Name:

Enrolment No:

UPES

End Semester Examination, May 2025

Course: Hazard Identification, Risk Analysis and Management (HSFS 7011) **Semester: II**

Program: MTech HSE/ HSE(DM) **Time : 03 hrs.**

Course Code: HSFS 7011 **Max. Marks: 100**

Instructions: Students are advised to answer questions sequentially and start each answer on a new sheet of paper.

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q1	Define the terms 'inherent safety' and 'engineered safety/engineering controls.' Provide an example to illustrate the difference between these two approaches in the context of chemical process design.	**4**	**CO1**
Q2	Explain the concept of a Safety Instrumented System (SIS) and its role in process safety. Use a simple diagram to illustrate the basic components of an SIS.	**4**	**CO2**
Q3	What is the Failure Mode and Effects Analysis (FMEA)? Provide a brief explanation of how it is used to assess risks in a system, including one example.	**4**	**CO3**
Q4	What are the conditions which dictate whether a flammable vapour cloud will burn in a flash fire or undergo vapor cloud explosion?	**4**	**CO2**
Q5	Would the outcome of Bhopal Gas Tragedy be any different if the gas leak would have happened on a hot summer day with strong winds? Explain your answer.	**4**	**CO3**
	SECTION B **(4Qx10M= 40 Marks)**		
Q6	Explain the concepts of individual risk and societal risk, highlight the key differences. Explain how each type of risk is quantified?	**10**	**CO4**
Q7	Discuss the relative limitation and strengths of models used for estimation of overpressure arising from vapour cloud explosions.	**10**	**CO3**
Q8	Discuss the strength and limitations of Fault Tree Analysis (FTA) in risk management. Explain your answer with the help of an example.	**10**	**CO1**
Q9	A cylindrical water tank 2 meters tall (h) is filled to the brim. There is a small circular hole with a diameter of 2 centimeters (d) at the bottom center of the tank. **(a)** Assuming ideal fluid flow (incompressible, inviscid), what is the theoretical exit velocity (v) of the water stream exiting the hole?	**5×2=10**	**CO4**

	(b) Briefly explain two factors that would affect the actual exit velocity compared to your calculation in part (a). **Constants:** Acceleration due to gravity (g) = 9.81 m/s²		
	SECTION-C **(2Qx20M=40 Marks)**		
Q10	Layer of Protection Analysis (LOPA) is a semi-quantitative risk assessment method used in process industries to evaluate safeguards for mitigating risks. Write an essay addressing: 1. **Definition and Purpose** (5 Marks): • Define LOPA and its role in process safety management. • Explain why LOPA complements methods like HAZOP. 2. **Methodology** (5 Marks): • Outline the steps for conducting a LOPA study. • Define Independent Protection Layers (IPLs). 3. **Application in a Process Plant** (5 Marks): • Describe how LOPA can assess and mitigate a high-risk scenario, e.g., reactor overpressure. 4. **Advantages and Limitations** (5 Marks): • Discuss two advantages of LOPA. • Identify two limitations and their impact. Include a diagram and example to support your explanation.	**20**	**CO5**
Q11	A chemical reactor's cooling system consists of three components in series: a flow measurement device (fluids), a controller, and a control valve. Additionally, a parallel high-pressure alarm system is installed, consisting of a pressure switch and an indicator lamp. Using the failure rate data provided below, calculate for a 1-year period: 1. The overall failure rate of the cooling system (components in series). (6 marks) 2. The overall reliability and failure probability of the cooling system. (6 marks) 3. The Mean Time Between Failure (MTBF) for the cooling system. (3 marks) 4. The overall failure probability of the parallel alarm system. (5 marks) **Failure Rate Data**: • Flow measurement (fluids): 1.14 faults/year • Controller: 0.29 faults/year • Control valve: 0.60 faults/year • Pressure switch: 0.14 faults/year • Indicator lamp: 0.044 faults/year Use relevant equations and show all calculations. **Or**	**20**	**CO5**

	An accidental release of anhydrous ammonia from a chemical plant's storage tank formed a toxic vapor cloud, impacting a nearby community with respiratory irritation. Using ALOHA software, model the incident to assess the impact zone. Address: 1. **Input Data** (5 Marks): List the key data needed for ALOHA to model the ammonia release. 2. **ALOHA Configuration** (5 Marks): Outline the steps to configure the ammonia release scenario in ALOHA. 3. **Dispersion Modeling** (5 Marks): Explain how ALOHA models the ammonia vapor cloud dispersion. 4. **Impact Assessment** (5 Marks): Describe how to interpret ALOHA's results to determine the affected area. **Additional Considerations**: • Identify one limitation of ALOHA in this context. • Explain how ALOHA results can guide emergency response.		