Name: **Enrolment No:**	UPES UNIVERSITY OF TOMORROW

UPES

End Semester Examination, December 2024

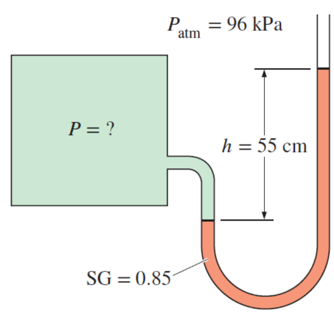
Course: Chemical Eng I (Thermodynamics & A. Inst.) – MECH2067 **Semester: III**

Programme: BTech (FSE)

Time: 03 hrs. **Max. Marks: 100**

Instructions: All Questions in Section A are compulsory. Section B has 4 Questions with Question 9 having an internal choice. Section C has 2 questions Question 10 having an internal choice. Answer all the questions sequentially.

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Distinguish between an isolated system, a closed system, and an open system. Provide examples of each.	**4**	**CO1**
Q2	Explain the First Law of Thermodynamics in your own words. How does it relate to the conservation of energy? A system undergoes a process in which it absorbs 50 J of heat and does 20 J of work on its surroundings. What is the change in internal energy of the system?	**4**	**CO1**
Q3	A manometer is used to measure the pressure of a gas in a tank. The fluid used has a specific gravity of 0.85, and the manometer column height is 55 cm, as shown in the adjacent figure. If the local atmospheric pressure is 96 kPa, determine the absolute pressure within the tank. 	**4**	**CO3**
Q4	What are the different types of level measurement devices used in industries? Discuss the working principle, advantages, and limitations of any two types and provide suitable examples.	**4**	**CO2**
Q5	In context of spectrophotometry. How does electromagnetic radiation interact with matter at the molecular level? Discuss the specific effects of different types of electromagnetic radiation on molecules, including absorption, emission, and excitation.	**4**	**CO2**

SECTION B
(4Qx10M= 40 Marks)

Q6	Consider the following general reaction: aA + bB → cC + dD a) Write the general rate law expression for this reaction. b) What are the units of the rate constant (k) in the rate law?	**10**	**CO2**

	c) State Le Chatelier's principle. d) How does the order of a reaction influence its overall rate?		
Q7	What is a reversible cycle? Explain the Carnot cycle with a neat sketch. Why is the Carnot cycle considered the most efficient cycle? What are the limitations of the Carnot cycle in practical applications?	**10**	**CO4**
Q8	Describe Joule's experiment. What was the primary objective of this experiment? How did it contribute to our understanding of energy conservation and the relationship between mechanical energy and heat energy?	**10**	**CO4**
Q9	State Bernoulli's principle. Apply it to derive an expression for the velocity of fluid flowing out of a small orifice at the bottom of a tank filled to a height 'h'. Clearly state the assumptions made in the derivation. **OR** A piston–cylinder device initially contains 0.4 m^3 of air at 100 kPa and 80°C. The air is now compressed to 0.1 m^3 in such a way that the temperature inside the cylinder remains constant. Determine the work done during this process. Draw the P-V diagram of the process.	**10**	**CO3**
SECTION-C **(2Qx20M=40 Marks)**			
Q10	Explain Joule-Thomson effect. Derive the following expression. $\alpha_J = \left(\frac{\partial T}{\partial V}\right)_U = -\frac{1}{C_V}\left[T\left(\frac{\partial P}{\partial T}\right)_T - P\right]$ **OR** Explain the concept of feedback control systems with a neat block diagram. Discuss the role of various components like sensors, actuators, and controllers in a feedback control system. Describe the different types of controllers, such as Proportional (P), Integral (I), and Derivative (D) controllers. Explain how these controllers work and how their combination (PID controller) can be used to achieve better control performance.	**20**	**CO5**
Q11	Knowing kinetics of a chemical reaction is crucial for design of a chemical reactor. i) What are the various methods used for the determination of rate equations? ii) Using the initial rate and chemical data given in the table below. Determine a) rate equation and b) the rate constant. $CH_3COCH_3(aq) + I_2(aq) \xrightarrow{H^+} CH_3COCH_2I(aq) + H^+(aq) + I^-(aq)$	**20**	**CO5**

Initial rate (mol dm^{-3} s^{-1})	Initial concentration (mol dm^{-3})		
	$[I_2(aq)]$	$[CH_3COCH_3(aq)]$	$[H^+(aq)]$
3.5×10^{-5}	2.5×10^{-4}	2.0×10^{-1}	5.0×10^{-3}
3.5×10^{-5}	1.5×10^{-4}	2.0×10^{-1}	5.0×10^{-3}
1.4×10^{-4}	2.5×10^{-4}	4.0×10^{-1}	1.0×10^{-2}
7.0×10^{-5}	2.5×10^{-4}	4.0×10^{-1}	5.0×10^{-3}