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309301

December, 2019

B.Tech. (ME/MAE/AE) III SEMESTER

Thermodynamics

(PCC-ME-201 ///PCC-AE-201 /// PCC-MAE-201)

Time : 3 Hours] [Max. Marks : 75

Instructions :

1. *It is compulsory to answer all the questions (1.5 marks each) of Part-A in short.*
2. *Answer any four questions from Part-B in detail.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*
4. *Use of steam table and mollier diagram is allowed.*

PART - A

1. (a) Give the thermodynamic definition of work. (1.5) CO1

(b) Differentiate between thermal and thermodynamic equilibrium. (1.5) CO2

(c) The temperature t on a thermometric scale is defined in terms of a property P by the relation, $t = a \log_e P + b$, where a and b are constants. The temperatures of the ice point and the steam point are assigned the numbers 32 and 212 respectively. Experiments give values of P of 1.86 and 6.81 at the ice point and steam point respectively. Evaluate the temperature corresponding to a reading of P = 2.50 on the thermometer. (1.5) CO2

(d) Differentiate between an ideal and a real gas. (1.5) CO3

(e) Draw the phase equilibrium diagram for a pure substance on p-T coordinates. (1.5) CO3

(f) What is a steady flow process? What are the assumptions made in driving the S.F.E.E.? (1.5) CO2

(g) Define COP. How does it differ from thermal efficiency? (1.5) CO4

(h) Show that entropy is a property of the system. (1.5) CO4

(i) Differentiate between I law and II law efficiencies. (1.5) CO4

(j) Show the basic Rankine cycle on a p-V and T-S plots. (1.5) CO1

PART - B

2. (a) Differentiate clearly between heat and work. Show that both are path functions. (7) CO1

(b) A piston cylinder device operates 1 kg of fluid at 20 atm. pressure. The initial volume is 0.04 m^3. The fluid is allowed to expand reversibly following a process $pV^{1.45}$ = constant, so that the volume becomes double. The fluid is then cooled at constant pressure until the piston comes back to its original position. Keeping the piston unaltered, heat is added reversibly to restore it to the initial pressure. Calculate the work done in the cycle. (8) CO2

3. (a) Explain in detail the process of change of phase of water at constant pressure. Show the various stages on a T-H diagram with all the relevant curves. (7) CO3

(b) Steam flows in a pipeline at 1.5 MPa. After expanding to 0.1 MPa in a throttling calorimeter, the temperature is found to be 120ºC. Find the quality of steam in the pipeline. Show the process on h-s plot. (8) CO3

4. Air flows steadily at the rate of 0.4 kg/s trough an air compressor, entering at 6 m/s with a pressure of 1 bar and a specific volume of 0.85 m^3/kg, and leaving at 4.5 m/s with a pressure of 6.9 bar and specific volume of 0.16 m^3/kg. The internal energy of air leaving is 88 kJ/kg greater than that of the air entering. Cooling water in the jacket surrounding the cylinder absorbs heat from the air at the rate of 59 W. Calculate the power required to drive the compressor and the inlet and outlet pipe cross-sectional areas. (15) CO2

5. (a) State and prove the Carnot theorem. (7) CO4

   (b) Three reversible heat engines have the same thermal efficiency and are connected in series. The first engine absorbs 2400 kJ of heat from a thermal reservoir at 1250 K and the third engine rejects its waste of 300 kJ to a sink at 150 K. Determine the work output from each engine. (8) CO4

6. (a) Determine the maximum work obtainable by using one finite body at temperature T and a thermal reservoir at temperature T_0, $T > T_0$. (7) CO4

   (b) What do you understand by 'useful work'? Derive expressions for useful work for a closed system and a steady flow system which interact with the surroundings only. (8) CO4

7. (a) Derive the expression of optimum pressure ratio for maximum net work output in an ideal Brayton cycle. What is the corresponding cycle efficiency? (7) CO1

   (b) Explain the vapour compression refrigeration cycle with the help of p-h and T-s diagrams. Explain the effect of superheat and subcooling on this cycle. (8) CO1
