SAFETY AND HAZARDS IN ENERGY INDUSTRY
(REEN 6122)

Time Allotted : 2½ hrs   **Full Marks : 60**

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
<u>any 4 (four)</u> from Group B to E, taking <u>one</u> from each group.*

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

Group – A

1. Answer any twelve   **12 × 1 = 12**

    Choose the correct alternative for the following

    (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)   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) none of the above.

    (iii) 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.

    (iv)   Failure Mode and Effect Analysis (FMEA)
           (a) is done along with Hazop analysis
           (b) is an alternative method of hazard identification
           (c) involves the consideration of the possible outcomes from all discerned failure
               modes of evaluations within a system
           (d) both (b) and (c).

    (v)   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.

(vi) Decision trees are used for
(a) classification task (b) regression task
(c) both classification and regression tasks (d) none of the above.

(vii) Fault trees are
(a) a logical method for identifying ways in which hazards can lead to accidents
(b) a deductive method for identifying ways in which hazards can lead to accidents
(c) combination of both logical and deductive methods for identifying ways in which hazards can lead to accidents
(d) none of the above.

(viii) 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

(ix) The periodic inspection
(a) should be intrusive (b) should not be intrusive
(c) both (a) and (b) (d) none of the above.

(x) Preventive maintenance is concerned with
(a) increasing the usability of manufacturing units
(b) increasing the longevity of manufacturing units
(c) both (a) and (b)
(d) none of the above.

Fill in the blanks with the correct word

(xi) An outstanding safety program prevents the ------------------ of safety hazards.

(xii) The OSHA incidence rate is based on cases per ------------- worker years.

(xiii) Corrosion is the ---------------- of metals and alloys in the presence of an environment by chemical or electrochemical means.

(xiv) Failure mode and effect analysis (FMEA) is an --------------- method of hazard identification

(xv) Crevice corrosion is a ------------- attach on a metal adjacent to the crevice between two joining surfaces.
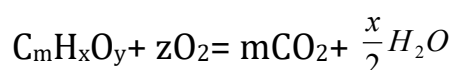
Group - B

2. Distinguish between:
(i) Fire and explosion. (ii) Flash point and fire point
(iii) Lower and Upper flammability point (iv) Explosion and Detonation.

[(CO2)(Apply/IOCQ)]
(4 × 3) = 12

3. (a) Write the empirical equations used for evaluating LFL and UFL for the following reaction:

$$C_mH_xO_y + zO_2 = mCO_2 + \frac{x}{2}H_2O$$

[(CO2) (Apply/HOCQ)]

(b) A fuel air gas mixture containing 2% CH_4, 0.5% C_2H_4 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. of the mixture.

Component	LFL (vol%)	UFl (vol%)
CH_4	5.3	15.0
C_2H_4	3.1	32.0
C_6H_{14}	1.2	7.5

[(CO2)(Apply/HOCQ)]
5 + 7 = 12

Group - C

4. (a) What do you understand by the term HAZOP? *[(CO2) (Apply/LOCQ)]*
   (b) Discuss briefly the objectives of HAZOP. *[(CO2) (Apply/LOCQ)]*
   (c) Write a brief note on composition and responsibility of a typical HAZOP team for a new project. *[(CO2) (Apply/LOCQ)]*
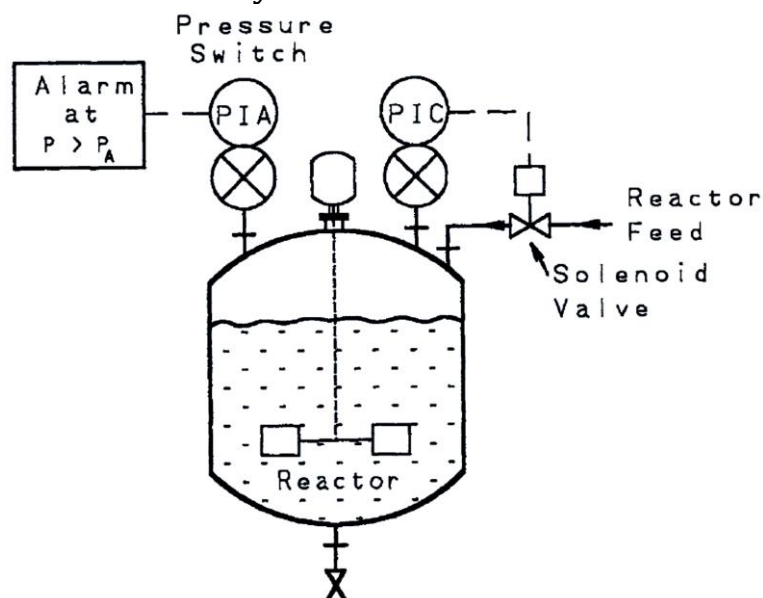   **2 + 4 + 6 = 12**

5. (a) What is the meaning of lubrication and its role in process industry?
   [(CO3)(Remember/LOCQ)]
   (b) State the different types of lubrication and their function in reducing friction
   [(CO3)(Remember/LOCQ)]
   (3 + 3) + (3 + 3) = 12

Group – D

6. 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.

Estimate also 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) (Apply/HOCQ)]
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 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}

[(CO4)(Apply/HOCQ)]
12

Group - E

8. (a) Explain the term overhauling of machine.   *[(CO3) (Apply/LOCQ)]*
   (b) Write a detail note on responsibility of safety.   *[(CO3) (Remember/LOCQ)]*
   6 + 6 = 12

9. Discuss in detail the different types of preventive maintenance and different steps to create a preventive maintenance schedule.   *[(CO3) (Remember/HOCQ)]*
   12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	37.5	12.5	50