

**INDUSTRIAL SAFETY AND HAZARDS ANALYSIS
(CHEN 3142)**

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) 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 first layer of safety protection is
 - (a) Inclusion of control system
 - (b) Inclusion of interlocks
 - (c) The process design
 - (d) Inclusion of safety shut down system.

 - (iii) A process has a reported FAR of 0.4. If an employee works a standard 8 hr shift 300 days per year, the death per person per year will be
 - (a) 4.8×10^{-5}
 - (b) 9.6×10^{-6}
 - (c) 1.2×10^{-5}
 - (d) 2.4×10^{-6} .

 - (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) Disaster management plans are
 - (a) monolayered
 - (b) bilayered
 - (c) multilayered
 - (d) None of the above

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- (vi) 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
- (vii) Lower Flammability Limit of a mixture is given by
 (a) $LFL_{\text{mix}} = \frac{1}{\sum \frac{y_i}{LFL_i}}$
 (b) $LFL_{\text{mix}} = \sum \frac{y_i}{LFL_i}$
 (c) $LFL_{\text{mix}} = \sum \frac{LFL_i}{y_i}$
 (d) None of the above
- (viii) Disaster Management is a
 (a) logic based planning
 (b) strategic planning
 (c) both logic based and strategic planning
 (d) none of the above.
- (ix) If two intermediate combination events $Q = A + B$ and $R = A + C$ are connected by AND gate, the probability (P) of the final event will be
 (a) $P = A + B + C$ (b) $P = A.B.C$ (c) $P = A.B + C$ (d) $P = A + B.C$
- (x) A fault tree
 (a) gives the probability of an untoward incident
 (b) examines the possible consequences of an untoward incident.
 (c) gives the probability of an untoward incident as well as examines the possible consequences of that incident.
 (d) none of the above

Group – B

2. (a) Describe in detail different type of risks encountered in chemical process industry
 (b) Distinguish between good and outstanding safety program. Discuss in details the various ingredients required for a successful safety program.
6 + (2 + 4) = 12
3. (a) What do you understand by Inherent Safety? Discuss in details the major approaches to inherently safer process designs.
 (b) Estimate the minimum oxygen concentration for methane for the reaction

$$\text{C}_2\text{H}_4 + 3\text{O}_2 = 2\text{CO}_2 + 2\text{H}_2\text{O}$$
 Given that the lower flammability limit for ethylene is 3.1 volume%.
(2 + 5) + 5 = 12

Group – C

4. (a) What do you understand by the term HAZOP and its objective? State the composition of a typical HAZOP team for a new project.
 (b) Discuss briefly the methodologies followed during FMEA (2 + 4) + 6 = 12
5. (a) With the help of a neat flow chart discuss in detail the procedure for carrying out Dow Fire and Explosion Index analysis.
 (b) What are general process hazards and special process hazards? 7+ 5 = 12

Group – D

6. (a) Define:
 i. Probability
 ii. Frequency
 iii. Duration
 iv. Fractional dead time
 (b) Two relief valves discharge into a common header. The header is underdesigned and could rupture if both valves discharge at the same time. Using the data given below, estimate the frequency of rupture ah the header and the duration of discharge from the ruptured header.
 Data: $\lambda_A = 4yr^{-1}, \lambda_B = 1yr^{-1}, D_A = 0.75hr, D_B = 0.5hr$
 Derive the formulas used for solving the problem. 4 + (3 + 5) = 12
7. 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 engulfsLPG tanks causing explosion | 0.2 |
| Probability that a derailed train hits the LPG installation causing an explosion | 0.05 |
| Frequency of derailment of train | $3.8 \times 10^{-4}, year^{-1}$ |

Group – E

8. (a) Discuss in details the safety precautions to be taken during working in laboratory.
- (b) State the principles of industrial ventilation. Discuss in details different types of ventilation used in industry.

6 + (2 + 4) = 12

9. (a) Explain the detail how emergency management is organized.
- (b) Describe in detail any one major accident that took place in chemical industry. Highlight the cause of the accident and plan of action to mitigate such accident

4 + 8 = 12

| Department & Section | Submission Link |
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| CHE | https://classroom.google.com/c/MTQzMjU0NzQ1OTAy/a/MjcxMTQxOTU0Njc3/details |