BACHELOR OF CHEMICAL ENGINEERING EXAMINATION, 2017

(4th Year, 2nd Semester)

Risk Assessment & Safety in Process Industries

Time: 3 Hr.   Full Marks: 100

Answer any **four**

Assume any **missing** data

1.a. What are the probable reasons of 'overpressure' in upstream operations? What are the common pressure relief devices used in process industries? Compare them as per the relief system considerations.

b. A pool fire scenario arises from a leak in an auxillary cooling water pump oil tank. This event allows the fuel contents of the pump to spill and spread over the compartment floor. 5 gallon, 9 ft^2 surface area spill of flammable liquid leads to consideration of a pool fire in a compartment with a concrete floor. The fuel is ignited and spreads rapidly over the surface, reaching steady burning almost instantly. Compute the heat release rate, burning duration, and flame height of the pool. The dimensions of the compartment are 15 ft wide x 15 ft deep x 10 ft high. The cable tray is located 8 ft above the pool fire. Determine whether the flame will impinge upon the cable tray.

Flame height (Thomas, 1963)

$$\frac{H}{D} = 42 \, x \left(\frac{m^{"}}{\rho_a\sqrt{gD}}\right)^{0.61} \quad ; \text{H: Flame height, D: diameter of circular pool}$$

Burning rate (Buegess et al., 1961)

$$m^{"} = 1.27 . 10^{-6} \, \rho_l \frac{\Delta H_c}{\Delta H^{\bullet}_v}, \text{Kg/m}^2\text{-s}$$

Given data:

Heat of combustion: 43,700 KJ/Kg

Heat of vaporization: 300 KJ/Kg

Boiling point of liquid: 363 K

Ambient temperature: 298 K

Liquid density: 730 Kg/m^3

Heat capacity of liquid: 2.5 KJ/Kg-K

10+15

[Turn over

2.a. What do you understand about "Risk Management"? Mention all the relevant steps along with risk target and risk limit.

b. Compare Fault-tree analysis (FTA) and Event-tree analysis (ETA) techniques as hazard identification methods.

c. What is 'Flammable/Explosive limit' of a liquid? Discuss the parameters on which 'Flammable/Explosive limit' depends.

d. What are the precautions & restrictions should be maintained during storage of compressed gases?

<div align="right">7+7+7+4</div>

3.a. A reactor system is shown in following figure where an exothermic reaction is carrying out with provision of cooling jacket to avoid runaway reaction which may results rupture of the vessel wall. Prepare a HAZOP analysis considering a particular study node.

Temperature control of an exothermic reactor
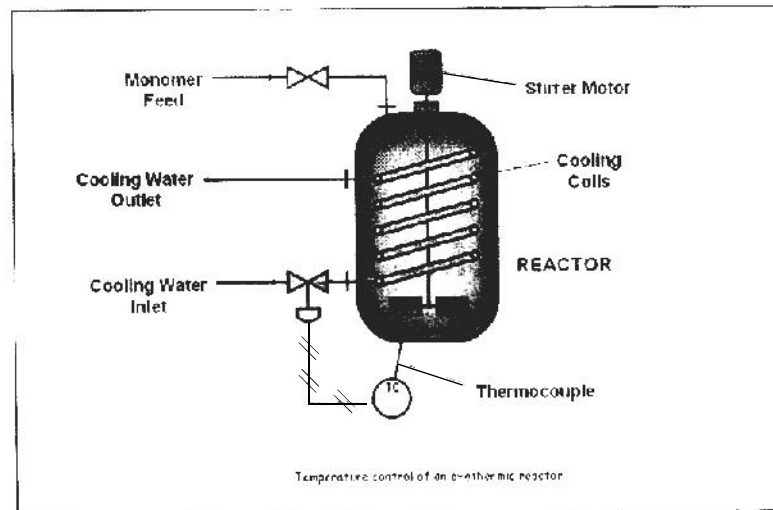
b. Compare What-If analysis and HAZOP analysis practiced as hazard identification techniques in chemical process industries.

c. How the Run-away reaction related hazard can be controlled or minimized?

