Code No: 123AB

R15

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B.Tech II Year I Semester Examinations, March - 2017
THERMODYNAMICS
(Common to AE, AME, ME, MSNT)

Time: 3 Hours **Max. Marks: 75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A.
Part B consists of 5 Units. Answer any one full question from each unit.
Each question carries 10 marks and may have a, b, c as sub questions.

PART – A

(25 Marks)

1.a) What is the difference between a closed system and an open system? [2]
b) What is constant volume gas thermometer? Why is it preferred to a constant pressure gas thermometer? [3]
c) All spontaneous processes are irreversible. Explain. [2]
d) Differentiate reversible and irreversible processes. Entropy remains constant in a reversible adiabatic process. Justify. [3]
e) Explain in brief throttling process and free expansion. How does they differ from each other? [2]
f) Draw P-V diagram for water and a pure substance other than water. Also draw P-T diagram of water. [3]
g) What is mole? State Dalton's law of partial pressure and Avogadro's laws of additive volumes. [2]
h) What is the difference in wet bulb temperature, dew point temperature, and thermodynamic wet bulb temperature? [3]
i) Why P-H diagram is used to represent Vapour compression cycle? Draw P-H diagram of actual vapour compression Cycle. [2]
j) Write the expressions for efficiency in case of Otto, Diesel, Sterling, Atkinson, Ericsson and Lenoir cycle. [3]

Part – B

(50 Marks)

2.a) The resistance of a platinum wire is found to be 11000 ohms at the ice point, 15.247 ohms at the steam point and 28.887 at the sulphur point. Find the constants A and B in the equations.

$$R = R_0\left(1 + At + Bt^2\right)$$

b) What is irreversibility and State the causes of irreversibility.
c) A turbine operates under steady flow conditions, receiving steam at the following state: 1.2 MPa, 180^0c, 2785 kJ/kg, 33.3 m/sec and elevation 3 m. Steam leaves the turbine at the following state: 20 KPa, 2512 kJ/kg, 100 m/sec and elevation 0 m. Heat is lost to the surrounding at the rate of 0.29 kJ/sec. if the rate of steam flow through the turbine is 0.42 kg/sec. what is power output of turbine in kW. [4+2+4]

OR

3.a) A cylinder, A_{cyl} = 7.012cm^2 has two pistons mounted, the upper one, m_{p1}=100kg, initially resting on the stops. The lower piston, m_{p2}=0kg, has 2 kg water below it, with a spring in vacuum connecting he two pistons. The spring force fore is zero when the lower piston stands at the bottom, and when the lower piston hits the stops the volume is 0.3 m^3. The water, initially at 50 kPa, V=0.00206 m^3, is then heated to saturated vapor. i) Find the initial temperature and the pressure that will lift the upper piston. ii) Find the final T, P, v and work done by the water.

b) Nitrogen gas flows into a convergent nozzle at 200 kPa, 400K and very low velocity. It flows out of the nozzle at 100 kPa, 330K. If the nozzle is insulated, find the exit velocity. [5+5]

4.a) If 20 kJ are added to a Carnot cycle at a temperature of 110^{0}c and 14.5 kJ are rejected at 0^{0}C, determine the location of absolute zero on Celsius scale.

b) The amount of entropy generation quantifies the intrinsic irreversibility of a process. Explain.

c) Air flows through an adiabatic compressor at 2 kg/s. the initial conditions are 1 bar and 310 K and the exit conditions are 7 bar and 560 K. Compute the net rate of availability transfer and irreversibility. Take T_0=298 K. [4+2+4]

OR

5.a) We wish to produce refrigeration at -30^0 C. A reservoir is available at 200^0 C and the ambient temperature is 30^{0}C. This, work can be done by a cyclic heat engine operating between the 200^{0}C reservoir and the ambient. This work is used to drive the refrigerator. Determine the ratio of heat transferred from 200^{0}C reservoir to the heat transferred from the -30^0 C reservoir, assuming all process are reversible.

