Registration No. : | | | | | | | | | | |

Total number of printed pages – 3

B. Tech

BE 2103

First Semester Regular Examination – 2014

THERMODYNAMICS

BRANCH : B. TECH

QUESTION CODE : H 457

Full Marks – 70

Time : 3 Hours

*Answer Question No. **1** which is compulsory and any **five** from the rest.*

The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2 ×10

   (a) What do you mean by Quasi-static process ?

   (b) What is the difference between universal gas constant and characteristic gas constant ?

   (c) What is thermocouple ? On what principle, thermocouple works ?

   (d) Show that work is a path function, not a property.

   (e) Find the enthalpy, entropy at 1.4 Mpa, 400°C.

   (f) Draw the p-v and T-s diagram for a reversed carnot cycle.

   (g) Convert 40 cm Hg vacuum pressure into pressure in kPa format.

   (h) What is COP ? Relate COP of refrigerator with that of heat pump.

   (i) Name four mountings used in steam power plant.

   (j) Draw constant pressure process and constant volume process on same T-s diagram.

2. (a) Show that energy is a property of a system. 4

   (b) A fluid at 0.7 bar occupying $0.09m^3$ is compressed reversibly to a presseure of 3.5 bar according to a pv^n = constant. The fluid is then heated reversibly

at constant volume until the pressure is 4 bar, the specific volume is then 0.5 m^3/kg. A reversible expansion according to a law pV^2=constant, restores the fluid to its initial state. Sketch the cycle on p-V diagram and calculate

(i) the mass of the fluid present

(ii) the value of "n" in the first process

iii) the net work of the cycle. 6

3. (a) What do you mean by an Adiabatic process ? Derive the p-V relation for adiabatic process, i.e. pv^k=constant where, adiabatic index, $k = c_p/c_v$ 5

(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 0.20m^3 and 1.20m^3. the specific internal energy of the gas is given by the relation u=1.5pv-85 kJ/kg where p is kPa and v is in m^3/kg. Calculate the net heat transfer and the maximum internal energy of the gas attained during expansion. 5

4. (a) Write down the mass conservation equation and steady flow energy equation single stream entering and single stream leaving open system having 4

(b) A turbine operating under steady flow conditions receives steam at the following state: Pressure =13 bar, specific volume = 0.13 m^3/kg, Specific internal energy = 2300 kJ/kg, Velocity = 30 m/s. The state of the steam leaving the turbine is as follows: Pressure=0.3 bar, Specific volume = 4.3m^3/kg, specific internal energy = 1500 kJ/kg, Velocity = 90 m/s. Heat rejected to the surrounding at the rate of 0.25 kW and the rate of steam flow through turbine is 0.4 kg/s. Calculate the power developed by the turbine. 6

5. (a) Establish the equivalence of Kelvin-Planck and Clausius statements. 4

(b) A heat pump is to be used to heat a house in winter and then reversed to cool the house in summer. The interior temperature is to be maintained at 20°C. Heat transfer through the walls and roof is estimated to be 500 J/s per degree temperature difference between the inside and outside.

(i) if the outside temperature in winter is 5°C what is the minimum power required to drive the heat pump?

(ii) What is the maximum outer temperature for which the inside can be maintained at 20°C. 6

6. (a) What do you mean by entropy principle? State Clausius theorem. 4

(b) 0.5 kg of air is compressed at constant volume from 0.5MPa, $0.2m^3$, 100°C to $0.05m^3$, 160°C. Detrmine the change in internal energy, change in enthalpy and change in entropy. 6

7. (a) Draw h-s diagram for water and indicate the following on the same 4

(i) saturated liquid line

(ii) saturated vapor line

(iii) critical point

(iv) constant pressure line

(v) constant temperature line

(vi) constant quality line

(b) A rigid tank of volume $3m^3$ contains 5 kg of wet steam at a pressure of 200 kPa. The tank is heated until the steam becomes dry saturated. Determine the final pressure, the heat transfer to the tank and entropy change. 6

8. Write short notes on any two : 5×2

(a) Spark ignition engine and Compression ignition engine

(b) Reciprocating type air compressor and centrifugal type air compressor

(c) Refrigerator and heat pump.