Hall Ticket No | | | | | | | | | | Course Code: AMEC06

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

B.Tech III SEMESTER END EXAMINATIONS (REGULAR / SUPPLEMENTARY) - FEBRUARY 2023

Regulation: UG20

THERMODYNAMICS

Time: 3 Hours **(MECHANICAL ENGINEERING)** **Max Marks: 70**

Answer ALL questions in Module I and II
Answer ONE out of two questions in Modules III, IV and V
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

MODULE – I

1. (a) What is work transfer and heat transfer? Represent both work and heat transfer in quasi-static process on p-v and T-s coordinates. [BL: Understand| CO: 1|Marks: 7]

   (b) In a gas turbine, the gases flow through the turbine at 17 kg/sec and the power developed by the turbine is 14000 kW. The specific enthalpies, of the gases at inlet and outlet are 1200 KJ/Kg and 3600 KJ/Kg, respectively. The velocities of the gases at inlet and outlet are 60m/s and 50 m/s respectively. Calculate the rate at which heat is rejected from the turbine. Also, find the area of inlet pipe given that the specific volume of the gases at inlet is 0.5 m^3/kg.
   [BL: Apply| CO: 1|Marks: 7]

MODULE – II

2. (a) Which is the more effective way to increase the efficiency of a Carnot engine: to increase source temperature (T1), keeping sink temperature constant (T2) or decrease (T2), keeping (T1) constant?
   [BL: Understand| CO: 2|Marks: 7]

   (b) The heat engine shown schematically in Figure 1, receives a heat transfer rate of 1 MW at a high temperature of 550^0C and rejects energy to the ambient surroundings at 300 K. Work is produced at a rate of 450 kW. How much energy is discarded to the ambient surroundings and the engine efficiency and compare both of these to a Carnot heat engine operating between the same two reservoirs [BL: Apply| CO: 2|Marks: 7]

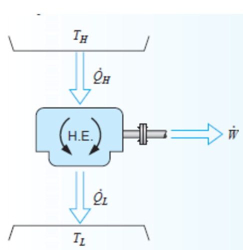

Figure 1

MODULE – III

3. (a) By taking arbitrary scale, explain the temperature- volume diagram of water having liquid and vapor phases. [BL: Understand| CO: 3|Marks: 7]

   (b) A pressure cooker holding 2 kg of steam at 5 bar and 90% dry is being cooled slowly. What quantity of heat has to be extracted so as to reduce the steam quality down to 60%? Calculate the pressure and temperature of the steam that remains in the pressure cooker after the heat rejection. [BL: Apply| CO: 3|Marks: 7]

4. (a) Show the phase equilibrium diagram for a pure substance on T-s and h-s plot with relevant constant property line [BL: Understand| CO: 4|Marks: 7]

   (b) One kg of CO_2 has a volume of 1 m^3 at 100°C. Compute the pressure by i) Van der Waals' equation ii) Perfect gas equation. The values of a and b for CO_2 are 362850 Nm^4/(kg-mol)^2 and 0.0423 m^3/kg-mol respectively. [BL: Apply| CO: 4|Marks: 7]

MODULE – IV

5. (a) Discuss the mole fraction and mass fraction in the mixture of perfect gas. Summarize the Dalton's law of partial pressure with an example [BL: Understand| CO: 6|Marks: 7]

   (b) A mixture of ideal gases consists of 4 kg of nitrogen and 6 kg of carbon dioxide at a pressure of 4 bar and a temperature of 20°C. Determine: i) The mole fraction of each constituent, ii) The equivalent molecular weight of the mixture iii) The equivalent gas constant of the mixture, iv) The partial pressures and partial volumes. [BL: Apply| CO: 6|Marks: 7]

6. (a) Explain the concept of dew point temperature. Differentiate specific humidity and relative humidity and derive the relation between them [BL: Understand| CO: 6|Marks: 7]

   (b) Moist air at 1 atm. pressure has a dry bulb temperature of 320C and a wet bulb temperature of 26^0C. Calculate i) The partial pressure of water vapour, ii) Humidity ratio, iii) relative humidity, iv) Dew point temperature, v) Density of dry air in the mixture, vi) Density of water vapour in the mixture and vii) Enthalpy of moist air using perfect gas law model and psychrometric equations. [BL: Apply| CO: 6|Marks: 7]

MODULE – V

7. (a) Determine an expression for thermal efficiency of Otto cycle by drawing p-v and T-s diagram. [BL: Understand| CO: 5|Marks: 7]

   (b) The compression ratio of an Otto Cycle is 8. At the beginning compression stroke, the temperature and pressure is 300K and 1 bar respectively. The amount of energy added to the air as a result of combustion is 1500 kJ/Kg. Determine the pressure and temperature of the air at the end of each process of the cycle. Also determine the thermal efficiency of the cycle. [BL: Apply| CO: 5|Marks: 7]

8. (a) Draw P-V and T-S diagrams for diesel cycle and derive the equation for coefficient of performance. [BL: Understand| CO: 5|Marks: 7]

   (b) An air standard dual cycle has a compression ratio of 16 and compression begins at 1 bar, 50^0C. The maximum pressure is 70 bar. The heat transferred to air at constant pressure is equal to that at constant volume. Estimate

   i) The pressures and temperatures at the cardinal points of the cycle

   ii) The cycle efficiency

   iii) The m.e.p of the cycle. (Cv=0.718 kJ/Kg.K, Cp=1.005 kJ/Kg.K,)

   [BL: Apply| CO: 5|Marks: 7]