Name:

Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2022

Course: Chemical Process Safety **Semester: VI**
Program: B.Tech FSE **Time : 03 hrs.**
Course Code: HSFS3008 **Max. Marks: 100**

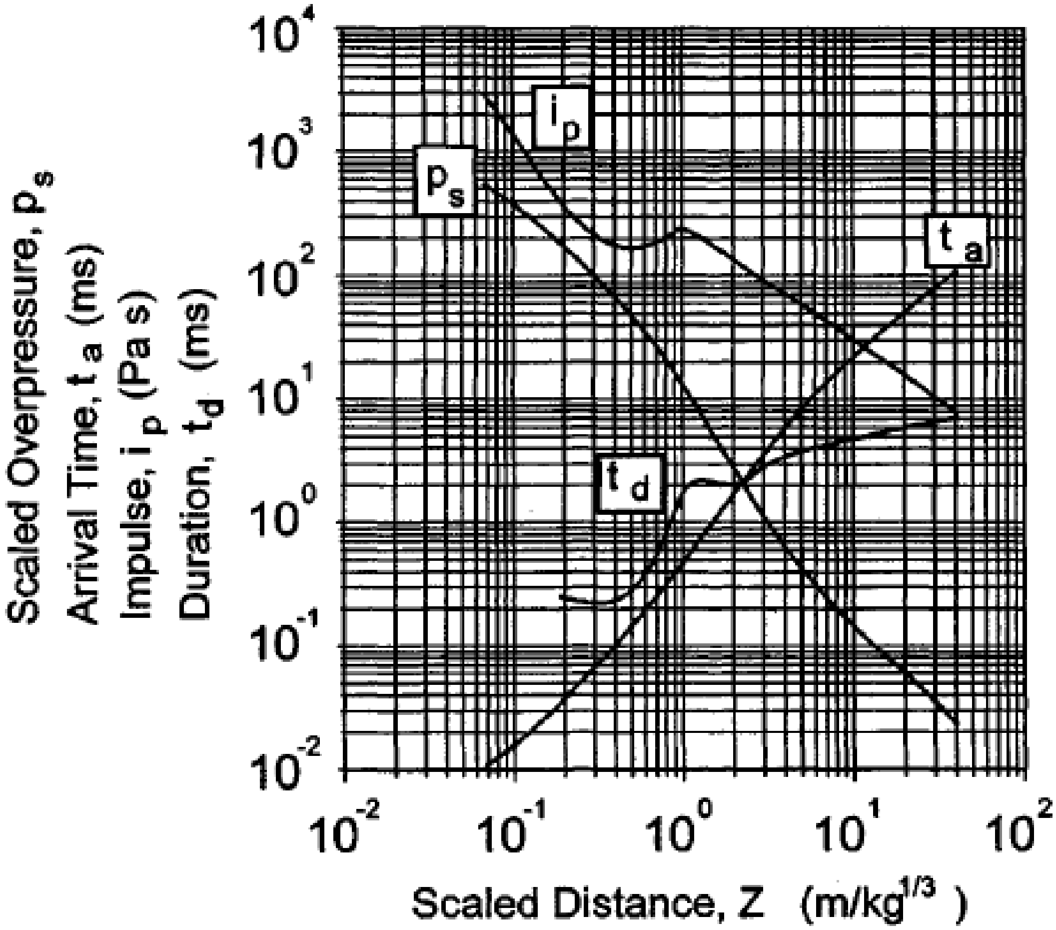
Instructions:

SECTION A
(5Qx4M=20Marks)

Q. No.		Marks	CO
Q 1	a. What is shortstopping? (2M) b. BLEVES are common in ____________________type of storage tanks? (1M) c. Silos/hoppers type of storage tank is used for storing_______________. (1M)	**4**	**CO1**
Q 2	The best method to store LPG is by the use of mounded storage tanks. Is this statement true? Justify your answer with four points.	**4**	**CO2**
Q 3	List the consequences of explosions.	**4**	**CO1**
Q 4	a) Alarms are an example of which safety strategy? (Inherent, Passive, Active, Procedural) b) Processes operationg at pressures below 101325 Pa are a __________. (General process hazard, Special process hazard, Both of these, None of these) c) Ignition control in storage tanks can be done using ____________. (Inerting, Avoiding free fall of liquids, Grounding, All of these) d) Which of the following is not a cause of BLEVE? (Mechanical damage and fire engulfment, Fire engulfment, Mechanical damage, Boil over)	**4**	**CO1**
Q 5	Most failure in heat exchangers can be prevented by proper inspection and frequent maintenance. Justify this statement.	**4**	**CO2**

