Name: **Enrolment No:**	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
Online End Semester Examination, May 2021

Course: Chemical process safety **Semester: VI**
Program: B. Tech, Fire & Safety Engineering **Time 03 hrs.**
Course Code: HSFS 3008 **Max. Marks: 100**

SECTION A

1. **Each Question will carry 5 Marks**
2. **Instruction: Complete the statement / Select the correct answer(s)**

S. No.	Question	CO
Q 1	Discuss the strengths and weakness of the existing methods used to model vapor cloud explosions.	**CO2**
Q 2	If you could go back in time and make changes to the UCC plant in Bhopal which had ultimately led to the Bhopal gas disaster, what are the inherently safer strategies you would implement?	**CO3**
Q 3	What are the methods used to reduce the oxygen concentration in vessels to avoid fires/explosions? List any four such methods with brief one line description of each.	**CO1**
Q 4	What are the problems associated with fouling? Describe briefly any four types of fouling.	**CO1**
Q 5	What kind of equipment are involved in a BLEVE? Briefly describe the mechanism of occurrence of a BLEVE.	**CO1**
Q 6	Fill in the blanks for question c and d, for the others choose the correct answer from the options given in the bracket. **a)** Loss of _____ is known to be the cause of major accidents in chemical process industries. (control, cooling, pressure, containment) **b)** _____is an equipment to separate solids from fluid streams. (Centrifuge, Strippers, Compressors, Impellers) **c)** A knockout drum is also known as a _____. **d)** Electrostatic discharges from surfaces can occur when the voltage goes beyond the _____. **e)** The density of a _____ gas is less than that of ambient air. (passive, active, dense)	**CO1**

SECTION B

1. **Each question will carry 10 marks**
2. **Instruction: Write short / brief notes**

Q 7	A plant undergoes an instantaneous leak at the ground level which results in release of 2kg of gas of molecular weight 35g/mol. Assuming class E stability, determine the maximum concentration at the plant fence located 600m from the release.	**CO3**
Q 8	Bring out at least two points each to differentiate between: **a)** a pressure relief valve and a pressure safety valve **b)** LC50 and LD50 **c)** minimize and moderate (in the context of inherent safety) **d)** absorption and stripping **e)** underground storage tanks and mounded storage tanks	**CO3**
Q 9	Illustrate with the help of a diagram the mechanism of operation of a spring-operated relief valve.	**CO2**
Q 10	What are the hazards associated with reactors? With the help of a table describe the failure modes, causes, consequences and design considerations for reactors.	**CO1**
Q 11	Discuss the various types of electrostatic discharges and suggest some design considerations that can be made to avoid them.	**CO2**

SECTION C

1. **Each Question carries 20 Marks.**
2. **Instruction: Write long answer.**

Q 12	**a)** Compute the distance downwind from the following LNG release to obtain a concentration of 5% by volume. Assume ambient conditions of 300 K and 1 atm. The release is continuous. The following data is available: Spill rate of LNG is 50 Kg/s Spill duration is 2 minutes Wind speed at 10 m above ground is 10.9 m/s LNG vapor density is 1.76 Kg/m^3 **OR** **b)** Briefly describe any two methods to model VCEs with equations and expressions. **(10M)** **c)** Determine the effective stack height required when SO2 emissions are 5.58g/s and SO2 concentration of 30micro grams per m3 is permitted at a distance of 500 m from the stack. Assume wind velocity of 5m/s and that overcast conditions prevail. What is the maximum ground level concentration and at what distance will it occur? **(10 M)**	**CO4**

TABLE 2.16. Equations Used to approximate the Curves in the Britter–McQuaid Correlations Provided in Figure 2.42 for Puffs

