

Name:

Enrolment No:



UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2021

Course: Chemical Eng I (Thermodynamics & Measuring A. Inst.) – HSFS2001

Semester: III

Programme: BTech (FSE)

Time: 03 hrs.

Max. Marks: 100

Instructions:

- (i) 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 11 having an internal choice.
- (ii) Answer all the questions sequentially.

SECTION A (5 × 4 = 20; Maximum marks 20)

S. No.		Marks	COs
Q 1	Define: 1. Surrounding of a thermodynamic system 2. Phase equilibrium 3. Latent heat. Why is it called latent?	4	CO1
Q2	True or False (a) As per 1 <sup>st</sup> Law of Thermodynamics - there is no restriction on direction of conversion of energy. (b) Dip Stick and Float type level measurement devices give direct measurement of level. (c) For an open system energy can travel through the boundaries of a system in the form of heat and work but mass is not allowed to cross the boundaries of a system. (d) Joule Thomson coefficient is a measure of the change in temperature with pressure during a constant enthalpy process.	4	CO1
Q3	The pressure in a natural gas pipeline is measured by the manometer shown in the figure below with one of the arms open to the atmosphere where the local atmospheric pressure is 14.2 psia. Determine the absolute pressure in the pipeline. <p style="text-align: center;">Mercury SG = 13.6</p> <p style="text-align: center;">Water</p>	4	CO3

Q4	Methyl alcohol (CH <sub>3</sub> OH) is burned with the stoichiometric amount of air. Calculate the mole fractions of each of the products, and the apparent molar mass of the product gas. Also, calculate the mass of water in the products per unit mass of fuel burned.	4	CO3								
Q5	What is the difference between intensive and extensive properties? Explain with the help of examples.	4	CO2								
<b>SECTION B (4 × 10 = 40; Maximum marks 40)</b>											
Q6	What are controllers and list the types of controllers? Which controller is susceptible to reset-windup and why? What type of controller is best suited to overcome the problem of reset-windup?	10	CO4								
Q7	a. What does the Joule-Thomson coefficient represent? b. Describe the inversion line and the maximum inversion temperature. c. Does the Joule-Thomson coefficient of a substance change with temperature at a fixed pressure? d. The pressure of a fluid always decreases during an adiabatic throttling process. Is this also the case for the temperature?	10	CO2								
Q8	Explain the principle behind the working of a strain gauge. How is the resistance in a metal related to the applied force? What instrument is used to measure the change in resistance? Explain its working.	10	CO4								
Q9	Write Bernoulli's equation and derive the expression for velocity of fluid flowing out from the bottom of a water tank filled to a height of $h$ meters. Explain all the assumptions made in the derivation.  <p style="text-align: center;"><b>OR</b></p> A rigid tank contains a hot fluid that is cooled while being stirred by a paddle wheel. Initially, the internal energy of the fluid is 800 kJ. During the cooling process, the fluid loses 500 kJ of heat, and the paddle wheel does 100 kJ of work on the fluid. Determine the final internal energy of the fluid. Neglect the energy stored in the paddle wheel. Clearly explain all the assumptions made in solving the problem.	10	CO3								
<b>SECTION-C (2 × 20 = 40; Maximum marks 40)</b>											
Q10	(a) Define the coefficient of performance of a refrigerator in words. Can it be greater than unity? (b) A food department is kept at -12°C by a refrigerator in an environment at 30°C. The total heat gain to the food department is estimated to be 3300 kJ/h and the heat rejection in the condenser is 4800 kJ/h. Determine the power input to the compressor, in kW and the COP of the refrigerator. (c) What are the methods used for flow measurement? Of the various fluid flow measurement devices which one has least head loss (pressure loss) and why?	5+5+ 10	CO3 (a&b) CO4 (c)								
Q11	i) What are polymers? Explain the molecular structure of polymers with the help of diagrams and comment on relative strength of various polymer structures. ii) How is molecular weight of a polymer calculated? iii) Calculate the molecular weight for a polymer with number and mass of monomer given as below:	20	CO5								
	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">Number of monomer units</th> <th style="width: 50%;">Mass of monomer units(Kg)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>60</td> </tr> <tr> <td>3</td> <td>40</td> </tr> <tr> <td>4</td> <td>70</td> </tr> </tbody> </table>			Number of monomer units	Mass of monomer units(Kg)	1	60	3	40	4	70
Number of monomer units	Mass of monomer units(Kg)										
1	60										
3	40										
4	70										

2	50		
1	80		
<b>OR</b>			
What factors dictate the type of bonding that may exist between various chemical species? Describe the characteristics of metallic crystals. Define Atomic packing factor (APF) and calculate the atomic packing factor for a body centered cubic structure.			