Hall Ticket No | | | | | | | | | | | Question Paper Code:AAEC02

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal-500043, Hyderabad

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

Regulation:UG20

ENGINEERING THERMODYNAMICS

Time: 3 Hours **AERONAUTICAL 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]

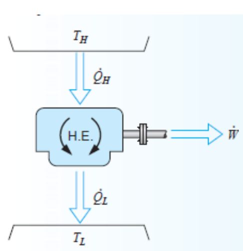

Figure 1

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) 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: 4|Marks: 7]

MODULE – IV

5. (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]

6. (a) Draw P-V and T-S diagrams for Bell Coleman refrigeration 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, 500C. 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]

MODULE – V

7. (a) Find the expression for effectiveness of a balanced heat exchanger with equal heat capacities. Why are counter flow heat exchangers superior to parallel flow heat exchangers?

[BL: Understand| CO: 6|Marks: 7]

(b) A gas turbine utilises a two stage centrifugal compressor. The pressure ratios for the first and second stages are 2.5 to 1 and 2.1 to 1, respectively. The flow of air is 5 kg/s, this air being drawn at 1.013 bar and 10^0C. If the temperature drop in the intercooler is 50^0C and the isentropic efficiency is 85% for each stage, Calculate i) The actual temperature at the end of each stage and ii) The total compressor power. Take $\gamma = 1.4$ and Cp = 1.005 KJ/kg K.

[BL: Apply| CO: 6|Marks: 7]

8. (a) Describe in detail different modes of heat transfer. Discuss natural convention and forced convention. [BL: Understand| CO: 6|Marks: 7]

(b) A certain building wall consists of 0.25 m of concrete (k = 1.8 W/m K), 0.05 m of fiber glass insulation and 15 mm of gypsum board (k = 0.03 W/m K). The inside and outside convection coefficient is $15W/m^2$ K and $40W/m^2K$ respectively. The outside air temperature is -8^0C and the inside temperature is 28^0C. Calculate the overall heat transfer coefficient for the wall, the R value, and the heat loss per area. [BL: Apply| CO: 6|Marks: 7]