Concentration ration C_m/C_0	Valid range for $\alpha = \log_{10}\left(\frac{g_0 V_0^{1/3}}{u^2}\right)$	Equation for $\beta = \log_{10}\left[\frac{x}{V_0^{1/3}}\right]$
0.1	$\alpha \leq -0.44$	$\beta = 0.70$
0.1	$-0.44 < \alpha \leq 0.43$	$\beta = 0.26\alpha + 0.81$
0.1	$-0.43 < \alpha \leq 1$	$\beta = 0.93$
0.05	$\alpha \leq -0.56$	$\beta = 0.85$
0.05	$-0.56 < \alpha \leq 0.31$	$\beta = 0.26\alpha + 1.0$
0.05	$0.31 < \alpha \leq 1.0$	$\beta = -0.12\alpha + 1.12$
0.02	$\alpha \leq -0.66$	$\beta = 0.95$
0.02	$-0.66 < \alpha \leq -0.32$	$\beta = 0.36\alpha + 1.19$
0.02	$-0.32 < \alpha \leq 1$	$\beta = -0.26\alpha + 1.38$
0.01	$\alpha \leq -0.71$	$\beta = 1.15$
0.01	$-0.71 < \alpha \leq 0.37$	$\beta = 0.34\alpha + 1.39$
0.01	$0.37 < \alpha \leq 1$	$\beta = -0.38\alpha + 1.66$
0.005	$\alpha \leq -0.52$	$\beta = 1.48$
0.005	$-0.52 < \alpha \leq 0.24$	$\beta = 0.26\alpha + 1.62$
0.005	$-0.24 < \alpha \leq 1$	$\beta = -0.30\alpha + 1.75$
0.002	$\alpha \leq 0.27$	$\beta = 1.83$
0.002	$0.27 < \alpha \leq 1$	$\beta = -0.32\alpha + 1.92$
0.001	$\alpha \leq -0.10$	$\beta = 2.075$
0.001	$-0.10 < \alpha \leq 1$	$\beta = -0.27\alpha + 2.05$

TABLE 2.15. Equations Used to Approximate the Curves in the Britter–McQuaid Correlations Provided in Figure 2.41 for Plumes

Concentration ration C_m/C_0	Valid range for $\alpha = \log_{10}\left(\frac{g_0^2 q_0}{u^5}\right)$	Equation for $\beta = \log_{10}\left[\frac{x}{(q_0/u)^{1/2}}\right]$
0.1	$\alpha \le -0.55$	$\beta = 1.75$
0.1	$-0.55 < \alpha \le -0.14$	$\beta = 0.24\alpha + 1.88$
0.1	$-0.14 < \alpha \le 1$	$\beta = 0.50\alpha + 1.78$
0.05	$\alpha \le -0.68$	$\beta = 1.92$
0.05	$-0.68 < \alpha \le -0.29$	$\beta = 0.36\alpha + 2.16$
0.05	$-0.29 < \alpha \le -0.18$	$\beta = 2.06$
0.05	$-0.18 < \alpha \le 1$	$\beta = -0.56\alpha + 1.96$
0.02	$\alpha \le -0.69$	$\beta = 2.08$
0.02	$-0.69 < \alpha \le -0.31$	$\beta = 0.45\alpha + 2.39$
0.02	$-0.31 < \alpha \le -0.16$	$\beta = 2.25$
0.02	$-0.16 < \alpha \le 1$	$\beta = -0.54\alpha + 2.16$
0.01	$\alpha \le -0.70$	$\beta = 2.25$
0.01	$-0.70 < \alpha \le -0.29$	$\beta = 0.49\alpha + 2.59$
0.01	$-0.29 < \alpha \le -0.20$	$\beta = 2.45$
0.01	$-0.20 < \alpha \le 1$	$\beta = -0.52\alpha + 2.35$
0.005	$\alpha \le -0.67$	$\beta = 2.40$
0.005	$-0.67 < \alpha \le -0.28$	$\beta = 0.59\alpha + 2.80$
0.005	$-0.28 < \alpha \le -0.15$	$\beta = 2.63$
0.005	$-0.15 < \alpha \le 1$	$\beta = -0.49\alpha + 2.56$
0.002	$\alpha \le -0.69$	$\beta = 2.60$
0.002	$-0.69 < \alpha \le -0.25$	$\beta = 0.39\alpha + 2.87$
0.002	$-0.25 < \alpha \le -0.13$	$\beta = 2.77$
0.002	$-0.13 < \alpha \le 1$	$\beta = -0.50\alpha + 2.71$