BRAINWARE UNIVERSITY

Term End Examination 2025-2026
Programme – B.Tech.(ME)-2024
Course Name – Heat Transfer and Thermal Mechanics
Course Code - BTM40108
(Semester IV)

Full Marks : 60 **Time : 2:30 Hours**

[The figure in the margin indicates full marks. Candidates are required to give their answers in their own words as far as practicable.]

Group-A
(Multiple Choice Type Question) 1 x 15=15

1. *Choose the correct alternative from the following :*

(i) Identify the mode of heat transfer governed by Fourier's law.
a) Convection b) Radiation
c) Conduction d) Evaporation

(ii) State the basic assumption of steady-state heat conduction.
a) Temperature varies with time b) Heat generation is zero
c) Temperature is time-independent d) Heat flow is zero

(iii) Identify the dimensionless number used in lumped system analysis.
a) Reynolds number b) Nusselt number
c) Biot number d) Prandtl number

(iv) Identify the shape for which critical insulation thickness applies.
a) Plane wall b) Cylinder and sphere
c) Plane wall only d) Cube

(v) Identify the shape factor used in conduction analysis.
a) Geometry factor b) Radiation factor
c) View factor d) Emissivity

(vi) Identify the governing dimensionless number for forced convection.
a) Grashof number b) Rayleigh number
c) Reynolds number d) Biot number

(vii) Identify the dimensionless number associated with natural convection.
a) Reynolds b) Prandtl
c) Grashof d) Nusselt

(viii) Predict the role of Prandtl number in convection heat transfer.
a) Describes buoyancy forces b) Relates velocity and thermal boundary layers
c) Defines flow regime d) Measures turbulence

(ix) Select the reasons for which polished metals resembles poor radiators.

a) High absorptivity
b) Low emissivity
c) High conductivity
d) High temperature

(x) Interpret the term radiosity of a surface.

a) Energy absorbed by surface
b) Energy reflected only
c) Total radiation leaving a surface
d) Radiation received by surface

(xi) Identify the primary function of a heat exchanger.

a) Store thermal energy
b) Transfer heat between fluids
c) Generate power
d) Reduce fluid pressure

(xii) Identify a commonly used industrial heat exchanger.

a) Shell and tube
b) Reciprocating pump
c) Gas turbine
d) Centrifugal compressor

(xiii) Identify the phase change involved in boiling.

a) Liquid to vapor
b) Vapor to liquid
c) Solid to liquid
d) Solid to vapor

(xiv) Identify the role of latent heat in boiling.

a) Causes sensible heating
b) Absorbed during phase change
c) Released during cooling
d) Negligible effect

(xv) Identify the effect of vapor film thickness in film boiling.

a) Increases heat transfer
b) Decreases resistance
c) Increases thermal resistance
d) No effect

Group-B

(Short Answer Type Questions) 3 x 5=15

2. Explain the physical meaning of thermal conductivity and its role in heat conduction. (3)
3. Apply Fourier's law to evaluate the direction of heat flow in a plane wall. (3)
4. Distinguish between forced convection and natural convection. (3)
5. Apply Stefan–Boltzmann law to calculate the emissive power of a black body at temperature T. (3)
6. Evaluate the suitability of the LMTD method versus effectiveness–NTU method for heat exchanger analysis. (3)

OR

Evaluate the criteria for selecting a heat exchanger for industrial applications. (3)

Group-C

(Long Answer Type Questions) 5 x 6=30

7. Calculate the critical radius of insulation for asbestos ($k = 0.17\ W/m \cdot °C$) surrounding a pipe and exposed to room air at (20 °C) with ($h = 3.0\ W/m^2 \cdot °C$). Calculate the heat loss from a (200 °C), (5 cm) diameter pipe when covered with the critical radius of insulation and without insulation. (5)

8. Apply Fourier's law to calculate the rate of heat conduction through a plane wall of thickness L and thermal conductivity k subjected to temperatures T_1 and T_2 at its faces. (5)
9. Apply the concept of boundary layer thickness to explain how velocity and thermal boundary layers develop over a heated flat plate. (5)
10. The filament of a 75 W light bulb may be considered as a black body radiating into a black enclosure at 700 °C. The filament diameter is 0.10 mm and length is 5 cm. considering the radiation, determine the filament temperature . (5)

11. Apply the concept of LMTD to determine the heat transfer rate in a parallel flow heat exchanger, given inlet and outlet temperatures. (5)
12. Evaluate the effectiveness of dropwise condensation compared to filmwise condensation. (5)

OR

Evaluate the role of mass diffusion in gas separation processes. (5)

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