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B082312(037)

B. Tech. (Third Semester) Examination, Nov.-Dec. 2020

(AICTE Scheme)

(Mechanical Engg. Branch)

ENGINEERING THERMODYNAMICS

Time Allowed : Three hours

Maximum Marks : 100

Minimum Pass Marks : 35

Note : *Attempt any* ***two*** *parts from each question. Use of steam table and mollier chart is permitted. All questions carry equal marks. Assume any suitable data if missing.*

Unit-I

1. (a) A spherical balloon of 1 m diameter contains a gas at 200 kPa and 300K. The gas inside the balloon is heated untill the pressure reaches 500 kPa. During the process of heating, the pressure of gas inside the balloon is proportional to the diameter of balloon. Calculate the work done by gas inside the balloon. 10

(b) A mass of 8 kg gas expands within a flexible container so that the P-V relationship is of the form $PV^{1.2} = C$. The initial pressure is 1000 kPa and the initial volume is 1 m^3. The final pressure is 5 kPa. If specific internal energy of the gas decreases by 40 kJ/kg, find the heat transfer in magnitude and direction. 10

(c) At the inlet to a certain nozzle, the enthalpy of fluid passing is 3000 kJ/kg and velocity is 60 m/s. At the discharge end, the enthalpy is 2762 kJ/kg. The nozzle is horizontal and there is negligible heat loss from it : 10

(i) Find the velocity at exit from nozzle.

(ii) If inlet area is 0·1 m^2 and specific volume is 0·187 m^3/kg, find mass flow rate.

(iii) If the specific volume at nozzle exit is 0·498 m^3/kg find exit area of the nozzle.

Unit-II

2. (a) State and prove Carnot's Theorem. 10

(b) A household refrigerator is maintained at a

temperature of 2°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 ideal COP. The cost of work is 32 paise per kWh. What is the monthly bill of refrigerator for the month of April? The atmosphere is at 30°C. 10

(c) Two kg of water at 80°C are mixed adiabatically with 3 kg of water at 30°C in a constant pressure process of 1 atm. Find the increase in the entropy the total mass of water due to mixing process. 10

Unit-III

3. (a) Air flows through an adiabatic compressor at 2 kg/s. The inlet conditions are 1 bar and 310K and the exit conditions are 7 bar and 560 K. Compute the net rate of availability transfer and irreversibility. Take $T_0 = 298K$. 10

(b) Discuss the available energy from a finite energy source and derive an expression for the same. 10

(c) One kg of air is contained in a piston cylinder assembly at 10 bar pressure and 500 K temperature. The piston moves outwards and the air expands to 2 bar pressure and 350 K temperature. Make Calculations for.

(i) The availability in initial and final states maximum useful work.

(ii) Irreversibility for the system.

Assume that the system in insulated and environmental conditions are at 1 bar and 290K.

Further for air $R = 0{\cdot}287$ kJ/kgK $C_v = 0{\cdot}718$ kJ kgK, $C_p = 1{\cdot}005$ kJ/kgK. 10

Unit-IV

4. (a) Define reduced parameter (property). State the Vanderwaal's equation in terms of reduced parameter. 10

(b) State and prove Amagat-Leduc law of partial volumes. 10

(c) A mixture of 1 kg oxygen and 2 kg nitrogen occupies

1·2 m^3 volume at temperature 300 K. Assuming perfect gas, determine : 10

(i) Specific volume

(ii) Pressure

(iii) Gas constant

(iv) Molecular mass

Unit-V

5. (a) A closed vessel of 0.2 m^3 capacity contains steam at a pressure of 10 bar and a temperature of 250°C. The vessel is cooled till the pressure of steam in the vessel falls to 3.5 bar. Find.

(i) Final temperature and dryness fraction

(ii) Change in internal energy & heat transfered

Represent the process in P-V and T-S diagram. 10

(b) A closed system containing dry saturated steam undergoes expansion according to the law $PV^n = C$ from an initial pressure of 10 bar to a final pressure of 2 bar. If the steam is finally wet with dryness fraction of 0·85. Find the work done. 10

(c) Steam at 15 bar and 300°C expands isentropical in a steam turbine till the temperature falls to 80°C. Find the condition of steam at the end of expansion process and work done per kg of air. If the steam flow rate is 10 kg/sec, what power will be produced by the turbine? 10