Indian Maritime University

(A Central University, Govt of India)

End Semester Examinations – December 2023

Programme Name: B Tech (ME)

Semester: V

Subject Code: UG11T4509

Subject Name: HEAT TRANSFER AND MARINE HEAT EXCHANGERS

Date: 26.12.2023	Max Marks: 70
Duration: 03 Hrs	Pass Marks: 35

General Instructions

(i) All Sections (A, B & C) are to be attempted.
(ii) Options, if any, are specified in respective section.

Section A

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

1. Thermal contact resistance is a function of

(a) surface roughness
(b) the pressure holding the two surfaces in contact
(c) the interface fluid and its temperature
(d) all of the above

2. The non-dimensional parameter known as Stanton number is used in which of the following heat transfer?

(a) Natural convection heat transfer
(b) Unsteady state heat transfer
(c) Condensation heat transfer
(d) Forced convection heat transfer

3. For effective working of fins, the thickness of the fins should be

(a) large
(b) small
(c) thickness of fin does not affect the fin effectiveness
(d) unpredictable

4. Up to the critical radius of insulation,
   (a) convective heat loss will be less than conduction heat loss
   (b) heat flux will decrease
   (c) added insulation will increase the heat loss
   (d) added insulation will decrease the heat loss

5. In liquid metal heat transfer, δ_t/δ_h is
   (a) very small
   (b) very large
   (c) about 1
   (d) dependent on thermal conductivity of the film

6. The overall coefficient of heat transfer is used in problems of
   (a) Conduction
   (b) Convection
   (c) Conduction & Convection
   (d) Conduction & Radiation

7. The characteristic length for computing Grashof number in the case of a horizontal cylinder is
   (a) the length of the cylinder
   (b) the diameter of the cylinder
   (c) the perimeter of the cylinder
   (d) the radius of the cylinder

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

9. Gases have poor
   (a) transmissivity
   (b) absorptivity
   (c) reflectivity
   (d) emissivity

10. For evaporators and condensers under the given conditions, LMTD for counterflow will be
   (a) greater than parallel flow
   (b) equal to parallel flow
   (c) less than parallel flow
   (d) very much larger than parallel flow

Section B

Five Questions of 02 Marks each

11. Define the importance of critical radius of insulation
12. Differentiate the parallel flow and counterblow heat exchangers.

13. Define Reynold's number and mention its importance.

14. Define overall heat transfer co-efficient
15. What will be the characteristic length for computing Grashof number in the case of a horizontal cylinder and provide a reason to substantiate the answer?

Section C

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

16. Draw the TEMA standard heat exchanger with channel and removable cover and one object pass (AES) and mention the various parts. (10 Marks)

17. For a particular engine, the underside of the crank case can be idealized as a flat plat measuring 80 cm x 20 cm. The engine runs at 80 km/hr and the crank case is cooled by air flowing past it at the same speed. Calculate the loss of heat from the crank case surface of temperature 75°C to the ambient air temperature 25°C. Assume the boundary layer becomes turbulent from the loading edge itself. (10 Marks)

18. 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 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.

(10 Marks)

19.. Consider the 5m× 5m× 5m cubical furnace, whose surfaces closely approximate black surfaces. The base, top, and side surfaces of the furnace are maintained at uniform temperatures of 800 K, 1500 K, and 500 K, respectively. Determine (a) the net rate of radiation heat transfer between the base and the side surfaces, (b) the net rate of radiation heat transfer between the base and the top surface, and (c) the net radiation heat transfer from the base surface.

(3+3+4=10 Marks)

20. Steam at $T_{\infty 1}$ = 320°C flows in a cast iron pipe (k = 80 W/m·K) whose inner and outer diameters are D_1 = 5 cm and D_2 = 5.5 cm, respectively. The pipe is covered with 3cm-thick glass wool insulation with k = 0.05 W/m.K. Heat is lost to the surroundings at $T_{\infty 2}$ = 5°C by natural convection and radiation, with a combined heat transfer coefficient of h_2 = 18 W/m^2·K. Taking the heat transfer coefficient inside the pipe to be h_1 = 60 W/m^2·K, determine the

(a) rate of heat loss from the steam per unit length of the pipe. (7 Marks)
(b) temperature drops across the pipe object and the insulation. (3 Marks)

21.a) Explain briefly the extended surfaces or fins (4 Marks)

b) Derive an expression for LMTD in Parallel flow Heat Exchangers. (6 Marks)

22. A counter-flow double-pipe heat exchanger is to heat water from 20°C to 80°C at a rate of 1.2 kg/s. The heating is to be accomplished by geothermal water available at 160°C at a mass flow rate of 2 kg/s. The inner tube is thin-walled and has a diameter of 1.5 cm. If the overall heat transfer coefficient of the heat exchanger is 640 W/m^2.K, using the NTU-method determine the length of the heat exchanger required to achieve the desired heating. (C_p of water = 4.18 kJ/kg.K; C_p of geothermal water = 4.31 kJ/kg.K) (10 Marks)