Hall Ticket No | | | | | | | | | | | Question Paper Code: AAEB02

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Four Year B.Tech III Semester End Examinations(Regular) - November, 2019

Regulation: IARE – R18

ENGINEERING THERMODYNAMICS

Time: 3 Hours **(AE)** **Max Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1. (a) Explain macroscopic and microscopic viewpoints of thermodynamics. **[7M]**

   (b) A piston cylinder device operates 1 kg of fluid at 20 atm. pressure. The initial volume is 0.04 m^3. The fluid is allowed to expand reversibly following a process $pV^1.45$ = constant so that the volume becomes double. The fluid is then cooled at constant pressure until the piston comes back to the original position. Keeping the piston unaltered heat is added reversibly to restore it to initial pressure. Calculate the work done in the cycle. **[7M]**

2. (a) Explain the working principle of constant volume gas thermometer. **[7M]**

   (b) A turbine operates under steady flow conditions, receiving steam at the following state: Pressure 1.2 MPa, temperature 188^0C, enthalpy 2785kJ/kg, velocity 33.3 m/sand elevation 3 m. The steam leaves the turbineat the following state: Pressure 20 kPa, enthalpy 2512 kJ/kg, velocity 100m/s, and elevation 0 m. Heat is lost to the surroundings at the rate of 0.29kJ/s. If the rate of steam flow through the turbine is 0.42 kg/s, what is the power output of the turbine in kW? **[7M]**

UNIT – II

3. (a) Explain Carnot cycle with a neat sketch of P-v and T-s diagrams and explain its significance. **[7M]**

   (b) A refrigeration plant for a food store operates as reversed Carnot heat engine cycle. The store is to be maintained at a temperature of -5^0C and the heat transfer from the store to the cycle is at a rate of 5 kW. If heat is transferred from the cycle to the atmosphere at a temperature 25^0C, calculate the power required to drive the plant. **[7M]**

4. (a) State Maxwell relations. Explain the limitations of First law of thermodynamics in detail. **[7M]**

   (b) In a Carnot cycle heat is supplied at 350^0C and rejected at 27^0C. The working fluid is water which, while receiving heat, evaporates from liquid at 35^0C to steam at 350^0C. The associated entropy change is 1.44 kJ/kg. If the cycle operates on a stationary mass of 1kg of water, how much is the work done per cycle and heat supplied. **[7M]**

UNIT – III

5. (a) Discuss about P-V-T surface with a neat sketch. **[7M]**

   (b) A vessel having a capacity of 0.05 m3 contains a mixture of saturated water and saturated steam at a temperature of 245^{o}C. The mass of the liquid present is 10 kg. Find the following : i) The pressure, ii) The mass, iii) The specific volume, iv) The specific enthalpy, v) The specific entropy, and vi) The specific internal energy. **[7M]**

6. (a) Discuss about dry bulb temperature, wet bulb temperature, specific humidity and relative humidity. **[7M]**

   (b) An air-water vapour mixture enters an adiabatic saturation chamber at 28^{0}C and leaves at 18^{0}C, which is the adiabatic saturation temperature. The pressure remains constant at 1.0 bar. Determine the relative humidity and humidity ratio of the inlet mixture. **[7M]**

UNIT – IV

7. (a) Obtain the relation to find the air standard efficiency of Otto cycle. **[7M]**

   (b) An air standard limited pressure cycle has a compression ratio of 15 and compression begins at 0.1 MPa, 40^{0}C. The maximum pressure is limited to 6 MPa and the heat added is 1.675 MJ/kg. Compute i) The heat supplied at constant volume per kg of air ii) The heat supplied at constant pressure per kg of air iii) The work done per kg of air iv) The cycle efficiency. **[7M]**

8. (a) Explain about processes in Bell Coleman cycle. **[7M]**

   (b) A diesel engine has a compression ratio of 15 and heat addition at constant pressure takes place at 6% of stroke. Find the air standard efficiency of the engine. Take for air as 1.4. **[7M]**

UNIT – V

9. (a) Derive the condition for minimum work done in case of two stage reciprocating air compressor. **[7M]**

   (b) A cold storage room has walls made of 0.23 m of brick on the outside, 0.08 m of plastic foam, and finally l.5 cm of wood on the inside. The outside and inside air temperatures are 22^{O}C and -2^{O}C respectively. If the inside and outside heat transfer coefficients are respectively 29 and 12 W/m^2 K, and the thermal conductivities of brick, foam, and wood are 0.98, 0.02, and 0.17 W /mK respectively, determine i) The rate of heat removed by refrigeration if the total wall area is 90 m^2 ii) The temperature of the inside surface of the brick. **[7M]**

10. (a) Obtain the expression for the reversible work of compression if the compression process is polytropic. **[7M]**

    (b) A single stage reciprocating air compressor has a swept volume of 2000 cm^3 and runs at 800 rpm. It operates on a pressure ratio of 8, with a clearance of 5% of the swept volume. Assume NTP room conditions at inlet (p= 101.3 kPa, t=15^{0}C) and polytropic compression and expansion with n=1.25. Calculate i) Indicated power ii) Volumetric efficiency iii) Mass flow rate.

    i) Construct the velocity diagrams at the mean blade diameter

    ii) Calculate the absolute Mach number

    iii) Calculate the specific work and power developed by this stage **[7M]**