Indian M6aritime University

(A Central University, Govt of India)

End Semester Examinations – December 2024

Programme Name: B Tech (Marine Engineering)

Semester: Five

Subject Code: UG11T4509

Subject Name: Heat Transfer and Marine Heat Exchanger

Date: 26.12.2024	Max Marks: 70
Duration: 03 Hrs	Pass Marks: 35

General Instructions

(i) All Sections (A, B & C) are to be attempted.
(ii) Assume standard values wherever required.
(iii) Options, if any, are specified in respective section.
(iv) Heat Transfer Data Handbook can be used

Section A

Ten MCQs/Fill in the Blanks of 01 Mark each – Choose the correct answer as applicable.

1.Why fins are provided on heat transferring surface?
a) To increase heat transfer area
b) To increase temperature gradient
c) To decrease heat transfer area
d) To decrease temperature gradient

2. The thermal conductivity of a damp brick is higher than that of dry brick, because
a) the thermal conductivity of air is less than that of water.
b) the heat transfer takes place in damp bricks by convection due to capillary motion of water within the porous material.
c) both (a) and (b)
d) none of the above

3. In natural convection heat transfer, the Nusselt number is a function of
a) Re and Pr
b) Re and Gr
c) Gr and Pr
d) Gr and Bi

4. The value of convective heat transfer coefficient depends upon
a) Nature of fluid flow
b) Geometry of surface
c) Nature of the surface
d) All of above

5. The relation $\nabla^2 T = 0$ is referred to as
a) Fourier heat conduction equation
b) Laplace equation
c) Poisson equation
d) Euler equation

6. Free convection dominates if
a) $Gr/Re^2 << 1$
b) $Gr/Re^2 >> 1$
c) $Gr/Re^2 = 1$
d) $Gr.Pr/Re^2 >> 1$

7. Most solids are
a) highly absorptive
b) highly transmittive
c) opaque
d) highly reflective

8. What does TEMA stand for in the context of heat exchangers?
a) Thermal Equipment Management Association
b) Tubular Equipment Manufacturing Authority
c) Tubular Exchanger Manufacturers Association
d) Thermal Exchanger Manufacturing Association

9. The total emissive power from a radiating plane surface in any direction is directly proportional to the cosine of the angle of emission.
a) Wien's law
b) Kirchhoff's law
c) Stefan-Boltzmann law
d) Lambert's cosine law

10. The additional wall thickness that would have to be added to compensate for the reduction in mass flow rate on account of boundary layer is called
a) Energy thickness
b) Momentum thickness
c) Displacement thickness
d) Boundary thickness

Section B

Five Questions of 02 Marks each

11. Define logarithmic mean area for hollow cylinder and its importance

12. Describe in brief different modes of heat transfer

13. Define fouling and discuss its effect on the performance of heat exchangers.

14. Define efficiency for a fin. Write the mathematical equation for the efficiency of an infinitely long fin.

15. Draw Temperature profile of Parallel Flow and Counter Flow Heat exchanger

Section C

Seven Questions of 10 Marks each of which any 05 questions to be answered

16. a) Derive the heat diffusion equation in Cartesian co-ordinates (7)

b) The inner surface of a plane brick wall is at 60^0C and the outer surface is at 35^0C. Calculate the rate of heat transfer per m^2 of surface area of the wall, which is 220mm thick. The thermal conductivity of the brick is 0.51 W/m^0C. (3)

17. Draw the TEMA standard heat exchanger with channel and removable cover, one object pass, and outside packed floating head (AEP) and mention the various parts. (10)

18. Briefly discuss the (a) velocity boundary layer and (b) thermal boundary layer. (5 +5)

19. a) Calculate the heat transfer from a 60W incandescent bulb at 115^0C to ambient air at 25^0C. Assume the bulb as a sphere of 50mm diameter. Also find percentage of power lost by free convection.

The correlation is given as : $Nu=0.60(Gr.Pr)^{\frac{1}{4}}$

Thermophysical properties of air at 70^0C are ---$k=2.964\times10^{-2}$W/m^0C; $V=20.02\times10^{-6}m^2/s$; Pr=0.694 (6)

b) Assuming the Sun to be a black body emitting radiation with maximum intensity at λ = 0.49 μm , Calculate the following :

i) The surface temperature of the sun

ii) The heat flux at the surface of the sun (4)

20) In a counter-flow double pipe heat exchanger, water is heated from 25°C to 65°C by an oil with a specific heat of 1.45 kJ/kg K and mass flow rate of 0.9 kg/s. The oil is cooled from 230°C to 160°C. If the overall heal transfer coefficient is 420 $W/m^{2o}C$, calculate the following:

a) The rate of heat transfer,
b) The mass flow rate of water,
c) The surface area of the heat exchanger. And
d) Effectiveness (10)

21.a) A plate of length 750mm and width 250mm has been placed longitudinally in a stream of crude oil which flows with a velocity of 5m/s. If the oil has a specific gravity 0.8 and kinematic viscosity of 1 stoke, Calculate
i) Boundary layer thickness at the middle of the plate (3)
ii) Shear stress at the middle of the plate (2)

b) Prove that the temperature distribution in a plane wall is linear. (5)

22. A steam main 80mm inside diameter and 90mm outside diameter is lagged with two successive layers of insulation. The layer in contact with the pipe is 40mm asbestos and the asbestos layer is covered with 25mm thick magnesia insulation. The surface coefficients for inside and outside surfaces are 227 W/m^2K and 6.8 W/m^2K respectively. If the steam temperature is 400^0C and the ambient temperature is 30^0C, Calculate the steady state loss of heat from steam for 60m length of pipe. Also, workout the overall heat transfer coefficient based on inside and outside surfaces of lagged steam main.

Thermal conductivities value of the pipe material, asbestos and magnesia insulation are 45 W/mK, 0.14 W/mK & 0.07 W/mK respectively. (10)