BACHELOR OF ENGINEERING (CIVIL ENGINEERING) FIRST YEAR FIRST SEMESTER
SUPPLEMENTARY EXAM 2018

THERMODYNAMICS AND HEAT POWER

Time:-Three Hours Full Marks:-100

Answer any five questions

All parts of the same question must be answered together
Data, consistent with the problem may be assumed if necessary

1. Answer the following questions (***any four***):
a) Define the terms: Phase, reversible cycle.
b) State and explain 1st law of thermodynamics.
c) Show that the enthalpy of a fluid before throttling is equal to that after throttling.
d) What is a heat engine? How does it differ from a heat pump?
e) What do you mean by clearance and stroke volumes of an IC engine? 20

2 a) Find out an expression of displacement work for a polytropic process (pV^n=*constant*). 8
c) A mass of 8 kg gas expands within a flexible container so that the p-v relationship is of the form $pv^{1.2}$=*const*. The initial pressure is 1000kPa and the initial volume is 1 m^3. The final pressure is 5 kPa. If specific internal energy of the gas increases by 40kJ/kg, find the heat transfer in magnitude and direction. 12

3 a) Prove that internal energy is a property of a system. 6
b) A gas of mass 1.5kg undergoes a reversible 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 $u = (1.5pv - 85)$ kJ/kg, where p is in kPa and v is in m^3/kg. Calculate the net heat transfer and the maximum internal energy of the gas attained during expansion. 14

4 a) Derive an expression of the velocity of a fluid leaving a nozzle. 5
b) In a steady flow apparatus, 135KJ of work is done by each Kg of fluid. The specific volume of the fluid, pressure, and velocity at the inlet are 0.37 m^3/Kg, 600KPa, and 16 m/s. The inlet is 32m above the floor and the discharge pipe is at floor level. The discharge conditions are 0.62 m^3/Kg, 100KPa, and 270 m/s. The total heat loss between the inlet and discharge is 9KJ/Kg of fluid. In flowing through this apparatus, does the specific internal energy increase or decrease and by how much? 15

5 a) A reversible power cycle is used to drive a reversible heat pump cycle. The power cycle takes in Q_1 heat units at T_1 and rejects Q_2 at T_2. The heat pump abstracts Q_4 from the sink at T_4 and discharges Q_3 at T_3. Develop the expression $Q_4/Q_1 = T_4(T_1 - T_2)/T_1(T_3 - T_4)$ 15

b) State statements of the second law of thermodynamics. 5

6. a) Differentiate between 4-stroke and 2-stroke engines. 10

c) A four-stroke engine delivers 40 kW with a mechanical efficiency of 85%.The fuel consumption of the engine is 0.5 kg/kW-hr and the air-fuel ratio is 14:1.The heating value of the fuel is 42 MJ/kg. Find (a) the indicated power,(b) the friction power, (c) the brake thermal efficiency, and (d) the fuel consumption per hour. 10

7. Write short notes on the following (***any four***):

a) Heat pump, b) Bore and stroke, c) Intensive property, d) Fusible plug, e) PMM2 f) Air standard cycle. 20