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UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2018

Program: B.Tech CE+RP/B.Tech APE-Gas **Semester – III**
Subject (Course): Chemical Engineering Thermodynamics-I **Max. Marks : 100**
Course Code : CHCE-2002 **Duration : 3 Hrs**
No. of page/s:2

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. Describe the working principle of **Throttling Colorimeter** for measurement of quality of Steam with neat diagram **CO3 [10]**
2. Explain the characteristics and working principle of **Ideal Vapor Compression Refrigeration Cycle** with the help of a neat sketch **CO5 [10]**
3. Air enters adiabatic nozzle steadily at **300 kPa**, **200^{O}C** and **30 m/s** and leaves at **100 kPa** and **180 m/s**. The inlet area of the nozzle is **80 cm^2**. Determine **(a)** the mass flow rate of the nozzle **(b)** the exit temperature of the air and the exit area of the nozzle. **CO2 [10]**
4. Why is the **Carnot cycle** not a realistic model for a steam power plant? Explain **CO3 [10]**
5. Consider a **210-MW** steam power plant that operates on a simple **ideal Rankine cycle**. Steam enters the turbine at **10 MPa** and **500^{O}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
   a. the quality of steam at the turbine exit
   b. the thermal efficiency of the cycle
   c. the mass flow rate of the steam. **CO3 [10]**
6. A household refrigerator is maintained at a temperature of **20^{O}C.** Every time the door is opened, warm material is placed inside, introducing an average of **420 kJ**, but making only a small change in temperature of the refrigerator. The door is opened **20 times a day**, and the refrigerator operates at **15%** of the ideal **COP**. The cost of the work is **Rs.2.50 per kWh**. What is the

monthly bill for this refrigerator? The atmosphere is at **30^{O}C.**

CO2 [10]

Section-B

(Answer any 2 questions)

2 x 20 = 40 Marks

7. Hydrogen is burned with a stoichiometric amount of air during an adiabatic steady-flow **C**ombustion 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 **CO4 [20]**

1. $$H_2 + \frac{1}{2}(O_2 + 3.76\,N_2) \rightarrow H_2O + \frac{1}{2}(3.76)\,N_2$$

Species	$\overline{h}_f^0$ kJ/kmol	$\overline{h}_{298}$ kJ/kmol
H_2	0	-
O_2	0	-
N_2	0	8669
$H_2O(g)$	-241820	9904

8. **Refrigerant-134a** enters a compressor of a refrigerator as superheat vapor at **0.14MPa** and **–10^{O}C** at a rate of **0.12 kg/s**, and leaves at **0.7MPa** and **50^{O}C**. The refrigerant is cooled in the condenser to **24^{O}C** and **0.65MPa** and it is then throttled to **0.15MPa**. Disregarding any heat transfer and pressure drop in the connecting lines between the components, show the cycle on a ***T-s*** diagram with respect to saturation lines and determine
(a) the rate of **heat removal** from the refrigerated space and **power input** to the compressor
(b) the **isentropic efficiency** of the compressor and
(c) the **COP** of the refrigerator **CO5 [20]**

OR

9. A refrigerator uses **R-134a** as the working fluid and operates on an ideal vapor compression refrigeration cycle between **0.12 MPa** and **0.7 MPa.** The mass flow rate of the refrigerant is **0.05 kg/s**. Show the cycle on **T-*s*** diagram with respect to saturation lines. Determine **(a)** the rate

of **heat removal** from the refrigerated space and **power input** to the compressor **(b)** the rate of the **heat rejection (c)** the **COP**. **CO5 [20]**