Printed Pages: 02 **Subject Code: RME-302**

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B TECH
(SEM-III) THEORY EXAMINATION 2018-19
THERMODYNAMICS

Time: 3 Hours ***Total Marks: 70***

Note: Attempt all Sections. If require any missing data; then choose suitably.

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SECTION A

1. Attempt *all* questions in brief. 2 x 7 = 14

a. Differentiate between intensive and extensive properties.
b. What do you mean by Joule-Thompson coefficient and Inversion curve?
c. State Kelvin Planck and Clausius statement of second law of thermodynamics.
d. What is refrigeration and What are the required properties of a refrigerant?
e. What do you mean by available and unavailable energy?
f. What is the difference between the critical point and the triple point?
g. Explain what you understand by thermodynamic equilibrium..

SECTION B

2. Attempt any *three* of the following: 7 x 3 = 21

a) A heat pump is used to meet the heating requirements of a house and maintain it at 20°C. On a day when the outdoor air temperature drops to _2°C, the house is estimated to lose heat at a rate of 80,000 kJ/h. If the heat pump under these conditions has a COP of 2.5, determine (*a*) the power consumed by the heat pump and (*b*) the rate at which heat is absorbed from

b) When a man returns to his well-sealed house on a summer day, he finds that the house is at 32°C. He turns on the air conditioner, which cools the entire house to 20°C in 15 min. If the COP of the air-conditioning system is 2.5, determine the power drawn by the air conditioner. Assume the entire mass within the house is equivalent to 800 kg of air for which c_v = 0.72 kJ/kg °C and c_p = 1.0 kJ/kg °C..

c) Define in pure substance by suitable phase change diagram the term (i) Triple Point (ii) Critical Point (iii) Saturation states (iv) Sub cooled state (v) Superheated vapour state.

d) An insulated rigid tank is divided into two equal parts by a partition. Initially, one part contains 4 kg of an ideal gas at 800 kPa and 50°C, and the other part is evacuated. The partition is now removed, and the gas expands into the entire tank. Determine the final temperature and pressure in the tank.

e) Write down the first and second TdS equations and derive the expression for the difference in heat capacities, C_p and C_v .

SECTION C

3. Attempt any *one* part of the following: 7 x 1 = 7

(a) A piston–cylinder device initially contains 0.4 m^3 of air at 100 kPa and 80°C.The air is now compressed to 0.1 m3 in such a way that the temperature inside the cylinder remains constant. Determine the work done during this process.

(b) Air at 100 kPa and 280 K is compressed steadily to 600 kPa and 400 K. The mass flow rate of the air is 0.02 kg/s, and a heat loss of 16 kJ/kg occurs during the process. Assuming the changes in kinetic and potential energies are negligible, determine the necessary power input to the compressor.

4. Attempt any *one* part of the following: 7 x 1 = 7

(a) The Two Carnot engines work in series between the sources and sink temperatures of 550 K 350 K. If both engines develop equal power, determine the intermediate temperature.

(b) Show that the Kelvin–Planck and the Clausius statement of the second law of thermodynamics are equivalent.

5. Attempt any *one* part of the following: 7 x 1 = 7

(a) In a certain process, a vapour while condensing at 420^0C, transfers heat to water evaporating at 250^0C. The resulting steam is used in power cycle, which rejects heat at 35^0C. What is the fraction of the available energy in the heat transferred from the process vapour at 420^0C that is lost due to the irreversible heat transfer at 250^0C?

(b) State the Clapeyron equation and discuss its importance during phase change of pure substance. Derive the equation for Clausius-Clapeyron equation for evaporation of liquids.

6. Attempt any *one* part of the following: 7 x 1 = 7

(a) Steam at 20 bar and 360^0C is expanded in a steam turbine to 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. (a) Assuming ideal processes, find per Kg of steam the net work and the cycle efficiency. (b) If the turbine and the pump have each 80 % efficiency, find the percentage reduction in the net work and cycle efficiency.

(b) Explain the following processes and show them on psychometric chart:

i. Sensible heating and cooling
ii. Heating and humidification
iii. Cooling and dehumidification

7. Attempt any *one* part of the following: 7 x 1 = 7

(a) Explain the vapour compression cycle with the help of T-s and p-h diagram.

(b) A refrigerator operates on ideal vapour compression cycle between 0.14 MPa and 0.8 MPa. If the mass flow rate of the refrigerant is 0.06 Kg/s, determine: (a) the rate of heat removal from the refrigerated space, (b) the power input to the compressor, (c) the heat rejection rate in the condenser and (d) the COP