KUMARAGURU
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Register Number:……………………..

B.E DEGREE EXAMINATIONS: NOV/DEC2014

(Regulation 2009)

Sixth Semester

AERONAUTICAL ENGINEERING

AER124**:** Cryogenic Heat Transfer

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

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Thermal conductivity is a function of

    a) pressure   b) temperature

    c) Co-ordinates   d) Mass of the body

2. Which of the following mode of heat transfer does not require any medium to transfer the heat?

    a) conduction   b) convection

    c) radiation   d) All of the above

3. Unit of thermal resistance is

    a) J/kgK   b) W

    c) W/K   d) K/W

4. Heat flux is known as

    a) Heat transfer per unit time   b) Heat transfer per unit area

    c) Heat transfer per unit volume   d) Heat transfer per unit thickness

5. Newton's law of cooling refers

    a) conduction   b) convection

    c) radiation   d) condensation

6. In lumped heat approach the value of Biot number is

    a) 1   b) 100

    c) Less than1   d) Less than 0.1

7. The overall heat transfer coefficient is

    a) sum of all resistances   b) sum of all conductances

    c) sum of the convection coefficients   d) resistance due to the wall material

8. The flow direction is immaterial in the case of heat exchange from

   a) Wet or saturated steam to water   b) Water to gas

   c) Oil to water   d) Oil to gas

9. Glasses are

   a) opaque for high temperature radiation   b) opaque for low temperature radiation

   c) Transparent at short wavelengths   d) Transparent at long wavelengths

10. The value of shape factor will be highest when

   a) the surfaces are farther apart   b) the surfaces are closer

   c) the surfaces are smaller and closer   d) the surfaces are larger and closer

PART B (10 x 2 = 20 Marks)

11. Define cryogenics.

12. State Fourier Law of heat conduction.

13. When can a system be referred as lumped heat approach?

14. Write down the conductive thermal resistance for radial heat conduction in cylinders.

15. What is meant by forced convection?

16. What is nucleate boiling?

17. Define effectiveness of a fin.

18. Write down the LMTD equation for cross flow heat exchanger.

19. What do you mean by monochromatic emissive power?

20. State Stefan Boltzmann law of radiation.

PART C (5 x 14 = 70 Marks)

21. a)   Explain the basic modes of heat transfer with practical examples.

(OR)

    b)   Write short notes on:

       (i) Aerodynamic heating   (7)

       (ii) Ablative heat transfer   (7)

22. a)   A furnace wall is of three layers, first layer of insulation brick of 12 cm thickness of conductivity 0.6 W/mK. The face is exposed to gases at 870°C with

a convection coefficient of 110 W/m^{2}K. This layer is backed by a 10 cm layer of firebrick of conductivity 0.8 W/mK. There is a contact resistance between the layers of 2.6×10^{-4} m^2 °C/W. The third layer is the plate backing of 10 mm thickness of conductivity 49 W/mK. The contact resistance between the second and third layers is 1.5×10^{-4} m^2 °C/W. The plate is exposed to air at 30°C with a convection coefficient of 15 W/m^{2}K. Determine the heat flow, the surface temperatures and the overall heat transfer coefficient.

(OR)

b) A concrete wall initially at 30°C is exposed to gases at 900°C with a convective heat transfer coefficient of 85 W/m. The thermal diffusivity of the material is $4.92 \times 10{-7}$ m^2/s. The thermal conductivity of the material is 1.28 W/mK. Determine the temperature of the surface and temperatures at 1 cm depth and also 5 cm depth after 1 hr. Also estimate the heat flow at the surface at the instant.

23. a) Water at 30°C flows over a flat plate 1 m × 1 m at 10°C with a free stream velocity of 4 m/s. Determine the thickness of boundary layers, displacement thickness, momentum thickness, local and average value of drag coefficient and convection coefficient.

(OR)

b) Water at atmospheric pressure (saturation temperature = 100°C) is boiling on a brass surface heated from below. If the surface is at 108°C, determine the heat flux and compare the same with critical heat flux.

24. a) Determine the area required in parallel flow heat exchanger to cool oil from 60°C to 30°C using water available at 20°C. The outlet temperature of the water is 26°C. The rate of flow of oil is 10 kg/s. The specific heat of the oil is 2200 J/kg K. The overall heat transfer coefficient U = 300 W/m^{2}K. Compare the area required for a counter flow exchanger.

b) A cross flow heat exchanger with both fluids unmixed is used to heat water flowing at a rate of 20 kg/s from 25°C to 75°C using gases available at 300°C to be cooled to 180°C. The overall heat transfer coefficient has a value of 95 W/m^{2}K. Determine the area required. For gas Cp = 1005 J/kgK.

25. a) Two large parallel planes are at 1000 K and 600 K. Determine the heat exchange per unit area. (i) if surfaces are black (ii) if the hot one has an emissivity of 0.8 and the cooler one 0.5 (iii) if a large plate is inserted between these two, the plate having an emissivity of 0.2.

(OR)

b) Two large parallel planes with emissivity value of 0.8 are exchanging heat by radiation. It is desired to interpose a radiation sheild with emissivity value of ε_s on both sides, so that the heat exchange will be reduced to 1/10 of the original value. Estimate the emissivity requirement.

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