Name: Enrolment No:	

UPES

End Semester Examination, May 2025

Programme Name : B.Tech (Fire and Safety Engineering) **Semester :** VI

Course Name : Chemical Process safety and security **Time :** 03 hrs

Course Code : HSFS 3042 **Max. Marks:** 100

Nos. of page(s) : Three

Instructions: Assume suitable data wherever necessary. Your answer should be precise and to the point.

SECTION A

(4 Marks *5 = 20 Marks)

S. No.		Marks	CO
Q 1	What is chemical process safety and security, and how do they relate to fire safety concerns?	**4**	**CO1**
Q 2	i. The most common cause of industrial chemical accidents is ____. ii. BLEVE stands for _____. iii. The safety valve is an example of a _____ protection system. iv. The risk is a combination of hazard and _____.	**4**	**CO1**
Q 3	A storage tank contains a flammable liquid with a flash point of 23°C. If the ambient temperature is 35°C, determine whether the liquid poses a fire hazard during handling.	**4**	**CO1**
Q 4	Choose the best answer: i. The primary purpose of MSDS (Material Safety Data Sheet) is to: a) Market the chemical b) Provide chemical pricing c) Inform about safe handling and hazards d) Replace first aid ii. The best method to prevent static electricity-induced fire in chemical tanks is: a) Heating b) Grounding and bonding c) Insulating d) Cooling iii. The term 'runaway reaction' means: a) A controlled process b) A reaction that stops suddenly c) A reaction that accelerates out of control d) A fire due to gas leak iv. Which of the following is a chemical security measure? a) Installing a pressure relief valve	**4**	**CO1**

	b) Guarding toxic chemical storage c) Using automatic sprinklers d) Grounding pipelines		
Q 5	What is the difference between active and passive fire protection systems in chemical plants?	**4**	**CO1**
SECTION B **(10 Marks * 4 = 40 Marks)**			
Q 6	Calculate the total energy released in megajoules (MJ) if 2,500 kg of Ammonium Nitrate detonates. Given: • TNT equivalence = 0.42 • Energy of TNT = 4.184 MJ/kg **OR** A chemical process plant is storing 50,000 liters of flammable liquids in an above-ground tank. The tank has a diameter of 12 meters and a height of 10 meters. According to NFPA 30, the fire protection design requires a firewater spray system to cover the tank. Calculate the minimum flow rate of water (in liters per minute) that should be provided to the tank, assuming the required spray rate is 0.25 gallons per minute per square foot of surface area.	**10**	**CO2**
Q 7	A chemical laboratory stores a variety of flammable solvents, corrosive acids, and volatile toxic compounds. One day, a minor spill of concentrated hydrochloric acid occurs near a storage cabinet containing ethanol and simultaneously, a fume hood in the lab member, who was not wearing PPE attempts to clean the spill using paper towels. Identify and explain at least five critical violations in this scenario and describe the potential consequences of each?	**10**	**CO3**
Q8	As a safety officer, in an industrial control system (ICS), explain how you would secure communication between a central control unit and field devices (like sensors and actuators). What are the common vulnerabilities in such systems and how would you mitigate them?	**10**	**CO4**
Q 9	A piping system is to be installed in a chemical plant to transport fluids with a pressure of 4 MPa and temperature of 120°C. The pipe material is carbon steel (ASTM A106, Grade B). The pipe has an outer diameter of 200 mm and is designed for a wall thickness based on ASME B31.3. The allowable stress for the material at the operating temperature is 140 MPa. i. Calculate the required thickness of the pipe. ii. Is the piping system safe?	**6+4**	**CO3**
SECTION C **(20 Marks * 2 = 40 Marks)**			

Q 10	**UPES chemistry lab and chemical storage facility audit** conducted by you as part of your class: i. List of three major chemical hazards you observed during the chemistry lab audit. Briefly explain why they pose a risk. ii. What type of ventilation system was present in the lab? Was it adequate according to chemical safety standards? Justify your answer. iii. Evaluate the chemical storage facility's layout in terms of the "5S" safety principles. Which of the 5S elements were followed, and which were lacking? iv. Identify and explain the role of any two-emergency equipment (e.g., eye wash station, fire extinguisher) found during the audit. v. As a future fire safety engineer, how would you redesign the chemical storage area for better risk mitigation based on your audit findings?	**4x5=20**	**CO4**
Q 11	Short answer type questions. Answer any four: **i.** The codes and standards commonly used in Fire Safety Engineering applications. ii. What is Explosive Potential of chemicals? iii. How does MSDS help in the event of a chemical spill? iv. What is the primary safety concern during the startup of a chemical process plant? v. During plant startup, what role do operators play in ensuring safety? vi. What is the role of the pressure relief valve during pressure testing of a vessel?	**5x4=20**	**CO1**