*, American Chemistry Council, Washington DC , 2001.
3. Jo Treweek, *Ecological impact assessment*, Blackwell Science, 1999.

### 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 804(A) SAFETY IN POWER PLANTS

### Module I

Introduction, Generation of electricity and sources of energy, Principal types of power plants. Power plant capacity. Principles of power plant design.

Solid, liquid and gaseous fuels, storage of fuels, Hazards in the storage of fuels. Safety precautions in storage and handling. Combustion and combustion equipment - safety in furnace operations - Effect of service conditions on refractories.

### Module II

Steam generator, types and safety measures- Dust collectors - Selection of site for steam plant. Layout. The diesel engine plant: use of diesel engine in a steam plant. Advantages and disadvantages of diesel plants. Safety and environmental problems of diesel plants.

### Module III

Principle of operation of hydro electric power plants. Installation of power plant. Safety during selection of power plant equipment -safety in commissioning of thermal power plant equipments, hydrostatic and air leakage test, acid and alkali cleaning, safety in auxiliary plants. Cooling water system. Safety in maintenance of power plants.

### Module IV

Nuclear Energy, Parts of a nuclear reactor, Classification of reactors, Design of nuclear reactors. Main components of a nuclear power plant. Boiling water reactor, Pressurised water reactor, Sodium graphite reactor, Fast breeder reactor. Light water reactors and Heavy water reactors. Power of a nuclear reactor. Safety measures for nuclear power plants.

Non-conventional sources of energy. Effective utilisation of solar energy, Energy from high velocity winds, Geothermal, Tidal and ocean thermal sources of energy.

### Textbooks:

1. P.K.Nag, " *Power Plant Engineering* ", Tata McGraw Hill Publishing Co. Ltd., 1998.
2. John V Grimaldi and Rollin H Simonds., *Safety Management*

### References:

1. S.C. Arora and S. Domkundwar, " *A Course in Power Plant Engineering* ", Dhanpat Rai and Sons, Tata McGraw Hill, 1998.
2. G.R. Nagpal, " *Power Plant Engineerig* ", Khanna Publishers, 1998.
3. Joel Weisman and Roy Eckart, " *Modern Power Plant Engineering* ", Prentice Hall International Inc., 1985.

### 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 804(B) SAFETY IN HEALTH CARE WASTE MANAGEMENT**

**Module I**

Definition & characterization of health-care waste - sources and generation of waste, Physico chemical characteristics. Hazards of health-care waste, public health impacts of health care waste.

Health- care waste management planning – waste management plan for health care establishments, management of health-car waste from scattered small sources, waste minimization, recycling and reuse.

**Module II**

Handling, storage and transportation of health-care waste - waste segregation and packaging, onsite collection, transport and storage of waste, offsite transportation of waste. Treatment and disposal of health care waste – Incineration chemical disinfection; wet and dry thermal treatment, Microwave irradiation, land disposal, Inertization.

**Module III**

Treatment and disposal methods – Infectious waste and sharps, pharmaceutical waste, cytotoxic waste, chemical waste, wastes with high heavy – metal content, pressurized containers – radioactive waste.

Collection and disposal of waste water – hazards of waste water from health care establishments – waste water management.

Workers' protection, cytotoxic safety, Emergency response.

**Module IV**

Epidemiology of nosocomial infections and prevention.

Training for health care personnel and waste management operators.

Minimal programmes for health care waste management – waste segregation, safe recycling, treatment & disposal, management of hazards health – care waste by waste categories.

