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UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2017

Program: B.Tech CE+RP/B.Tech APE-Gas

Subject (Course): Chemical Engineering Thermodynamics-I

Course Code : CHEG-222

No. of page/s:2

Semester – III

Max. Marks : 100

Duration : 3 Hrs

Instruction(s):

- (a) For all the problems state the assumptions you consider clearly.
- (b) Assume the appropriate value of missing data if any.

Section –A

(Answer all questions, equal marks)

6 x 10 = 60 Marks

1. State the First law for a closed system undergoing a cycle and derive steady flow energy equation for Turbine work.
2. **100 kg** of Water at **100°C** are mixed with **60 kg** of water at **60°C**, while the temperature of the surrounding is **15°C**, determine the decrease in available energy due to mixing
3. Draw the **T-s**, **P-v** and **T-v** diagrams for pure substance
4. What is **Adiabatic Flame Temperature**? Derive equations for obtaining Adiabatic Flame Temperature for **Constant Pressure** and **Constant Volume** Processes
5. Describe the working principle of **Throttling Colorimeter** for measurement of quality of Steam with neat diagram
6. A gas undergoes a thermodynamic cycle consisting of three processes beginning at the initial state where **$p_1 = 1\text{bar}$** , **$V_1 = 1.5\text{ m}^3$** and **$U_1 = 5412\text{ kJ}$** . The processes are follows
 - (a) Process **1-2**, compression with **$pV = \text{Constant}$** to **$p_2 = 2\text{ bar}$** , **$U_2 = 690\text{ kJ}$**
 - (b) Process **2-3**, **$W_{23} = 0$** , **$Q_{23} = -150\text{kJ}$** and
 - (c) Process **3-1**, **$W_{31} = 50\text{kJ}$** , neglecting **KE** and **PE** changes, determine the heat interactions **Q_{12}** and **Q_{31}** ?

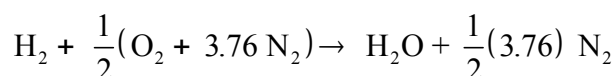
Section-B

(Answer any 2 questions)

2 x 20 = 40 Marks

7. (a) Explain the characteristics and working principle of **Ideal Vapor Compression Refrigeration Cycle** with the help of a neat sketch [10]
- (b) An ideal vapor compression refrigeration cycle that uses the refrigerant **R-134a**, as its working fluid maintains a condenser at **800 kPa** and the evaporator at **-12 °C**, determine the system's **COP** and the amount of power required to service a **150 kW** cooling load [10]
8. (a) Why is the **Carnot cycle** not a realistic model for a steam power plant? Explain [8]
- (b) Consider a **210-MW** steam power plant that operates on a simple **ideal Rankine cycle**. Steam enters the turbine at **10 MPa** and **500°C** and is cooled in the condenser at a pressure of **10 kPa**. Show the cycle of a **T – s** diagram *w.r.t* saturation lines and determine
- (i) the quality of steam at the turbine exit
 - (ii) the thermal efficiency of the cycle
 - (iii) the mass flow rate of the steam. [12]
9. (a) Hydrogen is burned with a stoichiometric amount of air during an adiabatic steady-flow combustion process. Both the fuel and the air enter the combustion chamber at **25° C** and **1 atm**. Calculate the exit temperature of the product gases, assuming complete combustion.

The combustion equation for H₂ with stoichiometric air is [15]



Species	\bar{h}_f^0 kJ/kmol	\bar{h}_{298} kJ/kmol
H ₂	0	-
O ₂	0	-
N ₂	0	8669
H ₂ O(g)	-241820	9904

- (b) Derive the **Clapeyron's** equation for latent heat of vaporization of a pure substance [5]