b) Differences in surface water and deep-water temperature can be utilized for power generation. It is proposed to construct a cyclic heat engine that will operate near Hawaii, where the ocean temperature is 20^{0}C near the surface and 5^{0}C at some depth. What is the possible thermal efficiency of such a heat engine? [5+5]

6.a) A cylinder has a thick piston initially held by a pin, the cylinder contains carbon dioxide at 200 KPa and ambient temperature of 290 K. The metal piston has a density of 8000 Kg/m^3 and the atmospheric pressure is 101 KPa. The pin is now removed, allowing the piston to move and after a while the gas returns to ambient temperature. Is the piston against the stops?

b) A closed, partly insulated cylinder divided by an insulated piston contains air in one side and water on the other, there is no insulation on the end containing water. Each volume is initially 100L, with the air at 40°C and the water at 90°C, quality 10 %. Heat is slowly transferred to the water, until a final pressure of 500kPa. Calculate the amount of heat transferred. [5+5]

OR

7.a) Ammonia exists as a saturated mixture at 240.21 kPa and -14.6^{0}C in a rigid vessel with a volume of 1.0 m^3. The specific volumes of saturated liquid and saturated vapour are 1.5195 L/kg and 0.50063 m^3/kg. The quantity of ammonia is 0.275 kg vap/kg. What is total mass of ammonia inside the vessel?

b) A rigid close tank of volume 3 m^3 Contains 5 kg of wet steam at a pressure of 200 kPa. The tank is heated until the steam becomes dry saturated. Determine final pressure and heat transfer to the tank. [5+5]

8.a) A sling psychrometer reads 40^0C DBT and 36^0 C WBT. Find the humidity ratio, Relative humidity, Dew point temperature, specific volume and enthalpy of air.

b) What do you understand by saturated and unsaturated air? State the various properties of air.

c) Derive the Maxwell's equations. [5+2+3]

OR

9.a) On a particular day the weather forecast states that the dry bulb temperature is 37^0C, while the relative humidity is 50% and the barometric pressure is 101.325 kPa. Find the humidity ratio, dew point temperature and enthalpy of moist air on this day.

b) A constant volume chamber of 0.3 m^3 capacity contains 1 kg of air at 5^0C. Heat is transferred to air until the temperature is 100^0C. Find the work done, heat transfer, change in internal energy, enthalpy and entropy. [5+5]

10.a) In a Diesel cycle, the compression ratio is 15. Compression begins at 0.1 Mpa, 40^0C. The heat added is 1.675 MJ/kg. Find (i) the maximum temperature in the cycle, (ii) work done per kg of air (iii) the cycle efficiency (iv) the temperature at the end of the isentropic expansion (v) the cut-off ratio.

b) A Bell-Coleman refrigeration cycle works between 1 bar and 6 bar. The adiabatic efficiency of compression is 90% and expansion is 95%. Find the COP of the system and its tonnage when the air flow rate is 2 kg/sec. The ambient temperature is 25^0C and refrigerator temperature is -5^0C. [5+5]

OR

11.a) A water cooler using R12 refrigerant works between 30^0C to 9^0C. Assuming the volumetric and mechanical efficiency of the compressor to be 80 and 90% respectively, and the mechanical efficiency of motor to be 90% , and 20% of useful cooling is lost into water cooler, find: (i) The power requirement of the motor (ii) Volumetric displacement of the compressor Given C_p (saturated vapour at 30^0C) = 0.7 kJ/kg K.

b) In a Stirling cycle the volume varies between 0.03 and 0.06 m^3, the maximum pressure is 0.2 MPa, and the temperature varies between 540^0C and 270^0C. The working fluid is air (an ideal gas). Find the efficiency and the work done per cycle for both simple cycle and cycle with ideal regenerator. Compare the results with Carnot cycle with same temperature limits. [5+5]

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