

**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 2. 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) 2.4×10^{-5} (c) 1.2×10^{-5} (d) 2.4×10^{-6}
 - (iv) 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)
 - (v) 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

- (vi) Risk can be expressed as a function of the
 - (a) of the frequency of all incidents and the consequence of that incident
 - (b) of the probability of all incidents and the consequence of that incident
 - (c) both (a) and (b)
 - (d) none of the above

- (vii) The frequency of the level reaching the high level trip is an example of
 - (a) demand rate
 - (b) duration
 - (c) fractional dead time
 - (d) all of the above

- (viii) The Dow F&EI is designed for rating the relative hazards
 - (a) with the storage materials
 - (b) with the handling of flammable materials.
 - (c) with the processing of explosive materials.
 - (d) all of the above

- (ix) Mond index takes account of circumstances other than processing, such a storage, loading and Unloading
 - (a) True
 - (b) False
 - (c) not always true
 - (d) none of the above

- (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) Define:
 - i. Safety
 - ii. Hazard
 - iii. Risk. [(CO1) (Remember/LOCQ)]

- (b) Describe in detail different type of risks encountered in the process industry [(CO2) (Analyze/IOCQ)]

- (c) Distinguish between good and outstanding safety program. Discuss in details the various ingredients required for a successful safety program. [(CO1)(Analyze/IOCQ)]
3 + 4 + 5 = 12

- 3. (a) Distinguish between:
 - i. Fire and explosion.
 - ii. Flash point and fire point
 - iii. Lower and Upper flammability point. [(CO2) (Remember/LOCQ)]

- (b) Estimate the minimum oxygen concentration for methane for the reaction



Given that the lower flammability limit for ethylene is 3.1 volume%.

[(CO3) (Evaluate/HOCQ)]

- (c) A fuel air gas mixture containing 2% CH₄, 0.5% C₂H₄ and 0.8 % hexane and rest air by volume is used in a chemical process industry. From the data given below find its LFL and UFL.

Component	LFL (vol%)	UFL (vol%)
CH ₄	5.3	15.0
C ₂ H ₄	3.1	32.0
C ₆ H ₁₄	1.2	7.5

[(CO3)(Analyse/IOCQ)]

3 + 4 + 5 = 12

Group - C

4. (a) What is FMEA? Discuss briefly the methodologies followed during FMEA.
[(CO3) (Analyze/IOCQ)]

- (b) With the help of a neat flow chart discuss in detail the procedure for carrying out Dow Fire and Explosion Index analysis. [(CO3) (Analyze/IOCQ)]

6 + 6 = 12

5. (a) What do you understand by the term HAZOP and its objective? State the composition of a typical HAZOP team for a new project.

[(CO3) (Understand/LOCQ)]

- (b) What are general process hazards and special process hazards?

[(CO3) (Understand/LOCQ)]

6 + 6 = 12

Group - D

6. A 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. With the help of a Fault Tree diagram estimate the probability of over pressuring of reactor from the given data:

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

[(CO4) (Evaluate/HOCQ)]

12

7. (a) Two potentially dangerous but independent events occur at frequencies λ_A and λ_B respectively with duration D_A and D_B , show that the combined frequency of the two dangerous events is given by

$$\lambda_{AB} = \lambda_A \lambda_B (D_A + D_B)$$

And average duration for coincidence of the two recurring events is

$$D_{AB} = \frac{D_A D_B}{D_A + D_B} \quad \text{[[CO3] (Analyze/IOCQ)]}$$

- (b) 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. [[CO4] (Analyze/IOCQ)]

6 + 6 = 12

Group - E

8. (a) State the reasons for ventilation in industry. What are the disadvantages of ventilation? [[CO3] (Remember/LOCQ)]
- (b) Discuss in details the safety precautions to be taken during working in laboratory. [[CO3] (Understand/LOCQ)]
- (c) Name the different types of disaster and explain them. [[CO3](Remember/LOCQ)]

4 + 4 + 4 = 12

9. (a) Xylene is used as a solvent in paint. A certain painting operation evaporates an estimated 0.02 kg / min 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 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 / min. 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. Take $k = 0.126$. [[CO2] (Evaluate/HOCQ)]

- (b) Discuss in details the cause and effect of Bhopal accident in 1984.

[[CO2] (Analyze/IOCQ)]

8 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	31.25	43.75	25.00

Course Outcome (CO):

After the completion of the course students will be able to

1. use important technical fundamentals of chemical process safety and to impart basic knowledge that allows the students to evaluate occupational safety and health hazards in the workplace.
2. analyze the effects of workplace exposures, injuries and illnesses, fatalities.
3. use safety programs to prevent or mitigate damage or losses and to develop

B.TECH/CHE/5TH SEM/CHEN 3142/2021

preventative measure to avoid accident.

4. use logic based quantitative risk analysis.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question;
HOCQ: Higher Order Cognitive Question

Department & Section	Submission Link
CHE	https://classroom.google.com/c/NDA00TAxMDk00TMy/a/NDYzODM2OTUzMzA1/details