Register Number: ……..

B.E DEGREE EXAMINATIONS: APRIL/MAY 2014

(Regulation 2009)

Sixth Semester

AERONAUTICAL ENGINEERING

AER124**:** Cryogenic Heat Transfer

(Use of Heat and Mass transfer data books, Steam tables are permitted)

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

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. The thermal conductivity is expressed as
   a) W/mK b) W/m^2K
   c) W/hmK d) W/h^2m^2K
2. Heat transfer from higher temperature to lower temperature takes place according to
   a) Fourier law b) First law of thermodynamics
   c) Second law of thermodynamics d) Zeroth law of thermodynamics
3. In the heat flow equation $Q=kA(t_1-t_2)/x$,the term $(t_1-t_2)/x$ is known as
   a) Thermal conductivity b) Thermal coefficient
   c) Thermal resistance d) Temperature gradient
4. The temperature variation with time, in the lumped parameter model, is
   a) Exponential b) Sinusoidal
   c) Cubic d) Linear
5. The number generally associated with natural convection heat transfer is
   a) Prandtl b) Weber
   c) Nusselt d) Grashoff
6. When the bubbles formed on a submerged hot surface get absorbed in the mass of liquid, the process of boiling is known as
   a) Sub cooled boiling b) Pool boiling
   c) Film boiling d) Nucleate boiling
7. A correction of LMTD is necessary in case of ---------- heat exchanger.
   a) Cross flow b) Parallel flow
   c) Counter current d) All of the above
8. Compared to parallel flow heat exchanger log mean temperature difference in case of counter flow heat exchanger will be
   a) Less b) Same

   c) More d) Unpredictable
9. For a radiation shield which of the following parameters should be highest?
   a) Emissivity b) Reflectivity
   c) Absorptivity d) Transmissivity
10. A ---------- body reflects entire radiation incident on it.
   a) Transparent b) Black
   c) Grey d) White

PART B (10 x 2 = 20 Marks)

11. Define cryogenics.
12. Name some commonly used cryogens in aerospace applications.
13. Write down the three dimensional heat conduction equation in Cartesian co-ordinate system.
14. What is critical radius of insulation or critical thickness?
15. State Newton's law of convection.
16. Indicate the concept or significance of boundary layer.
17. Define NTU of a heat exchanger. Is it correct to say that, larger the NTU, larger the heat exchanger will be?
18. List down the different types of heat exchangers.
19. Mention the physical significance of view factor.
20. Define emissivity.

PART C (5 x 14 = 70 Marks)

21. a) i) Identify the mode of heat transfer in the following: (10)
   - Heat transfer from a room heater.
   - Boiling of water in a boiler.
   - Heat loss from a thermos flask.
   - Drying of wet hot plate in atmosphere.
   - Heat transfer from an auto radiator.
   - Heating of water in a bucket with an immersion heater.
   - Cooling of an I.C. engine cylinder by air/water.
   - Condensation of steam in a condenser.
   - Collection of solar energy by a collector.

   ii) Estimate the loss of heat through a red brick wall of length 5m, height 4m and thickness 0.25m, if the temperatures of the wall surfaces are maintained at (4)

110°C and 40°C respectively. Thermal conductivity for red brick is equal to 0.7 W/mK.

(OR)

b) i) Explain briefly the following (10)

- Aerodynamic heating
- Ablative heat transfer

ii) A wire 1.5mm in diameter and 150mm long is submerged in water at atmospheric pressure. An electric current is passed through the wire and is increased until the water boils at 100°C.Under the condition if the convective heat transfer coefficient is 4500 W/m^2°C find how much electric power must be supplied to the wire to maintain the wire surface at 120°C? (4)

22. a) In an experiment to determine the thermal conductivity of a long solid 2.5cm diameter rod, its base is placed in a furnace with a large portion of it projecting into the room air at 22°C.After steady state conditions prevail, the temperatures at two points,10cm apart, are found to be 110°C and 85°C respectively. The convective heat transfer coefficient between the rod surface and the surrounding air is 28.4 W/m^2K.Determine the thermal conductivity of the rod material.

(OR)

b) An aluminium sphere weighing 5.5 kg and initially at a temperature of 290°C is suddenly immersed in a fluid at 15°C.The convective heat transfer coefficient is 58 W/m^2K.Estimate the time required to cool the aluminium to 95°C,using the lumped capacity method of analysis.

23. a) A flat plate 1m wide and 1m long is placed in a wind tunnel. The temperature and velocity of free stream air are 10°C and 80 m/s respectively. The flow over the whole length of the plate is made turbulent with the help of a turbulizing grid placed upstream of the plate. Determine the thickness of the boundary layer at the trailing edge of the plate. Also calculate the mean value of the heat transfer coefficient from the surface of the plate.

(OR)

b) A metal plate 0.609 m high forms the vertical wall of an oven and is at a temperature of 161°C.Within the oven is air at a temperature of 93°C and one atmosphere. Assuming that natural convection conditions hold near the plate,

estimate the mean heat transfer coefficient and the rate of heat transfer per unit width of the plate.

24. a) Hot oil with a capacity rate of 2500 W/K flows through a double pipe heat exchanger. It enters at 360°C and leaves at 300°C.Cold fluid enters at 30°C and leaves at 200°C.If the overall heat transfer coefficient is 800 W/m^2K, determine the heat exchanger area required for (i) parallel flow and (ii) counter flow.

(OR)

b) Water enters a counter flow, double pipe heat exchanger at 15°C, flowing at the rate of 1300 kg/hr.It is heated by oil (C_p=2000 J/kg.K) flowing at the rate of 550 kg/hr from an inlet temperature of 94°C.For an area of 1 m^2 and an overall heat transfer coefficient of 1075 W/m^2K, determine the total heat transfer and the outlet temperatures of water and oil.

25. a) A pipe carrying steam having an outside diameter of 20 cm runs in a large room and is exposed to air at a temperature of 30°C.The pipe surface temperature is 400° C.Calculate the loss of heat to surroundings per meter length of pipe due to thermal radiation. The emissivity of the pipe surface is 0.8.
What would be the loss of heat due to radiation if the pipe is enclosed in a 40 cm diameter brick conduit of emissivity 0.91?

(OR)

b) The net radiation from the surface of two parallel plates maintained at temperatures, T1 and T2 is to be reduced by 79 times. Calculate the number of screens to be placed between the two surfaces to achieve this reduction in heat exchange, assuming the emissivity of the screens as 0.05 and that of the surfaces as 0.8.

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