Roll No. ..... Total Pages : 04

BT-3/D-19 33156

THERMODYNAMICS

MEC-205A

Time : Three Hours] [Maximum Marks : 75

Note : All questions in Part A and B are compulsory. Attempt any *four* questions from Part C selecting at least *one* from each Unit.

Part A

1. Answer the following questions :
   (i) Explain Zeroth law of thermodynamics. 3
   (ii) State the importance of Helmholtz and Gibbs function. 3
   (iii) What is principle of entropy increase ? Explain. 3
   (iv) Define thermodynamic relations and their importance. 3
   (v) Discuss the thermodynamic temperature scale. 3

Part B

Unit I

2. Derive the expression for adiabatic work of in non-flow process. 5

Unit II

3. Explain Carnot theorem and its corollaries. 5

Unit III

4. Define availability and derive an expression for availability of steady flow system. 5

Unit IV

5. What is Throttling ? How throttling device is used for measurement of dryness fraction ? 5

Part C 10×4=40

Unit I

6. 0.09 m^3 of a fluid at 0.7 bar are compressed reversibly to a pressure of 3.5 bar according to a law $PV^n = c$. The fluid is then heated reversibly at constant volume until the pressure is 4 bars and the specific volume is then 0.5 m^3/kg.
   A reversible expansion acc. to a law $PV^2 = c$ restores the fluid to its initial state. Calculate the mass of fluid present, the value of 'n' in the first process and the network done on or by the fluid in the cycle. Sketch the cycle on a P-V diagram. 10

7. Define Polytropic Law. Derive an expression for polytropic heat, polytropic specific heat and polytropic index. 10

Unit II

8. A heat engine working on Carnot cycle absorbs heat from three thermal reservoirs at 1000 K, 800 K and 600 K. The engine does 10 kW of net-work and rejects 400 kJ/min of heat to a heat sink at 300 K. If the heat supplied by the reservoir at 1000 K is 60% of the heat supplied by the reservoir at 600 K, make calculations for the quantity of the heat absorbed by each reservoir. **10**

9. One kg of ice at −10°C is exposed to the atmosphere which is at 30°C. The ice melts and comes into thermal equilibrium with with the atmosphere. (a) Determine the entropy increase of the universe. (b) What is the minimum amount of work necessary to convert the water back into ice at −10°C ? C*p* of ice is 2.093 kJ/kg K and the latent heat of fusion of ice is 333.3 kJ/kg and C*p* of water is 4.2 kJ/kg K. http://www.kuonline.in **10**

Unit III

10. A mass of 0.25 kg of air in a closed system expands from 2 bar and 60°C to 1 bar and 40°C, while receiving 1.05 kJ of heat from a reservoir at 100°C. The surroundings atmosphere is at 0.95 bar and 27°C. Determine the maximum work. How much of this work would be done on the atmosphere ? **10**

11. The expansion of superheated steam at 4 MPa and 350°C takes place to 0.35 MPa by a polytropic law where pressure and volume are related by the expansion $pv^{1.3}$ = constant. Make calculations for the work done, change in internal energy and heat transfer. **10**

Unit IV

12. Derive an expression for air standard efficiency and mean effective pressure of Otto cycle. State the assumptions made. **10**

13. Derive the first and second T ds equations and set up the expression for the difference in heat capacities *cp* and *cv*. State the significance of the expression. **10**