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Reg. No. : | | | | | | | | | | | | |

Question Paper Code: R4903

B.E. / B.Tech. DEGREE EXAMINATION, APRIL /MAY 2025

Fourth Semester

Chemical Engineering

R21UCH403– HEAT TRANSFER

(Regulations R2021)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. For a heat sink application, which type of fin configuration is most efficient for heat dissipation? CO1-U
   (a) Radial fins (b) Flat plate fins with high fin density
   (c) Pin fins arranged in a uniform grid (d) A solid block of material
2. Which material is typically used for fins in high-performance applications such as air-cooled radiators and heat sinks? CO1- U
   (a) Copper (b) Aluminum (c) Steel (d) Glass
3. The heat transfer coefficient in an annular space is influenced by CO1-U
   (a) The temperature difference only
   (b) The Reynolds number and the gap between the cylinders
   (c) The viscosity and conductivity of the fluid
   (d) All of the above
4. During condensation, the heat transfer process is primarily CO1-U
   (a) Conduction (b) Radiation
   (c) Convection (d) Combination of conduction, convection, and latent heat transfer
5. A surface for which emissivity is constant at all temperatures and throughout the entire range of wavelength is called CO1-U
   (a) Opaque (b) Grey (c) Specular (d) Diathermanous

6. The radiant heat transfer from a plate of 2.5 cm2 area at 1250 K to a very cold enclosure is 5.0 W. Determine the emissivity of the plate at this temperature CO1-U

(a) 0.544 (b) 0.144 (c) 0.044 (d) 0.244

7. A cross flow type air heater has an area of 50 cm^2. The overall heat transfer coefficient is 100 W/m^2 K and heat capacity of both hot and cold stream is 1000 W/m K. The value of NTU is CO1-U

(a) 1000 (b) 500 (c) 5 (d) 0.2

8. NTU is a number of transfer units, dimensionless parameter defined as CO1-U

(a) U A/C_{MIN} (b) 2 U A/C_{MIN} (c) 4 U A/C_{MIN} (d) 0.5 U A/C_{MIN}

9. Which evaporator uses the maximum number of pumps for its operation? CO1-U

(a) Forward feed (b) Backward feed

(c) Parallel feed (d) Mixed feed

10. What do we mean by the term Evaporator Consumption? CO1-U

(a) Steam consumed in 1hr (b) Steam produced in 1hr

(c) Feed supplied in 1hr (d) Feed supplied in 1day

PART – B (5 x 2= 10 Marks)

11. Define a fin and explain its purpose in heat transfer. CO1-U

12. How does the Reynolds number influence the transition from laminar to turbulent flow over a flat plate? CO2-App

13. How does emissivity affect radiation heat transfer? CO2-App

14. How does a shell and tube heat exchanger differ from a double-pipe heat exchanger? CO3-Ann

15. In a single-effect evaporator, if the latent heat of vaporization is 2200 kJ/kg and the mass flow rate of the feed is 0.5 kg/s, calculate the heat duty of the evaporator. CO4-App

PART – C (5 x 16= 80 Marks)

16. (a) Consider a composite cylindrical system with different materials. Use the general heat conduction equation to calculate the total heat transfer rate. Assume steady-state conditions and provide necessary assumptions. CO2-App (16)

Or

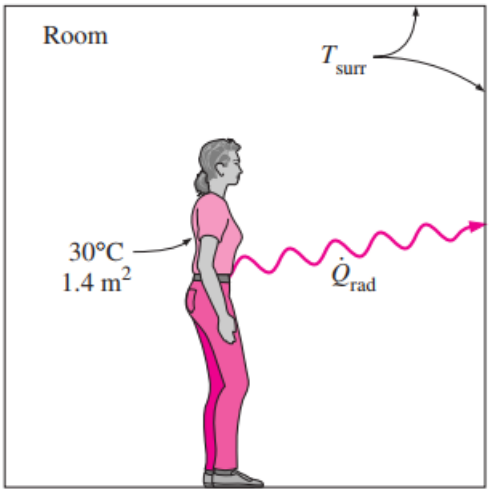
(b) Apply the equation for heat transfer through a composite wall with multiple layers to determine the thermal resistance and heat transfer rate. Discuss how different materials in the wall system influence the heat transfer process. CO2-App (16)

17. (a) Define film-wise and drop-wise condensation. Explain the process of each type of condensation and describe the main differences between them. CO1-U (16)

Or

(b) Describe the phenomenon of nucleate boiling and its importance in heat transfer. Identify the main factors affecting nucleate boiling onset, including surface conditions, temperature, and fluid properties. Explain how nucleate boiling improves heat transfer in boiling heat exchangers. CO1-U (16)

18. (a) i) It is a common experience to feel "chilly" in winter and "warm" in summer in our homes even when the thermostat setting is kept the same. This is due to the so-called "radiation effect" resulting from radiation heat exchange between our bodies and the surrounding surfaces of the walls and the ceiling. Consider a person standing in a room maintained at 22°C at all times. The inner surfaces of the walls, floors, and ceiling of the house are observed to be at an average temperature of 10°C in winter and 25°C in summer. Determine the rate of radiation heat transfer between this person and the surrounding surfaces if the exposed surface area and the average outer surface temperature of the person are 1.4 m^2 and 30°C, respectively. (8) CO3-Ann (16)



(ii) Write an essay on how microwave ovens work, and explain how they cook much faster than conventional ovens. Discuss whether conventional electric or microwave ovens consume more electricity for the same task. (8)

Or

(b) Discuss the difference between black body and gray body radiation. Derive the radiative heat exchange formula between two gray bodies. CO3-Ann (16)

19. (a) Explain the Effectiveness-NTU method for analyzing heat exchangers. Derive the expression for heat exchanger effectiveness in terms of NTU. CO4- App (16)

Or

(b) Apply the principles of heat exchanger design to classify different types of heat exchangers based on their construction, flow arrangement, and heat transfer mechanism. Discuss how each classification affects the selection of heat exchangers for specific industrial applications CO4- App (16)

20. (a) Compare natural circulation and forced circulation evaporators in terms of working principle, efficiency, and applications. CO5- Ana (16)

Or

(b) Compare the working of a single-effect evaporator with that of a multiple-effect evaporator in terms of energy efficiency, operating cost, and industrial applications. CO5- Ann (16)