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B.E DEGREE EXAMINATIONS: APRIL/MAY 2014

(Regulation 2009)

Sixth Semester

MECHATRONICS ENGINEERING

MCT116**:** Thermodynamics and Heat Transfer

(Approved HMT data book and Steam tables are permitted)

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

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. The process which follows consistent equilibrium states is
   a) Isothermal b) Isentropic
   c) Quasi static d) Equilibrium
2. Hyperbolic process applies to
   a) Solid b) Liquid
   c) Plasma d) Vapor
3. Entropy of a substance is a function of heat and
   a) Enthalpy b) Internal energy
   c) Absolute temperature d) Work
4. Brayton cycle consists of
   a) Two adiabatic and two constant volume processes b) Two adiabatic and two constant pressure processes
   c) Two adiabatic, two constant volume and one constant pressure process d) Two isothermal, two isobaric and one isochoric process
5. In a regenerative rankine cycle, the steam enters the condenser as a
   a) Saturated vapour b) saturated liquid
   c) Saturated liquid – vapour mixture d) superheated steam
6. Thermal Conductance of a material for a conduction heat transfer is (k-thermal conductions, A-area of heat transfer, L – thickness, h – heat transfer co – efficient)
   a) KA/L b) L/KA
   c) 1/hA d) hA(T1-T2)
7. Boundary layer is the fluid layer adjacent to
   a) Flow surface b) Turbulent layer
   c) Core flow d) All of above

8. Radiation heat transfer in solid conductors is due to
   a) Atomic activity b) Molecular diffusion
   c) Lattice waves d) Electro magnetic waves
9. The absorptivity of the grey body lies between
   a) 1 and 10 b) 0 and 1
   c) 0 and infinity d) 0.1 and 10
10. Stanton number is the ratio of
    a) Reynolds number to Prandtl number b) Prandtl to Nusselt number
    c) Nusselt number to Peclet number d) Peclet number to Reynolds number

PART B (10 x 2 = 20 Marks)

11. Define compression ratio.
12. State Kelvin Planck statement for second law of thermodynamics.
13. Draw the P-V and T-S diagram for reheat rankine cycle.
14. What is scavenging?
15. Define Newton’s law of cooling.
16. List out the significance of log mean area.
17. Write the significance of thermal diffusivity.
18. Write short notes on natural and forced convection.
19. State Kirchoff’s law of radiation.
20. What is shape factor algebra?

PART C (5 x 14 = 70 Marks)

21. a) Derive the expressions for work done, heat transfer, Change in enthalpy, change in internal energy and relation between pressure, volume and temperature for a polytropic process.

(OR)

b) Derive the Steady flow energy equation for the following

(i) Compressor (ii) Condenser (iii) Nozzle (iv) Turbine

22. a) (i) Air enters in an air standard Otto cycle at 3 bar and 390K. The ratio of heat rejection and heat supplied is 0.4. The maximum temperature of the cycle is 1800K. Find the efficiency, compression ratio, net work done. (10)
    (ii) Derive the expression for efficiency of Carnot cycle. (4)

(OR)

b) (i) Explain the working of an four stroke SI engine with neat sketches. (4)

(ii) In a sample gas turbine plant operating on air standard Brayton cycle, the air enters the compressor at 0.5MPa, 420K and leaves at 0.9 MPa. The maximum temperature of the cycle is 1500K. Determine the cycle efficiency. (10)

23. a) Derive the general differential equation for heat conduction in Cartesian coordinates.

(OR)

b) (i) A brick wall (k = Thermal conductivity = 0.7 W/mK) is 0.30m thick. If the temperatures of the inner and outer surfaces are maintained at 100°C and 30°C respectively, calculate the heat loss through one square metre area. Find also the temperature at an interior point of the wall 17 cm distant from the outer wall. (7)

(ii) Derive the relation for log mean area of the cylinder. (7)

24. a) Consider the flow of the following fluids over a plate 0.5 m by 1 m. Determine the free Stream velocity so that the flow turns turbulent just at leaving the plate at Re= 5×10^5. The plate is at 80°C and the fluid is at 25°C. Also determine the heat loss in the process over the plate area. The fluids are a) Ammonia b) Hydrogen c) Water.

(OR)

b) (i) A hollow sphere 10cm ID and 30 cm OD of a material having thermal conductivity 50 W/m-K is used as a container for a liquid chemical mixture. Its inner and outer surface temperatures are 300 °C and 100 °C respectively. Determine the heat flow rate through the sphere. Also estimate the temperature at a point quarter of the way between the inner and outer surfaces. (10)

(ii) Derive the overall coefficient for combined mechanisms of heat transfer. (4)

25. a) Derive the equations for steady state equimolar counter diffusion.

(OR)

b) Air at 50°C and atmospheric pressure, containing small quantities of iodine flows with a velocity of 8 m/s inside a 3.5 cm diameter tube. Determine the mass transfer coefficient from the air stream to the wall surface. Assume Diffusion co – efficient, D_{AB} (iodine-air)=0.83×10^{-5} m^2/s

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