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

Total number of printed pages – 4

B. Tech
BE 2103

Second Semester Examination – 2013

THERMODYNAMICS

QUESTION CODE : A 440

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) Convert 50 cm Hg vacuum in to absolute pressure in kPa, when the atmospheric pressure is 100 kPa.

   (b) Out of the following pick intensive and extensive properties :

   (i) Volume

   (ii) Density

   (iii) Pressure

   (iv) Specific enthalpy

   (c) Name four types of thermometers used for measuring temperatures.

   (d) Differentiate between Universal gas constant and Characteristic gas constant.

   (e) On a same P-V diagram, draw the adiabatic and isothermal expansion process.

   (f) Out of the following pick point functions and path functions :

   (i) Heat

   (ii) Volume

   (iii) Pressure

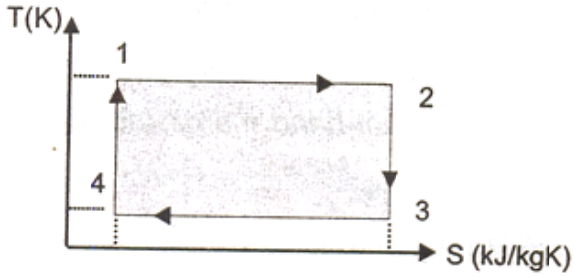
   (iv) Entropy

P.T.O.

(g) What is throttling device. Write the SFEE for this.

(h) An inventor claims to have developed and engine that takes in 105 MJ at a temperature of 400 K, rejects 42 MJ at a temperature of 200 K, and delivers 15 kWh of mechanical work. Would you advise investing money to put this engine in the market?

(i) For the Carnot cycle given below, $T_1 = 400$ K, $T_4 = 200$ K, $s_1 = 0.2$ kJ/kgK, $s_2 = 0.4$ kJ/kgK. Find the net work done and heat rejected.



(j) Saturated steam has an entropy of steam of 6.76 kJ/kgK. What are its pressure, temperature, specific volume and enthalpy ?

2. (a) State the first law of thermodynamics (for process and cycles) and second law of thermodynamics (K-P and Clausius). 4

(b) A fluid undergoes a reversible expansion process from 3 Mpa, 0.05 m^3 to 0.5 Mpa, 0.2 m^3 according to the law, $pv^{1.4}$ = constant. Determine the change in enthalpy, internal energy and entropy, heat transfer and work transfer during the process. 6

3. (a) What do you mean by flow work ? How is it different from pdv work ? 4

(b) At the inlet to a certain nozzle, the enthalpy of the fluid passing is 3000 kJ/kg and the velocity is 60 m/s. At the discharge end, the velocity, the enthalpy is 2762 kJ/kg. The nozzle is horizontal and there is negligible heat loss from it.

(i) Find the velocity at the exit of the nozzle

(ii) If the inlet area is 0.1 m^2 and the specific volume at inlet is 0.187 m^3/kg, find the mass flow rate

(iii) If the specific volume at the nozzle exit is 0.498 m^3/kg, find the exit area of the nozzle. 6

4. A reversible heat engine operates between two reservoirs at temperatures of 840° C and 60° C. The engine drives a reversible heat pump which operates between reservoirs at temperatures of 60° C and 5° C. The reversible engine also drives a machine that absorbs 30 kW. If the pump extracts 17 kW from 5° C reservoir. Determine

(i) the rate of heat supply from 840° C source.

(ii) the rate heat rejection to the 60° C sink.

Reconsider (i) and (ii) given that the efficiency of the heat engine and the COP of the refrigerator are each 40% of their maximum possible values. 10

5. (a) Derive the work done during a polytropic expansion process. 5

(b) A piston-cylinder device with air at an initial temperature of 30° C undergoes an expansion process for which pressure and volume are given as, State point 1 : 100 kPa, 0.1 m^3, State point 2 : 37.9 kPa, 0.2 m^3. Calculate the temperature at state point 2 and heat transfer. 5

6. (a) Draw the phase equilibrium diagram for a pure substance(water-steam) on T-s and h-s plot with relevant constant property lines. 4

(b) Steam initially at 1.5 MPa, 300°C expands reversibly and adiabatically in a steam turbine to 40° C. Determine the ideal work output of the turbine per kg of steam. 6

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

(b) A gas undergoes a thermodynamic cycle consisting of the following processes : 6

(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 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.

(a) Sketch the cycle on P-V plot

(b) Calculate the net work done in cycle

(c) Calculate the heat transfer Q_{12}.

8. Explain with a neat sketch, the components and working principle of a domestic refrigerator. How is it different from heat pump ? 10