SECTION B (4Qx10M= 40 Marks)			
Q 6	Bring out at least two points each to differentiate between: **a)** hazard and risk **b)** mechanical seal type and sealess pumps. **c)** minimize and moderate (in the context of inherent safety) **d)** extraction and stripping **e)** fixed roof type tanks and floating roof type tanks	**10**	**CO3**
Q 7	Illustrate with the help of a diagram the mechanism of operation of a pin type rupture device. Mention the applications, advantages and disadvantages associated with such a safety system.	**10**	**CO2**
Q 8	An accident investigation involving an explosion in a storage facility revealed that the root cause was misinterpreted level readings that lead to overfilling and spillage of a flammable liquid. Design a strategy to ensure such accidents do not occur in the facility again.	**10**	**CO4**
Q 9	With the help of a case study give an example of how an accident occurred due to inadequate cooling. **OR** With the help of a case study give an example of how an accident occurred due to fouling in heat exchangers.	**10**	**CO2**
SECTION-C (2Qx20M=40 Marks)			
Q 10	a) Compute the distance downwind from the following LNG release to obtain a concentration of 5% by volume. Assume ambient conditions of 280 K and 1 atm. The release is continuous. The following data is available: Spill rate of LNG is 60 Kg/s Spill duration is 3 minutes Wind speed at 10 m above ground is 11.2 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) Calculate the overpressure that will result at a distance of 15 m due to a vapor cloud explosion involving 15 kg of propane. The propane vapors are confined in dense pipe rack in the industry. The heat of	**20**	**CO3,CO 4**

	combustion of propane is 50 MJ/Kg. The energy of explosion of TNT is 4.6 MJ/Kg. Use the TNO method. Ambient temperature is 23 C. Molecular weight of propane is 44.1g/mole. **(10 M)**		
Q 11	Prepare a table giving details of the common failure modes, causes, consequences and design considerations for pumps and reactors. (10+10)	**20**	**CO3**



Scaled Overpressure, p_s
Arrival Time, t_a (ms)
Impulse, i_p (Pa s)
Duration, t_d (ms)
10^4
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
i_p
p_s
t_a
t_d
10^{-2}
10^{-1}
10^0
10^1
10^2
Scaled Distance, Z (m/kg$^{1/3}$)

