

KATHMANDU UNIVERSITY
End Semester Examination
February/March, 2019

Marks Scored:

Level : B.E.
Year : IV

Course : CHEG 406
Semester : I

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date 05 MAR 2019

SECTION "A"

[20 Q. × 0.5=10 marks]

Select the most appropriate answer.

- In the Flixborough disaster of England, the chemical plant produced caprolactam, a precursor chemical used in the manufacture of
a) plastic b) glass c) nylon d) electric wire
- What is the name of the petroleum company that is also known as Texas City Refinery explosion?
a) Petronas b) Gazprom c) ExxonMobil d) British Petroleum
- What ways can liquid chemicals enter into the body?
a) Skin absorption b) Eyes c) Inhalation d) All of the above
- What is the lethal dose of methyl isocyanate (MIC) in ppm?
a) 0.01 b) 0.02 c) 0.03 d) 0.04
- Which part of body is affected by mercury?
a) Blood b) Kidneys c) Heart d) Skin
- 25 mg of a narcotic substance under study causes a 200 g rat to sleep for 1 hour. What is this dose rate in mg/kg?
a) 120 mg/kg b) 125 mg/kg c) 200 mg/kg d) 250 mg/kg
- Given an exposure level of 2 ppm for 10 hr per week, 3 ppm for 20 hr per week and 4 ppm for 10 hr per week, what is the TWA for this exposure?
a) 1 ppm b) 2 ppm c) 3 ppm d) 4 ppm
- For many gases, the LOC is approximately
a) 5 % b) 10 % c) 15 % d) 20 %
- Which gas is mostly used for inert effect?
a) N₂ b) CO₂ c) Steam d) H₂
- Which type of purging process requires vessel to be partially filled by liquid?
a) Vacuum purging b) Pressure purging
c) Sweep through purging d) Siphon purging
- When is the vertical mixing of air higher?
a) Morning b) Afternoon c) Evening d) Night

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Level : B.E.
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Time : 2 hrs. 30 mins.

SECTION "B"

[4Q × 5 = 20 marks]

Attempt ANY FOUR questions.

1. Discuss in brief
 - a. How toxicants enter biological organism.
 - b. How toxicants are eliminated from biological organism.

2. A 0.1-in hole forms in a tank containing nitrogen at 200 psig and 80°F. Determine the mass flow rate through this leak.

$$\gamma=1.41, C_0=1.0, g_c = 32.17 \text{ ft.lbm/lb}_f.\text{s}^2, R_g = 1545 \text{ ft.lbf/lb-mol}^\circ\text{R}$$

$$\frac{P_{\text{choked}}}{P_0} = \left(\frac{2}{\gamma+1}\right)^{\gamma/(\gamma-1)}; (Q_m)_{\text{choked}} = C_0 A P_0 \sqrt{\frac{\gamma g_c M}{R_g T_0} \left(\frac{2}{\gamma+1}\right)^{(\gamma+1)/(\gamma-1)}}$$

3. A cylindrical tank 20 ft high and 8 ft in diameter is used to store benzene. The tank is padded with nitrogen to a constant regulated pressure of 1 atm gauge to prevent explosion. The liquid level within the tank is presently at 17 ft. A 1-in puncture occurs in the tank 5 ft off the ground because of the careless driving of a forklift truck. Estimate
 - a. The gallons of benzene spilled.
 - b. The time required for the benzene to leak out, and
 - c. The maximum mass flow rate of benzene through the leak.

