Code: 13A03302

R13

B.Tech II Year I Semester (R13) Regular Examinations December 2014

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) Define Zeroth law.
(b) What is a thermodynamic system?
(c) Contribution of Joule in establishing the first law
(d) Define steady flow process.
(e) What is a reversed heat engine?
(f) State Cluasius statement of second law.
(g) What are saturation states?
(h) What is normal boiling point?
(i) State Avogadro's law.
(j) Give two examples of cyclic and non-cyclic heat engines.

PART – B

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

UNIT - I

2 (a) Explain quasi – static process? What is its characteristic feature?

(b) A single-cylinder, single-acting, 4 stroke engine of 0.15 m bore develops an indicated power of 4 kW when running at 216 rpm. Calculate the area of the indicator diagram that would be obtained with an indicator having a spring constant of 25×10^6 N/m^3. The length of the indicator diagram is 0.1 times the length of the stroke of the engine.

OR

3 (a) What is thermodynamic equilibrium?

(b) At the beginning of the compression stroke of a two-cylinder internal combustion engine the air is at a pressure of 101.325 kPa. Compression reduces the volume to 1/5 of its original volume, and the law of compression is given by $pv^{1.2}$ = constant. If the bore and stroke of each cylinder is 0.15 m and 0.25 m, respectively, determine the power absorbed in kW by compression strokes when the engine speed is such that each cylinder undergoes 500 compression strokes per minute.

UNIT - II

4 (a) Define internal energy. How is energy stored in molecules and atoms?

(b) A gas of mass 1.5 kg undergoes a quasi-static expansion which follows a relationship p = a + bV, where a and b are constants. The initial and final pressures are 1000 kPa and 200 kPa respectively and the corresponding volumes are 0.20 m^3 and 1.20 m^3. The specific internal energy of the gas is given by the relation:

$$u = l.5\ pv - 85 \text{ kJ/kg}.$$

Where P is the kPa and V is in m^3/kg. Calculate the net heat transfer and the maximum internal energy of the gas attained during expansion.

OR

5 Air at a temperature of 15^{0}C passes through a heat exchanger at a velocity of 30 m/s where its temperature is raised to 800^{0}C. It then enters a turbine with the same velocity of 30 m/s and expands until the temperature falls to 650^{0}C. On leaving the turbine, the air is taken at a velocity of 60 m/s to a nozzle where it expands until the temperature falls to 500^{0}C. If the air flow rate is 2 kg/s, calculate:

(a) The rate of heat transfer to the air in the heat exchanger.
(b) The power output from the turbine assuming no heat loss.
(c) Velocity at exit from the nozzle, assuming no heat loss. Assume the data if any.

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UNIT - III

6 (a) All spontaneous processes are irreversible. Explain.
(b) What is absolute thermodynamic temperature scale?
(c) Show that the COP of heat pump is greater than COP of refrigerator by unity?

OR

7 (a) Explain the principle of entropy.
(b) Why energy of a fluid at high temperature is more than that at lower temperature? Explain with an example.

UNIT – IV

8 A mass of wet steam at temperature 165°C is expanded at constant quality 0.8 to pressure 3 bar. It is then heated at constant pressure to a degree of superheat of 66.5°C. Find the enthalpy and entropy changes during expansion and during heating. Draw the T–s and h–s diagrams.

OR

9 (a) Derive Maxwell's equations.
(b) Explain the Joule-Kelvin effect. What is inversion temperature?

UNIT – V

10 A mixture of ideal gases consists of 3 kg of nitrogen and 5 kg of carbon dioxide and at a pressure of 300 KPa and temperature of 20^0C. Find (i) the mole fraction of each constituent, (ii) the equivalent molecular weight of the mixture, (iii) the equivalent gas constant of the mixture, (iv) the partial pressures and partial volumes, (v) the volume and density of mixture, and (vi) the C_p and C_v of the mixture. If the mixture is heated at constant volume to 40^0C, find the changes in internal energy, enthalpy and entropy of the mixture. If heating is done at constant pressure, calculate the changes in internal energy, enthalpy and entropy of the mixture. Take γ for CO_2 and N_2 to be 1.286 and 1.4 respectively.

OR

11 (a) An air standard dual cycle has a compression ratio of 16, and compression begins at 1 bar, 50^0C. The maximum pressure is 70 bar. The heat transferred to air at constant pressure is equal to that at constant volume. Estimate (i) the pressures and temperatures at critical points of the cycle, (ii) the cycle efficiency, (iii) the m.e.p of the cycle.
(b) Derive an expression for the efficiency of Otto cycle.

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