Name:

Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2019

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 5 Questions with 2 questions having internal choice. Section C has 2 questions with one question having internal choice.
(ii) Answer all the questions sequentially.

SECTION A (Maximum marks 20)

S. No.		Marks	COs
Q 1	A 3-m^3 rigid tank contains nitrogen gas at 500 kPa and 300 K. Now heat is transferred to the nitrogen in the tank and the pressure of nitrogen rises to 800 kPa. The work done during this process is (a) 500 kJ (b) 900 kJ (c) 1500 kJ (d) 2400 kJ (e) 0 kJ	**2**	**CO1**
Q2	Degree of freedom for thermodynamic system is calculated with the help of following formula, where F is degree of freedom, π is number of phases and n is the number of components (a) $F = \pi+2 - N$ (b) $N = \pi - 2 + F$ (c) $F = 2 - \pi + N$ (d) $\pi = F +2 - N$	**2**	**CO1**
Q3	Give full forms of the following: (a) RTD (b) CVGT	**2**	**CO1 , 4**
Q4	IR spectrophotometer uses electromagnetic radiations in the range of a) 185 – 400 nm b) 400 – 700 nm c) 700 – 15000 nm d) 900 – 12000 nm	**2**	**CO4**
Q5	Two main synthetic approaches for the manufacture of polymers are _____ and _____ .	**2**	**CO5**
Q6	One kmol of methane (CH_4) is burned with an unknown amount of air during a combustion process. If the combustion is complete and there are 1 kmol of free O_2 in the products, the air–fuel mass ratio is (a) 34.6 (b) 25.7 (c) 17.2 (d) 14.3 (e) 11.9	**2**	**CO2**
Q7	Consider a fish swimming 5 m below the free surface of water. The increase in the pressure exerted on the fish when it dives to a depth of 45 m below the free surface is:	**3×2 = 6**	**CO1 , 4**

<table>
<tr><td></td><td>(i) 392 Pa
(ii) 9800 Pa
(iii) 50,000 Pa
(iv) 392,000 Pa
(v) 441,000 Pa</td><td></td><td></td></tr>
<tr><td>Q8</td><td>Constant pressure heat capacity is defined as:
(a) $C_p = \left(\frac{\partial H}{\partial T}\right)_p$ (b) $C_p = \left(\frac{\partial U}{\partial T}\right)_p$ (c) $C_p = \left(\frac{\partial S}{\partial T}\right)_p$ (d) $C_p = \left(\frac{\partial A}{\partial T}\right)_p$</td><td>2</td><td>CO1 , 2</td></tr>
<tr><td>Q9</td><td>Define the following for a controller:
(a) Offset
(b) PID</td><td>2</td><td>CO1 , 2</td></tr>
<tr><td>Q10</td><td>APF for a hexagonal close-packed structure (hcp) is:
(a) 0.64 (b) 0.74 (c) 0.54 (d) 0.84</td><td>2</td><td>CO1 , 2</td></tr>
<tr><td colspan="4">SECTION B (Maximum marks 40)</td></tr>
<tr><td>Q11</td><td>At high temperatures, ethyl chloride produces HCl and ethylene by the following reaction:
$CH_3CH_2Cl(g) \xrightarrow{\Delta} HCl(g)+C_2H_4(g)$
Using the rate data for the reaction at 650°C presented in the following table, calculate the reaction order with respect to the concentration of ethyl chloride and determine the rate constant for the reaction.
<table>
<tr><th>Experiment</th><th>$[CH_3CH_2Cl]_0$ (M)</th><th>Initial Rate (M/s)</th></tr>
<tr><td>1</td><td>0.010</td><td>1.6×10^{-8}</td></tr>
<tr><td>2</td><td>0.015</td><td>2.4×10^{-8}</td></tr>
<tr><td>3</td><td>0.030</td><td>4.8×10^{-8}</td></tr>
<tr><td>4</td><td>0.040</td><td>6.4×10^{-8}</td></tr>
</table></td><td>8</td><td>CO2</td></tr>
<tr><td>Q12</td><td>Explain reaction thermodynamics with the help of increase of entropy principle.</td><td>8</td><td>CO3</td></tr>
<tr><td>Q13</td><td>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 is resistance? Explain its working.</td><td>8</td><td>CO3</td></tr>
<tr><td>Q14</td><td>Explain inversion line, inversion temperature and maximum inversion temperature in context with Joule-Thompson coefficient. Which part of refrigeration cycle exploits Joule-Thompson effect and how?
Or
(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.</td><td>8</td><td>CO1 , 3</td></tr>
<tr><td>Q15</td><td>Discuss the advantage and disadvantage of using various flow measurement devices viz a viz orifice meter, venturi and nozzle.
OR
Write Bernoulli’s equation and derive the expression for velocity of fluid flowing out from the bottom of water tank filled to a height of h meters.</td><td>8</td><td>CO2 , 5</td></tr>
<tr><td colspan="4">SECTION-C (Maximum marks 40)</td></tr>
<tr><td>Q16</td><td>(a) What is the difference between instrument and machine?</td><td>20</td><td>CO1 , 4</td></tr>
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<tr><td></td><td>(b) List the advantage of instrumental methods of chemical analysis over the classical methods.
(c) What is Beer-Lambert law and what are its limitations?</td><td></td><td></td></tr>
<tr><td>Q17</td><td>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:

<table><tr><td>Number of monomer units</td><td>Mass of monomer units(Kg)</td></tr><tr><td>1</td><td>50</td></tr><tr><td>3</td><td>20</td></tr><tr><td>4</td><td>80</td></tr><tr><td>2</td><td>20</td></tr><tr><td>1</td><td>80</td></tr></table>
OR

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) Give the classification of various types of chemical reactor and their describe the principle on which they function</td><td>20</td><td>CO5</td></tr>
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