Name: Enrolment No:	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, Dec 2019

Programme Name: B. Tech. CE+RP **Semester : III**
Course Name : Thermodynamics-I **Time : 03 hrs**
Course Code : CHCE2002 **Max. Marks : 100**
Nos. of page(s) : 2

Instructions:

(a) **For all the problems state the assumptions you consider clearly.**

(b) Assume the appropriate value of missing data if any.

(c) Thermodynamic terms have their usual meanings.

SECTION A
(Answer all) **6 x 10 =60 marks**

S. No.		Marks	CO
Q 1	When the outside temperature is -10 ^oC, a residential heat pump must provide 3.5 X 10^6 kJ per day to a dwelling to maintain its temperature at 20 ^oC. If the electricity costs Rs 2.10 per kWh, find the minimum theoretical operating cost for each day of operation.	10	CO4
Q 2	Two kg of water at 80 ^oC are mixed adiabatically with 3 kg of water at 30 ^oC in a constant pressure process of 1 atmosphere. Estimate the increase in the entropy of the total mass of water due to the mixing process.	10	CO4
Q 3	Derive Maxwell's equations for homogeneous fluid of constant composition. Explain the significance of these equations in thermodynamics.	10	CO2
Q 4	Estimate the enthalpy change of vaporization for n-heptane at its normal boiling point by Clapeyron equation. Use the following vapor-pressure equation: $$\ln P^{sat}/kPa = 13.8587 - \frac{2911.32}{T/K - 56.51}$$	10	CO2
Q 5	One mole of air, initially at 423.15 K and 8 bar, undergoes the following mechanically reversible changes. It expands isothermally to a pressure such that when it is cooled at	10	CO1

<table>
<tr><td></td><td>constant volume to 323.15 K its final pressure is 3 bar. Assuming air is an ideal gas for which $C_P = (7/2)R$ and $C_V = (5/2)R$, calculate W and Q for this process.</td><td></td><td></td></tr>
<tr><td>Q.6</td><td>Explain the simple ideal Rankine cycle with a neat diagram. How do actual vapor cycles differ from idealized one.</td><td>10</td><td>CO5</td></tr>
<tr><td colspan="4">SECTION B
(2 x 20 = 40 marks)</td></tr>
<tr><td>Q 7</td><td>Methane gas is burned completely with 30 % excess air at approximately atmospheric pressure. Both the methane and the air enters the furnace at 298 K saturated with water vapor, and the flue gas leave the furnace at 1773.15 K. The flue gases then pass through a heat exchanger from which they emerge at 323.15 K. Estimate the heat lost from the furnace and heat transferred to the heat exchanger per mole of methane. The standard heat of combustion of methane at 298 K is -890 J/mol. The heat capacities are given by the following equation:

$$\frac{C_p}{R} = A + B\,T + CT^2 + DT^{-2}$$

The values for A, B and C for ethylene, water and ethanol are given :
<table>
<tr><td>component</td><td>A</td><td>B X 10^3</td><td>C X 10^6</td><td>D X 10^{-5}</td></tr>
<tr><td>CH4</td><td>1.702</td><td>9.081</td><td>-2.164</td><td></td></tr>
<tr><td>CO</td><td>3.376</td><td>0.557</td><td>-</td><td>-0.031</td></tr>
<tr><td>O2</td><td>3.639</td><td>0.506</td><td>-</td><td>-0.227</td></tr>
<tr><td>N2</td><td>3.280</td><td>0.593</td><td>-</td><td>0.040</td></tr>
</table></td><td>20</td><td>CO3</td></tr>
<tr><td>Q 8</td><td>A vapor compression refrigeration system operates using tetrafluoroethane as refrigerant. Given that the evaporation at 272.15 K, and the condensation at 300.15 K, efficiency of compressor equal to 0.79 and refrigeration rate 633 kW. Determine the circulation rate of the refrigerant, the heat transfer rate in the condenser, the power requirement, the coefficient of performance of cycle, and the coefficient of performance of a Carnot refrigeration cycle operating between the same temperature level</td><td>20</td><td>CO5</td></tr>
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