Code: 13A03302

R13

B.Tech II Year I Semester (R13) Supplementary Examinations June 2015

THERMODYNAMICS

(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

PART – A

(Compulsory Question)

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1 Answer the following: (10 X 02 = 20 Marks)

(a) What is a displacement work?
(b) Differentiate between extensive and intensive properties.
(c) State the first law for closed systems undergoing a change in state.
(d) Give the differential form of steady flow energy equation.
(e) What is a thermal reservoir?
(f) Define available energy.
(g) Examples of pure substances.
(h) What is triple point?
(i) State Dalton's law of partial pressures.
(j) Merits and demerits of stirling cycle.

PART – B

(Answer all five units, 5 X 10 = 50 Marks)

UNIT – I

2 (a) What do you mean by homogenous and heterogeneous systems?

(b) A closed cylinder of 0.25 m diameter is fitted with a light frictionless piston. The piston is retained in position by a catch in the cylinder wall and the volume on one side of the piston contains air at a pressure of 750 kN/m^2. The volume on the cylinder side of the piston is evacuated. A helical spring is mounted coaxially with the cylinder in this evacuated space to give a force of 120 N on the piston in this position. The catch is released and the piston travels along the cylinder until it comes to rest after a stroke of 1.2 m. The piston is the held in its position of maximum travel by a ratchet mechanism. The spring force increases linearly with the piston displacement to a final value of 5 kN. Calculate the work done by the compressed air on the piston.

(OR)

3 (a) Show that heat is path function and not a property.

(b) A steam turbine drives a ship's propeller through an 8:1 reduction gear. The average resisting torque imposed by the water on the propeller is 750 × 10^3 Nm and the shaft power delivered by the turbine to the reduction gear is 15 MW. The turbine speed is 1450 rpm. Determine: (i) the torque developed by the turbine. (ii) the power delivered to the propeller shaft. (iii) the net rate of working of the reduction gear.

UNIT – II

4 (a) Define the specific heats at constant volume and constant pressure.

(b) A gas undergoes a thermodynamic cycle consisting of the following processes:
(i) Process 1-2: constant pressure (P) = 1.4 bar, V_1 = 0.028 m^3, W_{12} = 10.5 kJ.
(ii) Process 2-3: compression with pV = constant, $U_3 = U_2$
(iii) Process 3-1: constant volume, U_1-U_3 = -26.4 kJ
There are no significant changes in KE and PE.
Determine: (i) Sketch the cycle on a p–V diagram.
(ii) Calculate the net work for the cycle in kJ.
(iiii) Calculate the heat transfer for process 1–2.

(OR)

5 In water cooling tower air enters at a height of 1 m above the ground level and leaves at a height of 7 m. The inlet and outlet velocities are 20 m/s and 30 m/s respectively. Water enters at a height of 8 m and leaves at a height of 0.8 m. The velocity of water at entry and exit are 3 m/s and 1 m/s respectively. Water temperatures are 80℃ and 50℃ at the entry and exit respectively. Air temperatures are 30℃ and 70℃ at the entry and exit respectively. The cooling tower is well insulated and a fan of 2.25 kW drives the air through the cooler. Find the amount of air per second required for 1 kg/s of water flow.

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UNIT – III

6 (a) Establish the equivalence of Kelvin-Planck and Clausius statements.

(b) Show that the efficiency of a reversible engine operating between the same temperature levels is the same.

(OR)

7 (a) How is entropy change of a reversible process estimated? Will it be different for an irreversible process between the same end states?

(b) Show that there is decrease in available energy when heat is transferred through a finite temperature difference.

UNIT – IV

8 (a) A rigid vessel of volume 0.86 m^3 contains 1 kg of steam at a pressure of 2 bar. Evaluate the specific volume, temperature, dryness fraction, internal energy, enthalpy and entropy of steam.

(b) The steam is heated to raise its temperature to 150°C. Show the process on a sketch of the p-V diagram and evaluate the pressure, increase in enthalpy, increase in internal energy, increase in entropy of steam and the heat transfer. Evaluate also the pressure at which the steam becomes dry saturated.

(OR)

9 (a) Write down the first and second Tds equations and derive the expression for the difference of heat capacities, C_P and C_V. What does the expression signify?

(b) Why does the maximum temperature drop occur if the state before throttling lies on the inversion curve?

UNIT – V

10 (a) Derive the equations used for computing the entropy change of an ideal gas.

(b) 0.1 m^3 of hydrogen initially at 1.2 MPa, 200°C undergoes a reversible isothermal expansion to 0.1 MPa. Find: (i) the work done during the process. (ii) the heat transferred. (iii) the entropy change of the gas.

(OR)

11 (a) State the four processes that constitute the diesel cycle.

(b) An Ericsson cycle operating with an ideal regenerative works between 1100 K and 288 K. The pressure at the beginning of isothermal compression is 1.013 bar. Determine: (i) the compressor and turbine work per kg of air. (ii) the cycle efficiency.

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