Code No: 133BX **R16**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B.Tech II Year I Semester Examinations, November/December - 2017

THERMODYNAMICS

(Common to ME, AE, 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 do you understand by macroscopic and microscopic viewpoints? [2]

b) What do you understand by point function and path function? What are exact and inexact differentials? [3]

c) State and prove the 'Clausis' theorem. [2]

d) What is PMM I? Why it is impossible? [3]

e) Define ideal gas. And show that for ideal gas internal energy depends only on its temperature. [2]

f) Why do the isobars on Mollier diagram diverge from one another? Why do isotherms on Mollier diagram become horizontal in superheated region at low pressures? [3]

g) Draw psychrometric chart and show psychrometric processes in the chart. [2]

h) State Gibb's theorem and write expressions of average specific internal energy, average specific enthalpy and average specific heats of the mixtures. [3]

i) Draw P-V, T-S diagrams of Sterling cycle, Duel cycle and Bell-Coleman cycle. [2]

j) State different types of power cycles. Mention the merits and demerits of Stirling and Ericsson Cycles. [3]

PART-B

(50 Marks)

2.a) Give the differential form of S.F.E.E. Under what condition the S.F.E.E. does reduces to Euler's equation.

b) A reciprocating air compressor takes in 2 m^3/min at 0.11 MPa, 20^0C which is delivers at 1.5 MPa, 111 ^{0}C to an aftercooler where the air is cooled at constant pressure to 25 ^{0}C. The power absorbed by the compressor is 4.15 kW. Determine the heat transfer in compressor and the cooler.

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. [2+4+4]

OR

3.a) A cylinder/ piston contain 100 L of air at 110 kPa, 25^0C. The air is compressed in reversible polytrophic process to a final state of 800 kPa, 200^0C. Assume the heat transfer is with the ambient at 25^0C and determine the polytrophic exponent 'n' and the final volume of air. Find the work done by the air, the heat transfer.

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) Prove that the COP of the reversible refrigerator operating between two given temperatures is the maximum.

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. [2+4+4]

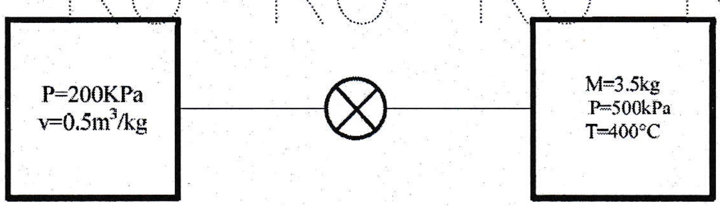
OR

5.a) In a steam power plant 1 MW is added at 700^0C in the boiler , 0.58 MW is taken at out at 40^0C in the condenser, and the pump work is 0.02 MW. Find the plant thermal efficiency. Assuming the same pump work and heat transfer to the boiler is given, how much turbine power could be produced if the plant were running in a Carnot cycle?

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 20^0C near the surface and 5^0C 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 290K. 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) Two tanks are connected as shown in figure, both containing water. Tank A is at 200 Kpa, v=1m^3 and tank B contains 3.5 Kg at 0.5 Mp, 400^0C. The valve is now opened and the two come to a uniform state. Find the specific volume. [5+5]



OR

7.a) Sample of steam from a boiler drum at 3 MPa is put through a throttling calorimeter in which pressure and temperature are found to be 0.1 MPa, 120^0C. Find the quality of a sample taken from the boiler.

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 36^0C 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) An air-water vapour mixture at 0.1 MPa, 30^0C, 80% relative humidity has a volume of 50 m^3. Calculate Specific humidity, Dew point, WBT, mass of dry air and mass of water vapour. [4+2+4]

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) Moist air at 1 atm. pressure has a dry bulb temperature of 32^0C and a wet bulb temperature of 26^0C. Calculate i) the partial pressure of water vapour, ii) humidity ratio, iii) relative humidity, iv) dew point temperature, v) density of dry air in the mixture, vi) density of water vapour in the mixture and vii) enthalpy of moist air using perfect gas law model and psychrometric equations. [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 refrigerator works on the carnet cycle in temperature between -70^0C and 270^0C. It makes 500kg of ice per hour at -50^0C from water at 140^0C. Find H.P required to drive the compressor and C.O.P. of the cycle. Take specific heat of ice as 2.1 kJ/kg-k and latent heat as 336kJ/kg? [5+5]

OR

11.a) An air standard Ericsson cycle has an ideal regenerator. Heat is supplied at 1000^0C and heat is rejected at 20^0C. If the heat added is 600 kJ/kg, find the compressor work, turbine work and cycle efficiency.

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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