The specific gravity of benzene at these conditions is 0.8794.

$$V = A_t h_L^0; t_e = \frac{1}{C_0 g} \left(\frac{A_t}{A}\right) \left[\sqrt{2 \left(\frac{g_c P_g}{\rho} + g h_L^0\right)} - \sqrt{\frac{2 g_c P_g}{\rho}} \right]; Q_m = \rho A C_0 \sqrt{2 \left(\frac{g_c P_g}{\rho} + g h_L^0\right)}$$

4. Discuss the ventilation systems.

5. Solve the following questions.
 - a. Xylene is used as a solvent in paint. A certain painting operation evaporates an estimated 3 gal of xylene in an 8-hr shift. The ventilation quality is rated as average. Determine the quantity of dilution ventilation air required to maintain the xylene concentration below 100 ppm, the TLV-TWA. Also, compute the air required if the operation is carried out in an enclosed hood with an opening of 50 ft² and a face velocity of 100 ft/min. The temperature is 77°F and the pressure is 1 atm. The specific gravity of the xylene is 0.864, and its molecular weight is 106.

Xylene = 106, R_g = 0.7302 ft³atm/lb-mol°R, k = 118=0.125

$$Q_v = \frac{Q_m R_g T}{k C_{\text{ppm}} P M} \times 10^6; Q_v = A \bar{u}$$

- b. The water flow to a chemical reactor cooling coil is controlled by the system. The flow is measured by a differential pressure (DP) device, the controller decides on an appropriate control strategy, and the control valve manipulates the flow of coolant. Determine the overall failure rate, the unreliability, the reliability, and the MTBF for this system. Assume a 1-yr period of operation.

$$R = \prod_{i=1}^3 R_i; P = 1 - R; 0.10 = e^{-\mu}; \text{MTBF} = \frac{1}{\mu}$$

Component	Reliability
Control valve	0.55
Controller	0.75
DP Cell	0.24

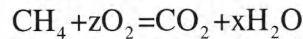
6. Write short notes on (ANY TWO)
- Reaction Hazard Index (RHI).
 - Ethylene Oxide Explosion.
 - Hazards and Operability Studies (HAZOP).

SECTION "C"

[2Q × 10 = 20 marks]

Attempt ANY TWO questions.

7. Discuss the procedure to construct flammability diagram for methane.



Flammability Characteristics of Methane	
Flammability limit in air	LFL 5.3 % fuel in air
	UFL 15 % fuel in air
Flammability limit in pure oxygen	LFL 5.1 % fuel in Oxygen
	UFL 61 % fuel in Oxygen

8. Discuss six purging methods used to reduce the oxygen concentration.
9. Solve the following questions
- On an overcast day a stack with an effective height of 60 m is releasing sulfur dioxide at the rate of 80 g/s. The wind speed is 6 m/s. The stack is located in a rural area. Determine
 - The mean concentration of SO₂ on the ground 500 m downwind.
 - The mean concentration on the ground 500 m downwind and 50 m crosswind.
 - The location and value of the maximum mean concentration on ground level directly downwind.

$$\langle C \rangle(x, 0, 0) = \frac{Q_m}{\pi \sigma_y \sigma_z u} \exp \left[-\frac{1}{2} \left(\frac{H_r}{\sigma_z} \right)^2 \right]; \langle C \rangle(x, y, 0) = \frac{Q_m}{\pi \sigma_y \sigma_z u} \exp \left[-\frac{1}{2} \left(\frac{y}{\sigma_y} \right)^2 - \frac{1}{2} \left(\frac{H_r}{\sigma_z} \right)^2 \right]; \sigma_z = \frac{H_r}{\sqrt{2}}$$

$$\langle C \rangle_{\max} = \frac{2Q_m}{e\pi u H_r^2} \left(\frac{\sigma_z}{\sigma_y} \right); \sigma_y = 0.08x(1+0001x)^{-1/2}; \sigma_z = 0.06x(1+0015x)^{-1/2}$$

$$(\sigma_y = 88\text{m})$$

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- b. A storage vessel contains 100% air by volume and must be made inert with nitrogen until the oxygen concentration is below 1.25% by volume. The vessel volume is 1000 ft³. How much nitrogen must be added, assuming the nitrogen contains 0.01% oxygen?

$$Q_v t = V \ln \left(\frac{C_1 - C_0}{C_2 - C_0} \right)$$

