INDUSTRIAL SAFETY & HAZARD ANALYSIS
(CHE3104)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) OSHA stands for:
(a) Organization of Safety and Health Administration
(b) Occupational Safety and Health Administration
(c) Organization of Safety and Health Agency
(d) Occupational Safety and Health Agency

(ii) The Risk Management Plan document is updated when
(a) There is a serious accident in the plant
(b) The process or chemistry changes
(c) A government audit requests an update
(d) Both (b) and (c)

(iii) Below the lower flammability limit
(a) Vapor- air mixture will burn spontaneously
(b) Vapor-air mixture will not burn
(c) Vapor- air mixture will burn if the pressure is increased
(d) Vapor-air mixture will burn spontaneously if pressure is reduced

(iv) The principal document/s for a Hazop is/are:
(a) P&ID (b) PFDs
(c) Safety procedure documents (d) All of the above

(v) Failure Mode and Effect Analysis(FMEA):
(a) Is done along with Hazop analysis
(b) Is an alternative method of hazard identification
(c) Involves the consideration of the possible outcomes from all discerned failure modes of deviations within a system.
(d) Both (b) and (c)

(vi) Fault Tree Analysis (FTA) is best described as:
(a) A bottom-up approach to identify initiating events of an accident
(b) A top-down deductive method to analyze causes of a system failure
(c) A statistical tool to evaluate frequency of equipment breakdown
(d) A checklist method to find minor operational problems

(vii) Fractional dead time:
(a) Is the fraction of the total time that the protective device is in failed state
(b) Is a measure of the probability of its failure to provide the design intended protection
(c) Both (a) and (b)
(d) None of the above

(viii) Basic rules for combination of probabilities of two events by AND gate is given by:
(a) P_AP_B (b) P_A+P_B (c) P_A-P_B (d) $P_A+P_B-P_AP_B$

(ix) Disaster Management is a:
(a) Logic based planning (b) Strategic planning
(c) Both logicbased and strategic planning (d) None of the above

(x) The main objective of process intensification in chemical industries is:
(a) To reduce equipment size and hazards (b) To increase process cost
(c) To expand plant area (d) To reduce automation

Fill in the blanks with the correct word

(xi) The OSHA incidence rate is based on cases per _____ worker years.

(xii) The FAR reports the number of fatalities based on _____ employees working their entire life time.

(xiii) _____ is defined as a chemical reaction process which accelerates out of control.

(xiv) Ventilation systems are composed of _____.

(xv) The average duration for coincidence of the two recurring events is (D_{AB}) = _____.

Group - B

2. (a) Distinguish between OSHA and FAR. *[(CO2)(Analyse/IOCQ)]*
(b) A process has a reported FAR of 2. If an employee works standard 8-hr shift 300 days per year, compute the deaths per person per year. *[(CO2)(Analyse/IOCQ)]*
(c) If twice as many people used motorcycles for the same average amount of time, what will happen to the OSHA incidence rate and the FAR? *[(CO2)(Analyse/IOCQ)]*

6 + 4 + 2 = 12

3. (a) Write a short notes on BLEVE. *[(CO2)(Analyse/IOCQ)]*
(b) What is fire triangle? Why it is used? *[(CO2)(Analyse/IOCQ)]*
(c) Estimate the minimum oxygen concentration for ethylene for the reaction.
$C_2H_4 + 3O_2 = 2CO_2 + 2H_2O$
Given that the lower flammability limit for ethylene is 3.1 volume%.
[(CO1)(Remember/LOCQ)]

4 + 4 + 4 = 12

Group - C

4. (a) What do you understand by the term HAZOP? *[(CO2)(Apply/LOCQ)]*
   (b) Discuss briefly the objectives of HAZOP. *[(CO2)(Apply/LOCQ)]*
   (c) Write a brief note on composition and responsibility of a typical HAZOP team for a new project. *[(CO2)(Apply/LOCQ)]*

2 + 4 + 6 = 12

5. Discuss briefly the basic preventative and protective measures that should be included in all chemical process designs. *[(CO3)(Remember/HOCQ)]*

12

Group - D

6. An LPG storage tank installation is sited close to a railway line on which trains pass carrying fuel oil to a power station. If a train derails, it may either plough directly into the LPG installation or it may overturn with a consequent possibility of the fuel oil catching fire. The fire may cause the LPG installation to explode. Make Fault Tree Analysis for the undesired event explosion of the LPG storage installation and estimate the frequency of explosion (year^{-1}) of the LPG storage installation from the data given below.

Data:

Probability that a derailed train overturns	0.5
Probability that an overturned train catches fire	0.1
Probability that fire engulfs LPG tanks causing explosion	0.2
Probability that a derailed train hits the LPG installation causing an explosion	0.05
Frequency of derailment of train	3.8×10^{-4} ,year^{-1}

[(CO4)(Apply/HOCQ)]

12

7. (a) What are the main steps in the creation of event tree? Enumerate the advantages of Event Tree Analysis in Quantitative Risk Assessment. Explain briefly how analysis of failure data is carried out. *[(CO3)(Apply/IOCQ)]*
   (b) Explain the different segments of Bath Tub curve. *[(CO4)(Apply/IOCQ)]*

(2 + 2 + 2) + 6 = 12

Group - E

8. (a) State the reasons for ventilation in industry. *[(CO1)(Remember/LOCQ)]*
   (b) What are the disadvantages of ventilation? *[(CO1)(Remember/LOCQ)]*

6 + 6 = 12

9. (a) An open toluene container evaporates at a rate of 1.0×10^{-4} kg/min in an enclosure ventilated at 2.83 m^3/min. At 27.6°C and 1 atm, estimate the concentration of toluene vapor in the enclosure: (i) in kg/m^3 (and mg/m^3), and (ii) in ppm (v/v). *[(CO4)(Evaluate/HOCQ)]*

(b) A painting operation evaporates 0.02 kg/min of xylene (MW = 106, SG = 0.864) in an 8-hour shift. Calculate the dilution ventilation air flow (m^3/min) required to maintain concentration below 100 ppm. *[(CO4)(Remember/LOCQ)]*

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	35.42	33.33	31.25