B.E. (CIVIL ENGINEERING) 1st YEAR 1st SEMESTER EXAMINATION, 2019

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***): 20

a) Define and classify thermodynamic property.

b) Define the following terms: Phase, thermodynamic cycle.

c) Prove that stored energy of an isolated system is constant.

d) What do you mean by a steady flow system?

e) What do you mean by *TDC, stroke, swept volume* and *compression ratio* of an IC engine?

2 a) Establish the mathematical expression of displacement work for a reversible process. 8

b) A gas in a piston-cylinder assembly undergoes an expansion process for which the relationship between pressure and volume is given by $pV^n=constant$. The initial pressure is 0.3 MPa, the initial volume is $0.1m^3$ and the final volume is $0.2m^3$. Determine the work for the process in kJ if (i) $n=1.4$, (ii) $n=1.0$, (iii) $n=0.0$. 12

3. a) 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

b) Prove that enthalpy of an ideal gas depends on temperature only. 8

4. a) Define and classify thermal energy reservoir. 6

b) A reversible power cycle is used to drive a reversible heat pump cycle. The power cycle takes 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. Prove that $Q_4/Q_1=T_4(T_1-T_2)/T_1(T_3-T_4)$. 14

5. a) Derive an expression of work done for a feed pump. 5

b) In a gas turbine unit, the gases flow through the turbine is 15 kg/s and the power developed by the turbine is 12MW. The enthalpies of gases at the inlet and outlet are 1260 kJ/kg and 400 kJ/kg respectively. The velocity of gases at the inlet and outlet are 50 m/s and 110 m/s respectively. Calculate: (i) The rate at which heat is rejected to the turbine, (ii) the area of the inlet pipe given that the specific volume of the gases at the inlet is 0.45 m^3/kg. 15

6. a) Differentiate between 2-stroke and 4-stroke engines. 8

b) A four stroke SI engine at full load delivers 50 kW. It requires 8.5 kW to rotate it without load at the same speed. Find its mechanical efficiency at full load, half load and quarter load. Also find out the volume of the fuel consumed per second at full load if the brake thermal efficiency is 25%, given that calorific value of the fuel is 42 MJ/kg and specific gravity of fuel 0.75. Estimate the indicated thermal efficiency. 12

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

a) Heat engine, b) Carnot cycle, c) Entropy, d) Refrigerator and heat pump, e) Reversible process f) Brake specific fuel consumption. 20