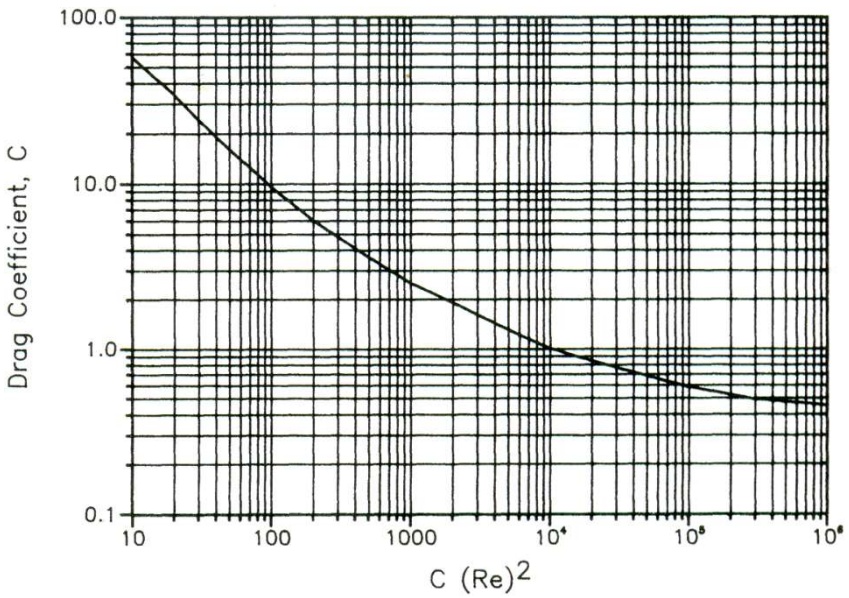
Name: Enrolment No:	

UPES
End Semester Examination, December 2024

Course: Process Safety and Security **Semester: : 3**
Program: M.Tech Health Safety and Environment **Time : 03 hrs.**
Course Code: HSFS 8033 **Max. Marks : 100**

SECTION A
(5Qx4M=20Marks)

S. No.	Question	Marks	CO
Q1	Choose the correct answer from the choices provided in brackets: a. Identify which system does not come in the category of line of defense (Containment dyke, Sprinkler systems, Centrifugal pump, Alarm) b. Another name for a knockout drum is (Blowdown drum, Blowdown drum and catch tanks, Catch tanks, None of these) c. What is the pressure difference between the relief set pressure and the relief reseating pressure called? (Blowout, Blowthrough, Blowdown, Backpressure, Overpressure) d. Name which device among the following is most appropriate for installing for pressure relief on a liquified chlorine storage tank (Rupture pin device, Spring-operated pressure relief valve, Globe valve, None of these)	**4**	**CO1**
Q2	List out four failure modes of heat-exchanger equipment.	**4**	**CO1**
Q3	Differentiate between corrosion fouling and chemical fouling.	**4**	**CO2**
Q4	Mention four possible threats to security of a chemical process plant.	**4**	**CO1**
Q5	How does security risk differ from safety risk?	**4**	**CO2**

	SECTION B **(4Qx10M= 40 Marks)**		
Q6	Determine the maximum vapor velocity in a horizontal knockout drum designed to drop out liquid particles. The system operates with a vapor rate of 150 lb/hr, a vapor density of 0.22 lb/ft³, and a liquid density of 28 lb/ft³. The vapor viscosity is 0.012 centipoise, and the particle diameter is 250 μm.  	**10**	**CO4**
Q7	A process plant producing specialty chemicals has installed relief devices for its storage tanks containing chlorine and reactors generating aqueous phosphoric acid. Currently, the plant design vents the contents of these relief devices directly into the atmosphere. Propose strategies to improve the plant's relief system to enhance safety and minimize environmental impact."	**10**	**CO3**
Q8	Briefly describe with the help of labeled diagrams, the various relief devices used in chemical process plants, outlining their working and applications. **OR** Describe various pressure relief valve characteristics and vessel/system characteristics	**10**	**CO1**
Q9	A process plant is installing a refrigeration system involving a new refrigerant. The process engineers want to analyze the performance of the refrigerants under varying thermal conditions to ensure that equipment don't fail due to unexpected phase transitions. What kind of analysis technique would they probably choose? Write brief notes on the technique.	**10**	**CO2**

SECTION-C (2Qx20M=40 Marks)			
Q10	Write short notes on SRFT. Using the below plant as an example, evaluate the level of security risk using SRFT. List the threats, vulnerabilities, consequences and recommendations and evaluate the risk score by listing out the risk factors. Assign a range of 0 to 5 with 0 as negligible, 1 as low, 2,3 as moderate and 4,5 as severe; for each risk factor. Once you evaluate the score compare it with the level of risk as categorized by the SRFT. **Fertilizer Production Plant Z** • Plant Z is situated 40 km from a small town and adjacent to a railway line. The site is partially obscured by forest cover but visible from the railway tracks. • It produces 1,500 MTPD of ammonium nitrate and 1,200 MTPD of calcium ammonium nitrate. • Ammonia is stored in two cryogenic tanks (-33°C) with a capacity of 8,000 MT each. The tanks are 25 meters in diameter. • Railcars deliver methanol, which is stored in three horizontal pressurized tanks, each with a capacity of 3,000 MT at 700 kPa. • The plant has experienced a minor explosion in a non-core storage area five years ago, attributed to poor maintenance. • Security measures include a reinforced wall, an automatic alarm system, armed guards, and regular emergency drills. • The location has no history of terrorist activities, but the region has seen occasional political protests targeting industrial operations.	**20**	**CO4**
Q11	Illustrate with the help of a flow chart, the sequence of events leading up to the Bhopal disaster. List out the failures in the line of defense. With the context of this disaster, explain how by employing inherently safer design principles the occurrence of such a disaster could be prevented. **OR** Summarize using a table the common failure modes, causes, consequences and design considerations for pumps and reactors.	**20**	**CO3**