Hall Ticket No | | | | | | | | | | | Question Paper Code: AME003

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

B.Tech III Semester End Examinations (Regular) - December, 2017

Regulation: IARE – R16

THERMODYNAMICS

(Mechanical Engineering)

Time: 3 Hours **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) Derive an expression for the non-flow displacement work done during adiabatic process given by $PV^{\gamma} = C$, where $\gamma = C_p/C_v$ **[7M]**

   (b) A closed system undergoes two processes one after the other-constant pressure process at pressure of 5 bar from initial volume of 0.03 m^3 to 0.09 m^3 it is followed by polytropic expansion. $PV^{1.3}$=C from 0.09 m^3 volume to 0.02 m^3 final volume find **[7M]**

   i. Final pressure after expansion

   ii. Work done during each process and net work done

2. (a) Explain Joules experiment with reference to PMM1. **[6M]**

   (b) Air flows steadily at the rate of 0.4 kg/s through an air compressor, entering at 6 m/s with a pressure of 1 bar and a specific volume of 0.85 m^3/kg, and leaving at 4.5 m/s with a pressure of 6.9 bar and a specific volume of 0.16 m^3/kg. The internal energy of the air leaving is 88 kJ/kg greater than that of the air entering. Cooling water in a jacket surrounding the cylinder absorbs heat from the air at the rate of 59 W. Calculate the power required to drive the compressor and the inlet and outlet cross-sectional areas. **[8M]**

UNIT – II

3. (a) Distinguish between heat engine and heat pump. **[5M]**

   (b) Two reversible heat engines A and B are arranged in series, A rejecting heat directly to B. Engine A receives 200 kJ at a temperature of 421°C from a hot source, while engine B is in communication with a cold sink at a temperature of 4.4°C. If the work output of A is twice that of B, find **[9M]**

   i. The intermediate temperature between A and B

   ii. The efficiency of each engine

   iii. The heat rejected to the cold sink

4. (a) What is Carnot's cycle? Explain in detail with relevant sketches and processes. **[6M]**

   (b) Two kg of water at 80°C are mixed adiabatically with 3kg of water at 30°C in a constant pressure process of 1 atmosphere. Find the increase in entropy of the total mass of water due to mixing process. **[8M]**

UNIT – III

5. (a) Draw the phase equilibrium diagram for pure substance on h-s plot with relevant constant property lines and why the isobars lines are diverges from one another? **[7M]**

   (b) A vessel of volume 0.04 m^3 contains a mixture of saturated water and saturated steam at a temperature of 250°C. The mass of the liquid present is 9 kg. Find pressure, the specific volume, the enthalpy, the entropy. **[7M]**

6. (a) Derive an expression for the Vander Walls constants 'a' and 'b' in terms of critical properties. **[7M]**

   (b) 1 kg of CO_2 has a volume of 0.86 m^3 at 120°C. Compute the pressure using

   i) Ideal gas equation **[7M]**

   ii) Vander Wall's Equation

   Take Vander Wall's constant for CO_2, a = 365.6 kN$m^4/(kg\ mole)^2$ and b = 0.0423 m^3/(kg mole)

UNIT – IV

7. (a) Define mole fraction and mass fraction. **[4M]**

   (b) 0.5 kg of helium and 0.5 kg of nitrogen are mixed at 20°C and at a total pressure of 100 kPa. Find **[10M]**

   (i) the mole fraction of each constituent

   (ii) Equivalent molecular weight of the mixture

   (iii) the equivalent gas constant of mixture

   (iv) the partial pressures and volumes

   (v) C_p and C_v of the mixture.

8. (a) Explain **[7M]**

   (i) Dew point temperature

   (ii) Degree of saturation

   (iii) Adiabatic saturation process

   (b) An air water vapour mixture enters an adiabatic saturator at 30°C and leaves at 20°C, which is the adiabatic saturation temperature. The pressure remains constant at 100kPa. Determine the relative humidity and the humidity ratio of the inlet mixture. **[7M]**

UNIT – V

9. (a) For the same compression ratio and heat rejection, which cycle is most efficient; Otto, diesel or dual? Explain with P-V and T-S diagrams. **[7M]**

   (b) An ideal diesel cycle with air as the working fluid has a compression ratio of 18 and a cut-off ratio of 2. At the beginning of compression, the air is at 100kPa, 27°C and 1917 cm^3. Determine

   (i) the pressure and temperature of air at each point **[7M]**

   (ii) the net work and thermal efficiency

10. (a) Derive air standard efficiency of Brayton cycle with P-V and T-S diagram **[7M]**

(b) An air refrigeration open system operating between 1 mpa and 100 kpa is required to produce cooling effect of 2000 kJ/min. the temperature of air leaving the cold chamber is -5°C and at leaving the cooler is 30°C. Neglecting losses and clearance in the compressor and expander determine **[7M]**

i) Mass of air circulated per hour

ii) Compressor work, expander work, cycle work

iii) Coefficient of performance and power required to run the machine

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