KUMARAGURU
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Register Number:……………………..

B.E DEGREE EXAMINATIONS: NOV / DEC 2014

(Regulation 2009)

Sixth semester

MECHATRONICS ENGINEERING

MCT116**:** Thermodynamics and Heat Transfer

(Approved HMT Data Book permitted)

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Example for intensive property is

   a) Momentum b) Volume

   c) Entropy d) Viscosity

2. For isochoric process, initial and final volume and pressure of the cylinder are $3m^3$ and 4.2 bar, 5.6 bar respectively. What is the work done on the system?

   a) 10J b) 15.4J

   c) 19J d) Zero J

3. Diesel is a

   a) Constant volume cycle b) Constant pressure cycle

   c) Constant temperature cycle d) Constant enthalpy cycle

4. For same compression ratio and heat rejection which cycle have higher efficiency

   a) Otto cycle b) Diesel cycle

   c) Dual cycle d) Brayton cycle

5. The heat transfer from solid to fluid with molecular motion called as

   a) Conduction b) Radiation

   c) Convection d) Mass transfer

6. conduction happens in solid metal due to

   a) Lattice vibration b) Molecular motion

   c) Atom displacement d) Inter molecular interaction

7. If the Reynolds number is less than 500000 in external flow then the flow is?

a) Laminar flow | b) Ideal flow
c) Turbulent flow | d) Transient flow

8. Emissive power of black body directly proportional to

a) Fourth power of temperature | b) Third power of temperature
c) Zeroth power of temperature | d) Second power of temperature

9. Mass transfer occur due to

a) Concentration difference | b) Temperature difference
c) Pressure difference | d) Volume difference

10. Molar fraction is equal to______________ 1 atm pressure

a) Partial pressure | b) Total pressure
c) Saturation pressure | d) Atmospheric pressure

PART B (10 x 2 = 20 Marks)

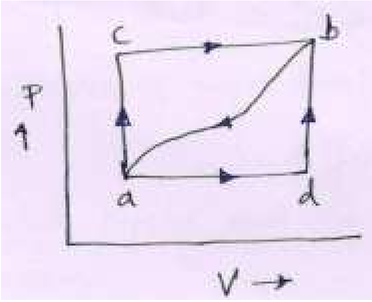
11. Define latent heat of sublimation.
12. The initial and final enthalpy of the fluid is the compressor is 417J/kg and 85 J/kg respectively. Find the work done upon the compressor using steady flow energy equation.
13. Mention the improvements made to increase the ideal efficiency of rankine cycle.
14. Define the terms degree of super heat and degree of sub-cooling.
15. Write down equation for conduction of heat through hollow sphere.
16. What is meant by steady state conduction?
17. What is hydrodynamic boundary layer?
18. State Kirchoff's law of radiation.
19. State Ficks law of diffusion.
20. Define forced convective mass transfer.

PART C (5 x 14 = 70 Marks)

21. a) Derive the general steady flow energy equation for open system and also find the work done by the turbine if the enthalpy of inlet and outlet are 35 kJ/kg and 10kJ/kg.

(OR)

b) When the system is taken from state “a” to state “b” shown in figure, along path acb, 84 kJ of heat flow into the system and the system does 32 kJ of work. (a) How much will the heat that flows into the system along path adb be if the work done is 10.5kJ? (b) When the system is returned from “b” to “a” along the curved path, the work done on the system is 21 kJ. Does the system absorb or liberate heat and how much of the heat is absorbed or liberated? (c) If U_a=0 and U_d=42 kJ find the heat absorbed in the process “ad” and “db” [U – Internal energy].