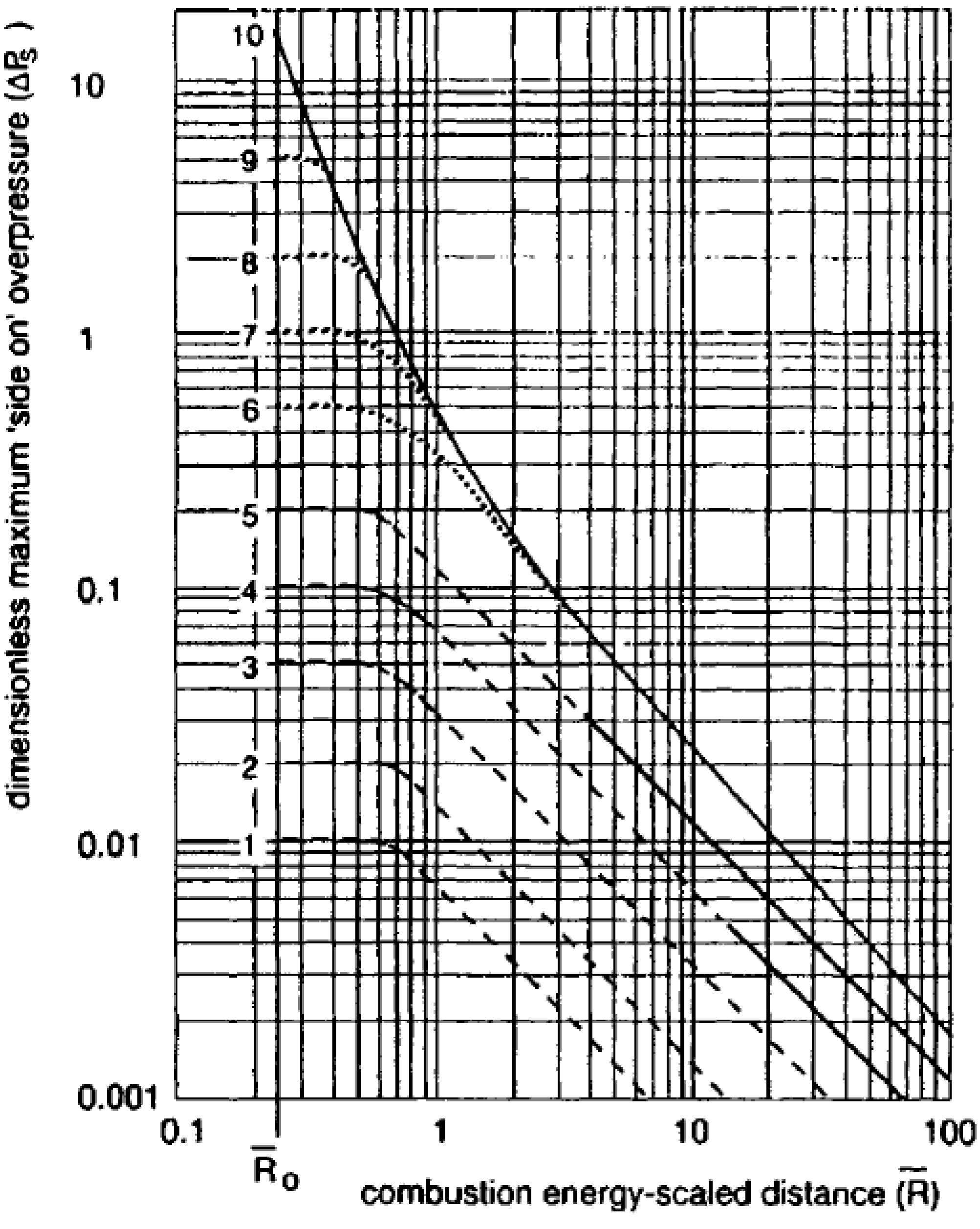

dimensionless maximum 'side on' overpressure ($\overline{\Delta P_s}$)
10
1
0.1
0.01
0.001
0.1
1
10
100
$\overline{R}_o$
combustion energy-scaled distance ($\overline{R}$)
10
9
8
7
6
5
4
3
2
1

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	$\alpha \le -0.44$	$\beta = 0.70$
0.1	$-0.44 < \alpha \le 0.43$	$\beta = 0.26\alpha + 0.81$
0.1	$-0.43 < \alpha \le 1$	$\beta = 0.93$
0.05	$\alpha \le -0.56$	$\beta = 0.85$
0.05	$-0.56 < \alpha \le 0.31$	$\beta = 0.26\alpha + 1.0$
0.05	$0.31 < \alpha \le 1.0$	$\beta = -0.12\alpha + 1.12$
0.02	$\alpha \le -0.66$	$\beta = 0.95$
0.02	$-0.66 < \alpha \le -0.32$	$\beta = 0.36\alpha + 1.19$
0.02	$-0.32 < \alpha \le 1$	$\beta = -0.26\alpha + 1.38$
0.01	$\alpha \le -0.71$	$\beta = 1.15$
0.01	$-0.71 < \alpha \le 0.37$	$\beta = 0.34\alpha + 1.39$
0.01	$0.37 < \alpha \le 1$	$\beta = -0.38\alpha + 1.66$
0.005	$\alpha \le -0.52$	$\beta = 1.48$
0.005	$-0.52 < \alpha \le 0.24$	$\beta = 0.26\alpha + 1.62$
0.005	$-0.24 < \alpha \le 1$	$\beta = -0.30\alpha + 1.75$
0.002	$\alpha \le 0.27$	$\beta = 1.83$
0.002	$0.27 < \alpha \le 1$	$\beta = -0.32\alpha + 1.92$
0.001	$\alpha \le -0.10$	$\beta = 2.075$
0.001	$-0.10 < \alpha \le 1$	$\beta = -0.27\alpha + 2.05$

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	$-0.13 < \alpha \le 1$	$\beta = -0.50\alpha + 2.71$