<div align="right">10+8+7</div>

4.a. Calculate the size and duration, and maximum thermal flux at 200 m distance from a BLEVE of an isolated 100,000 kg (200 m^3) tank of propane 20°C, 8.2 bar abs. Atmospheric

humidity (70% relative humidity) corresponds to a water partial pressure of 2810 N/m2. Assume heat of combustion of 46,350 KJ/kg.

$$E_{max} = 0.0133.f. M_{FB}^{\frac{1}{12}} ; kW/m^2$$

$f = 0.27 \, P_B^{0.32}$; P_B: burst pressure in MPa and $\tau = 2.02 \left\{ R. P_v \left[\sqrt{H_{FB}^2 + X^2} - \frac{D}{2} \right] \right\}^{-0.09}$

R: fractional relative humidity, H_{FB}: height of the center of the fireball; P_v: saturated vapour pressure iof water at ambient condition and X: distance of target from fireball.
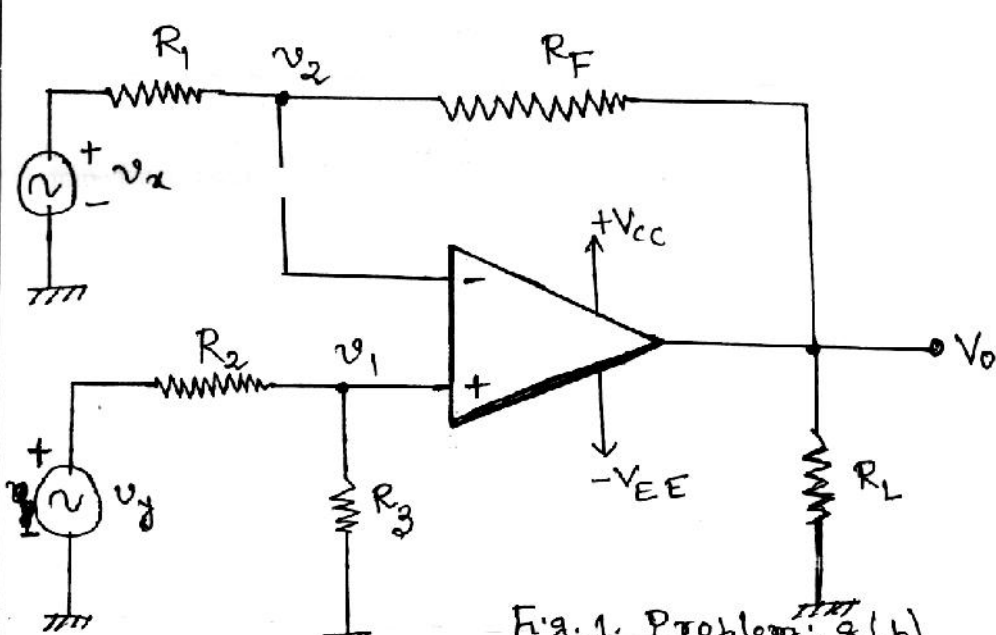
b. Discuss what is 'Emergency' and 'on-site emergency planning'?

c. What is LOPA process?

<div align="right">12+8+5</div>

5.a. Construct a general and revised Fault tree diagram for failure of a pumping system comprises of two pumps. Each pump may fail either due to stoppage of power supply (probability is 0.1) or due to mechanical failure (probability is 0.25) using suitable Gate symbols and find out the probability of pumping system failure.

b. Differentiate detonation and deflagaration as fire hazard.

c. Discuss about the NFPA classification of flammable and combustible liquids.

d. How the pressure relief valves (for liquid service) are sized for a specific discharge duty?

<div align="right">10+5+5+5</div>

	time integral of the input voltage.	
9.	a) Write down the working principle of a *Light Emitting Diode (LED)* with suitable energy band diagram. b) How *Hallow* can be display using 7-Segment display? c) Sketch the output current-voltage characteristics of a **photo-transistor** and explain the nature of this curve. d) Write down the working principle of **Opto-couplers** with suitable circuit diagram.	5+5+5+5

10.	a) Define the common mode rejection ratio (CMRR). What is the significance of this term?
	b) Design a *sawtooth* waveform generator using OPAMPs and explain the operation of the circuit.
	  b) Write short notes (any *two*) of the following:
	    i) Schmitt Trigger circuit using OPAMP ii) Liquid crystal display (LCD)
	    iii) Photoconductive cell iv) Photo-diode
		(2+2)+6+(5 x 2)

	 Fig. 1. Problem: 8 (b)	