Code No. : 5180

FACULTY OF ENGINEERING
B.E. 2/4 (M/P/AE) II Semester (Suppl.) Examination, January 2012
THERMODYNAMICS

Time: 3 Hours] [Max. Marks: 75

***Note** : 1) Answer **all** the questions from Part – **A** and answer **any five** questions from Part – **B**.*
*2) **Use** of steam tables and Mollier diagram is **permitted**.*
*3) Assume **any** missing data **suitably**.*

PART – A **(10×2$^1/_2$=25 Marks)**

1. What is the application of Zero'th law of thermodynamics ?
2. What is the working principle of constant pressure ideal gas thermometer ?
3. Is it correct to say for one kg of system undergoing an isobaric process, the change in specific internal energy is equal to $C_p(\Delta T)$? Justify your answer.
4. Helium gas is escaping from a large reservoir through an attached nozzle. The inside temperature is 90°C and outside temperature is 40°C. What is the velocity of gas at the exit of nozzle.
5. State the Clausius inequality.
6. What is the significance of availability function for a non flow process ?
7. For steam as pure substance, what does critical point state mean ?
8. Write down the Clapeyron equation and state its application.
9. What are the advantages of gaseous fuels over liquid fuels ?
10. Which process of Carnot cycle is modified to get Rankine cycle ?

PART – B **(5×10=50 Marks)**

11. a) Explain the working principle of ideal gas thermometer of constant pressure type. 5
    b) Differentiate between macroscopic and microscopic approaches of thermodynamics. 5

(This paper contains 3 pages)

P.T.O.

12. **Process 1** : Air initially at 100 kPa and 50°C undergoes reversible adiabatic compression such that its volume is reduced to 20% of its initial volume :

Process 2 : Then 940 kJ/kg of heat is added to this air at constant volume.

Process 3 : Process 2 is followed by reversible adiabatic expansion up to initial volume.

Process 4 : Finally heat is rejected at constant volume so as to reach the initial condition.

Draw the four processes on one PV diagram. Determine the maximum temperature, and heat rejected per kg of air. Assume adiabatic index of compression and expansion of 1.4 and constant volume specific heat as 0.717 kJ/kg°K. **10**

13. a) Derive the expressions for entropy change during isothermal and polytropic processes. **5**

b) A reversible engine working is supplied with 5,000 kJ/min of heat from a source at 800°K whilw it develops 25 kW of power. The engine rejects heat to two reservoirs at 300°K and 370°K. Determine the efficiency of the engine and heat rejected to each reservoir in kJ/min. **5**

14. a) One kg of steam at a pressure of 8 bar and dryness 0.8 is expanded hyperbolically in a cylinder to a pressure of 0.5 bar. Determine the final condition of steam and the heat transfer across the cylinder walls. **5**

b) Derive expression for dryness fraction for water as a pure substance. Also obtain relations for estimating enthalpy and entropy values for a two phase liquid vapor in terms of saturation properties. **5**

15. a) In a bomb calorimeter test, the following observations were recorded :
Weight of coal tested = 2 gm
Weight of water in the calorimeter = 1.2 kg
Water equivalent of the calorimeter = 0.8 kg
Rise in temperature of jacket water = 8.125°C.
If the coal contains 2% moisture by weight, the room temperature is 20°C and 1 kg moisture at 0°C requires 2466 kJ to evaporate to form dry and saturated steam, calculate HCV and LCV of the coal.. **6**

b) Represent Stirling cycle on T-s diagram and explain the various process of the cycle. **4**

16. Certain gas at a pressure of 1.4 MN/m^2 and 360°C is expanded adiabatically to a pressure of 100 kN/m^2. The gas is then heated at constant volume until it attains 300°C when the pressure is found to be 220 kN/m^2 and finally it is compressed isothermally to the original pressure of 1.4 MN/m^2. Sketch the process on P-V and T-s diagrams. For 0.23 kg of gas, evaluate.

   i) Change in internal energy during adiabatic expansion.

   ii) Change in entropy for each process.

   Assume : $C_v = 0.705$ kJ/kg K. **10**

17. a) Helium gas is expanded polytropically in a turbine, from 4 bar, 300°C to 1 bar such that final volume is 2.5 times the volume at inlet. Velocity of gas at exit is 50 m/s. What is the mass flow rate of gas required to produce 1 MW turbine output ? How much is the heat transfer during the process ? Also determine exit area of turbine. Assume specific heat of Helium = 5.193 kJ/kg°K at constant pressure. **5**

    b) A reversible engine working in a cycle takes 4800 kJ of heat from a source at 800°K per minute and develops 20 kW power. The engine rejects heat to two reservoirs at 300°K and 360°K. Determine the heat rejected to each sink in kJ/min. **5**