22. a) An engine working on the Otto cycle is supplied with air at 0.1MPa, 35°C. The compression ratio is 8. Heat supplied is 2100kJ/kg. Calculate the maximum pressure and temperature of the cycle, the cycle efficiency, and the mean effective pressure. (for air 1. Specific heat at constant pressure.C_p=1.005 Kj/kg K,
2. Specific heat at constant volume C_v=0.718kJ/kgK,
3. Gas constant R=0.287 kJ/kg K);

(OR)

b) In an air standard cycle, the compression ratio is 16, and at the beginning of isentropic compression, the temperature is 15 °C and pressure is 0.1 MPa. Heat is added until the temperature at the end of the constant pressure process is 1480 °C. Calculate (i) The cut – off ratio, (ii) The heat supplied per kg of air, (iii) The cycle efficiency, (iv) The mean effective pressure.

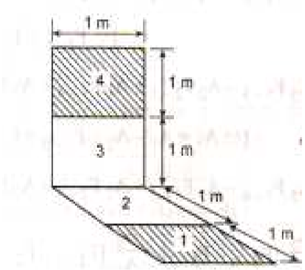
23. a) A steel tube with 5cm ID, 7.6cm OD and k=15W/m°C is covered with an insulative covering of thickness 2cm and k=0.2W/m °C. A hot gas at 330 °C with h=400W/m^2 °C flows inside the tube. The outer surface of the insulation is exposed to cooler air at 30 °C with h= 60 W/m^2 °C. Calculate the heat loss from the tube to the air for 10 m of the tube and the temperature drops resulting from the thermal resistances of the hot gas flow, the steel tube, the insulation layer and the outside air. [k=thermal conductivity; h=heat transfer coefficient]

(OR)

b) (i) Determine the heat transfer through the plane of length 6m, height 4m and thickness 0.30m. The temperatures of inner and outer surfaces are 100 °C and 40 °C. Thermal conductivity of wall is 0.55 W/mK. (6)

(ii) A steam boiler furnace is made of fire clay. the hot gas temperature inside the boiler furnace is 2100 °C, room air temperature is 50 °C, heat flow by radiation from gases to inside surface of the wall is 25.2kW/m^2, convection heat transfer co-efficient at the interior surface is 12.2W/m^2K, thermal conductance of the wall is 58 W/m^2K, heat flow by radiation from external surface to surrounding is 8.2kW/m^2 and interior wall surface temperature is 1080 °C. Calculate for external (8)
1. Surface temperature
2. Convective conductance.

24. a) Determine the view factor (F14) for the figure given below.



(OR)

b) (i) Air at 20 °C, at a pressure of 1 bar is flowing over a flat plate at a velocity of 3 m/s, If the plate is maintained at 60 °C, Calculate the heat transfer per unit width of the plate. Assuming the length of the plate along the flow of air is 2m. (6)

(ii) When 0.6 kg of water per minute is passed through a tube of 2cm diameter, it is found to be heated from 20 °C to 60 °C. The heating is achieved by condensing steam on the surface of the tube and subsequently the surface temperature of the tube is maintained at 90 °C. Determine the length of the tube required for fully developed flow. (8)

25. a) (i) Helium diffuses through a plane membrane of 2 mm thick. At the inner side the concentration of helium is 0.025 kg mole/m^3. At the outer side the concentration of helium is 0.007 kg mole/m^3. What is the diffusion flux of helium through membrane. Assume diffusion co-efficient of helium with respect to plastic is $1x10^{-9}$ m^2/s. (7)

(ii) A mixture of O_2 and N_2 with their partial pressure in the ratio 0.21 to 0.79 is in a container at 25 °C. Calculate the molar concentration, the mass density, and the mass fraction of each species for a total pressure of 1 bar. What would be the average molecular weight of the mixture? (7)

(OR)

b) Dry air at 20 °C (ρ=1.2kg/m^3, γ=15x10^{-6} m^2/s D=4.2x$10^{-5}$$m^2$/s) flows over a flat plate of length 50cm which is covered with a thin layer of water at a velocity of 1 m/s. Estimate the local mass transfer co- efficient at a distance of 10 cm from the leading edge and the average mass transfer co-efficient.[where ρ = density, γ = kinematic viscosity, D= Diffusion coefficient]

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