

**INDUSTRIAL SAFETY & HAZARD ANALYSIS
(CHEN 4142)**

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.*

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

**Group – A
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) The OSHA act governing the federal law of occupational health and safety in USA cover the risk and compensation for
- (a) private sector employers and their workers under Federal authority
 - (b) both private sector and Federal Government employers and their workers in USA
 - (c) self-employed persons under Federal Government of USA
 - (d) immediate family members of farm employers under Federal Government of USA.
- (ii) The probability of fire hazard in handling a combustible substance lies
- (a) above the upper flammability limit
 - (b) below the lower flammability limit
 - (c) within the flammability limit
 - (d) at any temperature and composition of the combustible mixture.
- (iii) The objective of HAZOP is
- (a) to stimulate the imagination of a review team
 - (b) to satisfy the safety audit team
 - (c) to identify potential hazards in process design
 - (d) all of the above.
- (iv) Flash point of a liquid
- (a) increases with increase in pressure
 - (b) increases with decrease in pressure
 - (c) is independent of pressure
 - (d) may increase or decrease with pressure depending on the type of liquid.

- (v) FMEA is
- (a) bottom up technique wherein each failure mode within the system is traced forward logically in sequence to the final effect
 - (b) top down technique wherein each failure mode within the system is traced forward logically in sequence to the final effect
 - (c) often used in conjunction with FTA
 - (d) both (a) and (c) .
- (vi) The Dow F and I procedure is:
- (a) independent of judgement factor
 - (b) designed for rating the relative hazards with the storage, handling, and processing of explosive
 - (c) to determine the relative magnitude of flammable hazards in a chemical plant
 - (d) all of the above.
- (vii) Below the lower flammability limit
- (a) vapour- air mixture will burn spontaneously
 - (b) vapour- air mixture will not burn
 - (c) vapour- air mixture will burn if the pressure is increased
 - (d) vapour- air mixture will burn spontaneously if pressure is reduced.
- (viii) In the HAZOP study team
- (a) the chairman must be a trained HAZOP leader
 - (b) the secretary must be a trained HAZOP leader
 - (c) the process design engineer must be a trained HAZOP leader
 - (d) no trained HAZOP leader is necessary.
- (ix) In calculating the F and EI for a unit, the value for the material with
- (a) lowest MF which is present in significant quantities is used
 - (b) highest MF which is present in significant quantities is used
 - (c) in between highest and lowest MF which is present in significant quantities is used
 - (d) none of these.
- (x) The relation between lower flammability limit (LFL) and stoichiometric coefficient (C_{st}) is given by:
- (a) $LFL = 3.0 C_{st}$
 - (b) $LFL = 0.5 C_{st}$
 - (c) $LFL = 1.5 C_s$
 - (d) $LFL = 0.55 C_{st}$.

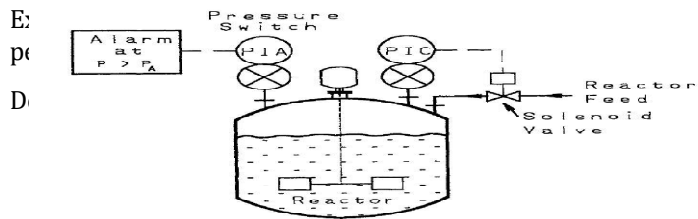
Group – B

2. (a) What do you understand by the terms Health, Safety, Hazard and Risk?
- (b) Discuss the safety measures to be implemented for combating the hazards due to fire, explosion and chemical toxicity in the work place.
- (c) Explain the term 'Inherent Safety' in chemical process industry.

3 + 3 + 6 = 12

3. (a) Define Upper Inflammability Limit (UIL) and Lower Inflammability Limit (LIL) of hazardous flammable substances.

(b) E: f the working



(c) D: 3) + 3 = 12

4. (a) W ating the Dow fire and explosion index and other risk analysis information.

(b) Explain the term Material Factor. 8 + 4 = 12

5. State the objective of HAZOP. What are the documentations required for HAZOP? Discuss briefly the procedure followed for HAZOP. 4 + 4 + 4 = 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 derailes 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

12

7. Consider the alarm indicator and emergency shutdown system shown in the figure below. Draw a fault tree for this system.

This reactor contains a high-pressure alarm to alert the operator in the event of dangerous reactor pressures. It consists of a pressure switch within the reactor connected to an alarm light indicator. For additional safety an automatic high-pressure reactor shutdown system is installed. This system is activated at a pressure somewhat higher than the alarm system and consists of a pressure switch connected to a solenoid valve in the reactor feed line. The automatic system stops the flow of reactant in the event of dangerous pressures.

Item	Probability of failure
Pressure switch 1	0.13
Pressure switch 2	0.13
Pressure indicator light	0.04
Solenoid valve	0.34

12

Group - E

8. (a) What are the safety precautions to be taken in chemical laboratory?
 (b) State the principle on which ventilation is based. Describe in detail any one method of ventilation used in chemical process industry. 5 + 3 + 4 = 12

9.(a) Xylene is used as a solvent in paint. A certain painting operation evaporates an estimated 0.01 m³ of xylene in an 8-hr shift. The ventilation quality is rated as average. Determine the quantity of dilution ventilation air required to maintain the xylene concentration below 100 ppm, the TLV-TWA. Also, compute the air quality required if the operation is carried out in an enclosed hood with an opening of 4.65 m² and a face velocity of 30.48 m/s. The temperature is 25°C and the pressure is 1 atm. The specific gravity of the xylene is 0.864, and its molecular weight is 106. Data: The non ideal mixing factor (k) = 0.125

(b) Discuss in detail the case history of Bhopal (India) accident on December 03, 1984. 5 + 7 = 12

12