

(3 Hours)

Total Marks: 80

N.B.

1. Question No. 1 is Compulsory.
2. Attempt any **Three** Questions from remaining **Five** Questions
3. Assume Suitable Data if needed and Justify the Same
4. Figures to the right indicate full marks.

1. Attempt any four

- a) Determine the concentration of toluene over a diked area (100 ft²) that contains toluene as a result of a spill. Assume that the process area (2500 ft²) is designed to handle Class I flammable materials and that the liquid and air temperature is 65°F. The vapor pressure of toluene at 65°F is 20 mm Hg. The LEL is 1.4% by volume. The mass transfer coefficient for water 0.83 cm/s. The non-ideal mixing factor k ranges between 0.1 and 0.5. The ventilation capacity for this process area is based on the design criterion of 1 ft³/min/ft². [05]
- b) Explain in details the safety programs. [05]
- c) Describe boiling-liquid expanding-vapor explosion [05]
- d) Explain Safe procedures for plant start-up and shut-down. [05]
- e) Write a short note: i) Fishbone analysis diagram ii) Why-why analysis [05]

2. a) Write on disaster of Flixborough, England from the perspective of Technical Failures and Consequences. [10]

- b) During an accident investigation, it is found that the source of the accident was an explosion that ruptured a 4-in-diameter stainless 316 schedule 40 pipe. It is hypothesized that a hydrogen and oxygen deflagration or a detonation was the cause of the accident. Deflagration tests in a small spherical vessel indicate a deflagration pressure of 500 psi. What pressure ruptured the pipe, and was it a deflagration or a detonation that caused this rupture? ($S_M=85000$ psi; Outside diameter:4.5 in; wall thickness t_v :0.237 in ; inside diameter:4.026 in). [10]

3. a) Use a vacuum purging technique to reduce the oxygen concentration within a 1000-gal vessel to 1 ppm. Determine the number of purges required and the total nitrogen used. The temperature is 75°F, and the vessel is originally charged with air under ambient conditions. A vacuum pump is used that reaches 20 mm Hg absolute, and the vacuum is subsequently relieved with pure nitrogen until the pressure returns to 1 atm absolute. [10]

- b) Describe Safety precautions for working on pipelines. [10]

4. a) Explain Quantitative Risk Analysis & Layer of Protection Analysis with Diagram. [10]
 b) What are the LFL and UFL of a gas mixture composed of 0.8% hexane, 2.0% methane, and 0.5% ethylene by volume? The mole fractions on a fuel-only basis are calculated in the following table. The LFL and UFL data: [10]

Component	Volume %	Mole Fraction on combustible basis	LFL _i Volume %	UFL _i Volume %
Hexane	0.8	0.24	1.2	7.5
Methane	2.0	0.61	5.3	15
Ethylene	0.5	0.15	3.1	32.0
Total Combustibles	3.3	-	-	-
Air	96.7	-	-	-

5. a) Explain Vessels Entry Permit. [10]
 b) Determine the mixture TLV at 25°C and 1 atm pressure of a mixture derived from the following liquid: [10]

Component	Mole Percentage	Species TLV(ppm)	P ^{sat}
Heptane	50	400	46.4 mm Hg
Toluene	50	50	28.2 mm Hg

6. Attempt Any Five [20]

- a) Explain Hazard and Operability Studies (HAZOP).
 b) Describe the Fire Triangle with diagram.
 c) Explain Relief Concept.
 d) Explain Pipelines identification color code with diagram.
 e) Write a short note: Safety Review.
 f) Explain OSHA.