

**SAFETY AND HAZARD ANALYSIS
(CHEN 4181)**

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) An unwanted event which may lead to an accident or a near miss is called
 - (a) Risk
 - (b) Hazard
 - (c) Unsafe condition
 - (d) Incident
 - (ii) Among the following, identify a commonly used system for eliminating hazards
 - (a) Hazop
 - (b) FAR
 - (c) Fatality rate
 - (d) QRA
 - (iii) The OSHA incidence rate is based on cases per _____ worker years
 - (a) 50
 - (b) 100
 - (c) 500
 - (d) 1000
 - (iv) The presence of a trace quantity of aluminium dust in the air in a room is hazardous because
 - (a) It is a fuel
 - (b) It is toxic
 - (c) It is an oxidiser
 - (d) It is explosive
 - (v) A mutagen causes
 - (a) Cancer
 - (b) Skin disease
 - (c) Chromosome damage
 - (d) Birth defects
 - (vi) In Fault Tree analysis, if you need to take the fault tree into or out of a sheet of paper, you should use
 - (a) TRANSFER symbols
 - (b) OR function
 - (c) INHIBIT function
 - (d) NOR function
 - (vii) Different unique sets of events that can lead to the top event are called
 - (a) Basic events
 - (b) Undeveloped events
 - (c) Intermediate events
 - (d) Minimal cut sets

- (viii) An example of a general process hazard in DOW Fire & Explosion Index is
(a) Toxic materials (b) Exothermic reaction
(c) Operation near flammable limits (d) Dust explosion risks
- (ix) Estimating the probability of failure on demand of a protection layer is a part of
(a) HAZOP (b) Event Tree
(c) QRA (d) LOPA
- (x) Handling large particle size solids to minimize dust is an example of
(a) Substitution (b) Minimization
(c) Attenuation (d) Simplification

Group - B

2. (a) Travelling by car has a FAR of 57 deaths/10⁸ hours and a fatality rate of 17×10⁻⁵ deaths per person per year. If the car users travel by car for double the time they did previously what will happen to the (i) OSHA incidence rate, (ii) FAR (iii) Fatality rate, (iv) Total number of fatalities? [(CO1)(Apply/IOCQ)]
(b) Explain the term "Safety audit". [(CO1)(Understand/LOCQ)] **8 + 4 = 12**
3. (a) In 1891 the copper industry in Michigan employed 7702 workers. In that year there were 28 fatalities in the mines. Estimate the FAR for this year, assuming that the workers worked 40-hour weeks and 50 weeks per year. [(CO1)(Apply/IOCQ)]
(b) What is the utility of MSDS in industry? Mention at least four sections of an MSDS. [(CO1)(CO2)(Understand/IOCQ)] **6 + 6 = 12**

Group - C

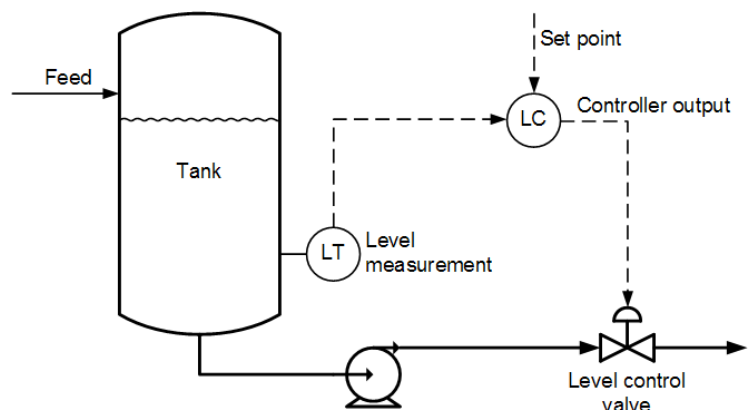
4. (a) Fires and explosions are substantial hazards in many chemical plants. Create a checklist with at least six items to identify fire hazards in any workplace. [(CO2)(CO3)(Analyze/IOCQ)]
(b) List six common fire prevention/protection features for chemical plants. [(CO2)(CO3)(Remember/LOCQ)] **6 + 6 = 12**
5. (a) Explain the steps of a BLEVE. [(CO1)(Understand/LOCQ)]
(b) Compute the LFL and the UFL for a mixture containing 0.6% Isopentane, 4% Ethylene and 2.8% Propane in air by volume. The LFL and UFL for the individual combustibles are as follows: Isopentane (1.4, 7.6), Ethylene (2.7, 36), Propane (2.1, 9.5). All LFL and UFL values are expressed as volume % in air. [(CO1)(Apply/IOCQ)] **7 + 5 = 12**

Group - D

6. (a) “Fail-safe” is a concept used to specify the position of process instrumentation in the event of power, air pressure, or other utility failures. For instance, the valve supplying cooling water to a chemical reactor would fail in the open position (“fail open”) in the event of a power failure. This would provide maximum cooling to the reactor and prevent dangerous high temperatures in the vessel. Specify the proper fail-safe positions for the valves in the following equipment. Specify either fail open or fail close with proper explanation.
- A flammable solvent is heated by steam in a heat exchanger. The valve controls the flow of steam to the exchanger.
 - A valve controls the flow rate of reactant to a reactor vessel. The reaction is exothermic.
 - A valve controls the flow rate of reactant to a reactor vessel. The reaction is endothermic. [(CO2)(CO3)(Evaluate/HOCQ)]
- (b) Distinguish between **basic event, intermediate event and undeveloped event** in connection with a fault tree. [(CO2)(CO3)(Analyze/IOCQ)]

9 + 3 = 12

7. The figure shows a tank, where the level of liquid is not allowed to fall below a certain height. If that happens, an alarm goes off; if no action is taken manually, the controller (LC) gives an output signal which closes the level control valve, thereby retaining liquid inside the tank. Construct an event tree for this system taking “Failure of level indicator (LT)” as the initiating event. [(CO3)(CO5)(Evaluate/HOCQ)]



12

Group - E

- During inerting process, what is generally considered to be a safe level of oxygen concentration? [(CO4)(Understand/LOCQ)]
 - Discuss the steps of inerting procedure. What is the utility of inerting? [(CO4)(Understand/LOCQ)]
9. (a) Why is a proper ventilation system integral for safety of a plant? [(CO4)(Understand/LOCQ)]

1 + (8 + 3) = 12

- (b) Differentiate between positive pressure ventilation and negative pressure ventilation. [(CO4)(Analyze/IOCQ)]

8 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	44.8%	33.3%	21.9%

Course Outcomes (CO):

After completing the course students will be able to:

1. Understand and recognize the important technical fundamentals of chemical process safety that allows the students to evaluate occupational safety and health hazards in the workplace.
2. Determine hazard and potential hazard areas and to adopt appropriate hazard controls.
3. Analyze the effects of workplace exposures, injuries and illnesses, fatalities
4. Use safety programs to prevent or mitigate damage or losses and to develop preventative measure to avoid accident.
5. Understand and use logic based quantitative risk analysis.
6. Carry out safety audits and to set up safe health management program.

Department & Section	Submission Link
BT/CE	https://classroom.google.com/c/MTQzMTU0ODE1MTcx/a/NDY0NjI1NzA4MTY1/details