

**SAFETY AND HAZARDS IN ENERGY INDUSTRY  
(REEN 6122)**

**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.*

***SYMBOLS ARE USUAL SIGNIFICANCE***

**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) 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).
- (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) 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)  $4.8 \times 10^{-5}$                       (b)  $2.4 \times 10^{-5}$                       (c)  $1.2 \times 10^{-5}$                       (d)  $2.4 \times 10^{-6}$ .
- (vi) 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)  $LFL = 1.5 C_{st}$                       (d)  $LFL = 0.55 C_{st}$ .

- (vii) A mixture is flammable only when
- (a) the composition is below LFL
  - (b) the composition is above UFL
  - (c) the composition is in between LFL and UFL
  - (d) the composition is above UFL.
- (viii) Deflagration is an explosion in which the reaction front
- (a) is stationary
  - (b) moves with a supersonic speed
  - (c) moves with a subsonic speed
  - (d) none of the above.
- (ix) The OR gate in FTA describes a situation
- (a) where the next event will occur if one or more of the input events exist
  - (b) where the next event requires the simultaneous existence of all the input events
  - (c) of transferred events
  - (d) none of the above.
- (x) Decision Trees are a non-parametric supervised learning method used for:
- (a) regression tasks
  - (b) classification tasks
  - (c) both classification and regression tasks
  - (d) none of the above.

### Group- B

2. (a) Runaway reactions have been the immediate cause of a number of the most notorious chemical process incidents. Stating the common causes of runaway reactions, explain critically the theory of runaway reactions.  
[[CO1](Remember/LOCQ)]
- (b) Distinguish between:
- i. Fire and explosion.
  - ii. Lower and Upper flammability point. [[CO2](Analyze/IOCQ)]
- (c) Estimate the minimum oxygen concentration for ethylene 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%.  
[[CO2](Analyze/IOCQ)]  
**3 + 4 + 5 = 12**
3. (a) Discuss in details the ingredients required for a successful safety program.  
[[CO2](Analyze/IOCQ)]
- (b) Define:
- (i) Fractional dead time
  - (ii) Detonation
  - (iii) Flash point. [[CO3](Understand/LOCQ)]
- (c) A fuel air gas mixture containing 2% CH<sub>4</sub>, 0.5% C<sub>2</sub>H<sub>4</sub> 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.  
[[CO1](Evaluate/HOCQ)]

Component	LFL (vol%)	UFl (vol%)
CH <sub>4</sub>	5.3	15.0
C <sub>2</sub> H <sub>4</sub>	3.1	32.0
C <sub>6</sub> H <sub>14</sub>	1.2	7.5

5 + 3 + 4 = 12

**Group - C**

4. (a) Define maintenance and maintenance engineering. Discuss in detail the responsibilities of maintenance personals in industry. [(CO4)(Analyze/IOCQ)]  
 (b) Discuss in details major types of corrosion of industrial importance. [(CO5)(Analyze/IOCQ)]  
**6 + 6 = 12**
5. (a) Describe briefly different types of Lubrication used in industry. [(CO3)(Understand/LOCQ)]  
 (b) State briefly the steps involved in the methodology of Failure Mode and Effect Analysis. [(CO5)(Understand/LOCQ)]  
**6 + 6 = 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. [(CO5)(Evaluate/HOCQ)]  
**12**
7. (a) Explain in details the role of decision tree for problems in machine tools in particular and safety as a whole. [(CO5)(Analyze/IOCQ)]  
 (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 of the header and the duration of discharge from the ruptured header.  
 Data:  $\lambda_A = 4\text{yr}^{-1}$ ,  $\lambda_B = 1\text{yr}^{-1}$ ,  $D_A = 0.75\text{hr}$ ,  $D_B = 0.5\text{hr}$   
 Prove the formulas used for solving the problem. [(CO5)(Analyze/IOCQ)]  
**6 + 6 = 12**

**Group - E**

8. (a) Explain the term periodic inspection and testing. What is visual inspection? [(CO5)(Remember/LOCQ)]  
 (b) Discuss briefly the advantages and disadvantages of preventive maintenance. [(CO4)(Remember/LOCQ)]

(c) Explain in detail preventive maintenance of Rotating machines with special reference to bearing materials. [(CO4)(Remember/LOCQ)]

4 + 4 + 4 = 12

9. (a) Explain preventive maintenance planning with the help of a preventative maintenance workflow. [(CO4)(Analyze/IOCQ)]

(b) Explain in detail preventive maintenance of Rotating machines with special reference to electrical motors. [(CO4)(Evaluate/HOCQ)]

6 + 6 = 12

---

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	31.25	45.83	22.92

**Course Outcome (CO):**

By the end of the course the students will be able to:

1. Analyze the effect of release of toxic substances
2. Apply the methods of prevention of fire and explosions
3. Understand the advantages of preventive maintenance.
4. Understand the methods of hazard identification and preventive measures
5. Apply logic based quantitative risk analysis

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