**Reference:**

- 1) A Pruss, E. Giroult P. Rushbrook (Ed.) : *Safe Management of Waste from health – care activities*. World Health Organization, Geneva

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 804( C) FLUID POWER SAFETY

### Module I

Introduction to Hydraulics- Pascal's Law- Conservation of energy- Pressure, Work and Power-Principles of Power Hydraulics, Pressure and Flow Measurements- Bernoulli's Principle- Hydraulic symbols- Advantages. Hydraulic fluids, Properties Pipings and Seals- Reservoirs. Actuators-Cylinders, Rams, Hydraulic Motors. Pumps- Gear, Vane and Piston types- Fixed and variable flow. Testing of Actuators & Pumps- Safety Precautions

### Module II

Directional Control- Check valve, Pilot – operated, Two- way and Four -way valves- Rotary valves. Pressure Control – Relief valves- Different functions. Volume control- Methods and Types. Testing of Control Valves and Safety precautions.

### Module III

Pneumatic Systems : Introduction : Production of compressed air, Air Receives, Accumulators, Dry and oil free compressed air.  
Pneumatic control : Components, Types of Cylinders, Control Valves- Direction, Pressure and Flow, Air Motors and Pneumatic Symbols.  
Maintenance & Safety : Compressors & Accessories.

### Module IV

Accessories- Accumulators, Pressure Switches. Fluid Power Systems, Simple circuits- Hydraulic, Pneumatic, Hydropneumatic and Electrohydraulic. System Maintenance and Safety .

### Text Books:

- 1) J. Pippenger & T. Hicks : *Industrial Hydraulics* , McGraw Hill
- 2) Majumdar. S. R : *Pneumatic Systems – Principles & Maintenance*, TMH

### References:

- 1) Ernst : *Oil Hydraulics and its Industrial Applications* , McGraw Hill
- 2) Jagdish Lal : *Hydraulic Machines*
- 3) W. Deppert & K. Stol: *Pneumatic Control* , Vogel Buch Verlag Wurzburg, 1987
- 4) W. Deppert & K. Stol: *Pneumatic Application* , Kemprath Reihe Vogel Verlag Wurzburg, 1976.

### 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 804 (D) TOTAL QUALITY MANAGEMENT

### MODULE I

Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs - Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

### MODULE II

TQM Principles - Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement – Juran Trilogy, PDCA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure.

### MODULE III

Statistical quality control - The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

### MODULE IV

TQM tools - Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs.  
Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing

### TEXT BOOK

1. Dale H.Besterfield, et al., “*Total Quality Management*”, Pearson Education, Inc. 2003. (Indian reprint 2004). ISBN 81-297-0260-6.

### REFERENCES

1. James R.Evans & William M.Lindsay, “*The Management and Control of Quality*”, (5<sup>th</sup> Edition), South-Western (Thomson Learning), 2002 (ISBN 0-324-06680-5).
2. Narayana V. and Sreenivasan, N.S. “*Quality Management – Concepts and Tasks*”, New Age International 1996.
3. Zeiri. “*Total Quality Management for Engineers*”, Wood Head Publishers, 1991.

### 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 805 PROJECT

Each batch of students (comprising of about five students) shall carry out a project in an industry / R&D institution / university department.

- A detailed project report in the prescribed formal shall be submitted at the end of the semester. All test results and relevant design and engineering documentation shall be included in the report
- The work shall be reviewed and evaluated periodically

The final evaluation of the project shall be done by a team of minimum 3 internal examiners including the project guide. The evaluation shall be based on :

- Presentation of the work
- Oral examination
- Quality and content of the project report

Guidelines for evaluation:

i. Regularity and progress of work	60
ii. Work knowledge and involvement	80
iii. End semester presentation and oral examination	100
iv. Project Report – Presentation style and content	60
Total	300 marks

Note : Points (i) and (ii) to be evaluated by the respective project guide and the project coordinator based on continuous evaluation. (iii)-(iv) to be evaluated by the final evaluation team comprising of 3 internal examiners including the project guide.

### SE 806 VIVA - VOCE

Each student is required to appear for a viva-voce examination at the end of the complete course work.. The examination panel shall comprise of a minimum of one internal examiner and one external examiner, both appointed by the University. The examiners shall evaluate the students in terms of their conceptual grasp of the course of study and practical/analysis skills in the field. The students shall produce the seminar report and project reports duly attested by the institutional authorities, before the examiners