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

Total number of printed pages – 4

B. Tech
BE 2103

Second Semester Regular Examination – 2015

THERMODYNAMICS

BRANCH (S) : AEIE, AERO, AUTO, BIOMED, BIOTECH, CHEM, CIVIL, CSE, EC, EEE, EIE, ELECTRICAL, ETC, IT, MINERAL, MINING, MME, TEXTILE

QUESTION CODE : J 405

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) Differentiate between an open system and a control volume.

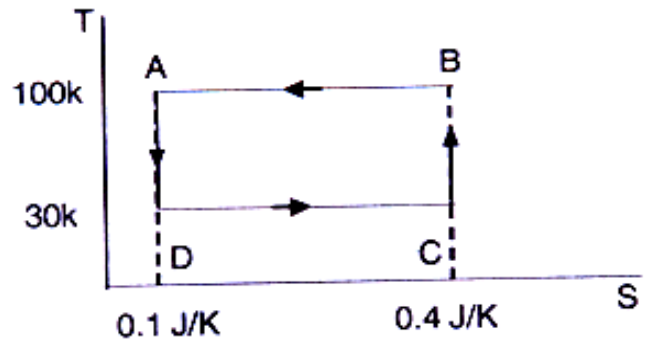
(b) Express the absolute pressure unit in bar when gauge reads 400 mm Hg vacuum and barometer reads760 mm of Hg.

(c) What is Zeroth law of thermodynamics?

(d) Explain free expansion.

(e) Differentiate macroscopic and microscopic forms of stored energy in a system when we consider 1st law of Thermodynamics.

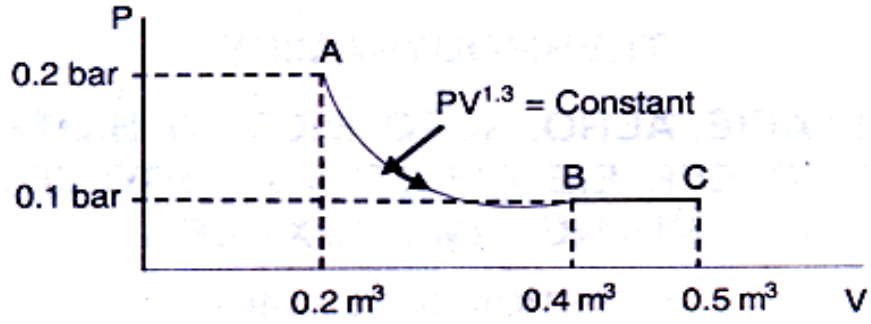
(f) Determine COP of the carnot refrigerator having T-s plot as given below :



P.T.O.

(g) A system undergoes a change of state from 100 kPa pressure, 0.1 m^3 volume to 40 kPa pressure, 0.2 m^3 volume. Determine expansion index 'n'.

(h) Find the work done for the process, A-B-C, as shown in the figure below :



(i) Differentiate between Gas constant and Characteristic gas constant in ideal gas calculations.

(j) Differentiate between 1st law of thermodynamics and 2nd law of thermodynamics.

2. (a) Draw the constructional details and explain working principle of Heat pump. 5

(b) With schematic layout, Describe working principle of a steam power plant. Explain various parts in it. 5

3. (a) Obtain formula derivation of specific volume of wet steam using first principle. 3.5

(b) Water at 40°C is continuously sprayed into a pipeline carrying 5000 kg of steam at 5 bar, 300°C per hour. At a section downstream where the pressure is 3 bar, the quality is to be 95%. Find the rate of water spray in kg/h. 6.5

4. (a) Water is heated at a constant pressure of 0.7 MPa. The boiling point is 164.97°C. The initial temperature of water is 0°C. The latent heat of evaporation is 2066.3 kJ/kg. Find increase of entropy of water, if the final state is dry steam. 3.5

(b) A mass of 0.25 kg of an ideal gas has a pressure of 300 kPa, a temperature of 80°C, and a volume of 0.07m^3. The gas undergoes an irreversible adiabatic process to a final pressure of 300 kPa and a final volume of 0.10 m^3, during which the workdone on the gas is 25 kJ. Evaluate the c_p,c_v of the gas and increase in entropy of the gas. 6.5

5. (a) Which is the more effective way to increase the efficiency of a Carnot engine : To increase T_{hot} keeping T_{cold} constant ; or to decrease T_{cold}, keeping T_{hot} constant ? Explain Mathematically and graphically. 4+2

(b) Two reversible heat engines A and B are connected in series. A rejecting heat directly to B. Engine A receives Q_a at a temperature of T_a from a hot source while engine B is in communication with a cold sink at T_c. 4

(i) If the work output of A is sameas that of B, find the intermediate temperature between A and B

(ii) if the efficiency of each engine are same, find the intermediate temperature between A and B.

6. (a) Write down the mass conservation equation and steady flow energy equation for an open system. Explain various terms in it. 4

(b) The stream of air and gasoline vapor in the ratio of 14 : 1 by mass, enters a gasoline engine at a temperature of 30°C and leaves as a combustion products at a temperature of 790°C. The engine has a specific fuel consumption of 0.3 kg/kWh. The net heat transfer rate from the fuel-air. stream to the jacket cooling water and to the surroundings is 35 kW. The shaft power delivered by the engine is 26 kW. Compute the increase in the specific enthalpy of the fuel-air stream, assuming kinetic energy and in elevation to be negligible. 6

7. (a) Define enthalpy. Show that change in enthalpy is same as heat transfer at constant pressure. 1+3

(b) A stationary fluid system goes through a cycle consisting of three processes beginning at an initial state where P_1=1 bar, V_1 = 1.5 m^3 and U_1 = 512 kJ. The processes are as follows : 6

(i) process 1-2 : Compression with PV=constant to P_2=2bar, U_2=690 kJ

(ii) Process 2-3 : W_{23} =0, Q_{23} = −150 kJ and

(iii) Process 3-1: W_{31}=50kJ. Neglecting KE and PE changes, determine the heat interactions Q_{12} and Q_{31}.

Draw the cycle on P-V plot.

8. Write short notes on any **two** of the following : 5 ×2

(a) Clausius' Theorem and Clausius inequality

(b) P-v and T-s diagram of pure substance (water-steam)

(c) Work transfer and heat transfer in a ploytropic process.