

GUJARAT TECHNOLOGICAL UNIVERSITY

BE-5 SEMESTER – OLD PAPER – S22 TO S25 – QUESTION BANK

Subject Name & Code:

Heat Transfer- 3151909

Unit 1: Conduction & Critical Radius of Insulation

Repeated Questions:

1. **Derive the general heat conduction equation in Cartesian/Cylindrical coordinates.**
 - (Summer 2022, 07 Marks) - Q1(c)
 - (Summer 2025, 07 Marks) - Q1(c)
 - (Winter 2022, 07 Marks) - Q2(c) OR
 - (Winter 2023, 07 Marks) - Q2(c) OR
 - (Winter 2024, 07 Marks) - Q2(c)
2. **Deduce the general equation to Laplace, Poisson, and Fourier equations.**
 - (Summer 2024, 07 Marks) - Q4(c)
 - (Winter 2022, 07 Marks) - Q2(c)
 - (Winter 2024, 07 Marks) - Q2(c)
3. **Concept and Derivation of Critical Radius of Insulation.**
 - (Summer 2024, 04 Marks) - Q4(c) [*for sphere*]
 - (Summer 2025, 03 Marks) - Q2(a) [*for sphere*]
 - (Winter 2023, 03 Marks) - Q1(a)
 - (Winter 2024, 03 Marks) - Q3(a)
4. **Numericals on Composite Walls/Insulation (Application of electrical analogy).**
 - (Summer 2022, Figure) - Q2(a)
 - (Winter 2023, 07 Marks) - Q1(c) [*Thermopane Window*]

Other Important Questions:

- Define Thermal Diffusivity and explain its significance. (Summer 2024, 03 Marks - Q1(a); Winter 2023, 03 Marks - Q3(a))
- State Fourier's law and give units. (Summer 2022, Q1(b))
- Arrange materials (Copper, Water, Air, Wood) in descending order of thermal conductivity. (Summer 2024, Q1(a))

Unit 2: Fins (Extended Surfaces)

Repeated Questions:

1. **Derive the temperature distribution and heat transfer rate for a fin (insulated tip/losing heat).**
 - (Summer 2025, 07 Marks) - Q3(c)
 - (Winter 2022, 03 Marks) - Q2(a) [*Efficiency & Effectiveness*]
2. **Numericals on Fin Heat Dissipation and Efficiency.**
 - (Summer 2022, 07 Marks) - Q2(c)
 - (Summer 2024, 07 Marks) - Q2(c)
 - (Winter 2022, 07 Marks) - Q1(c)
 - (Winter 2023, 07 Marks) - Q2(c)
 - (Winter 2024, 07 Marks) - Q2(c) OR
3. **Factors/Justifications for using fins.**
 - (Summer 2022, 03 Marks) - Q3(a) [*Factors for optimum design*]
 - (Winter 2024, 03 Marks) - Q2(a) [*"Fins may decrease heat transfer"*]
 - (Winter 2024, 04 Marks) - Q2(b) [*When are fins not useful?*]

Other Important Questions:

- Advantages and limitations of using fins. (Summer 2025, 04 Marks - Q3(b))
- Estimation of error in temperature measurement in a thermometer well. (Summer 2022, 07 Marks - Q2(c); Summer 2025, 04 Marks - Q3(b))

Unit 3: Transient Heat Conduction

Repeated Questions:

1. **Lumped Capacitance Method & its Applicability (Biot Number).**
 - (Summer 2025, 03 Marks) - Q3(a)
 - (Winter 2023, 03 Marks) - Q2(a)
 - (Winter 2024, 04 Marks) - Q4(b)
2. **Define and explain Biot Number and Fourier Number.**
 - (Winter 2024, 04 Marks) - Q4(b)
 - (Numericals in Summer 2023, Q2(c) and Winter 2024, Q5(c))

Other Important Questions:

- Derive the equation for temperature during Newtonian heating/cooling. (Summer 2022, 07 Marks - Q5(c))
- Derive the governing equation for 1D transient heat conduction in a plane wall. (Summer 2025, 03 Marks - Q3(a) OR)

Unit 4: Convection & Boundary Layer Theory

Repeated Questions:

1. **Define and explain Physical Significance of Dimensionless Numbers (Nu, Re, Pr, Gr, Bi, Pe).**
 - (Summer 2025, 07 Marks) - Q4(c)
 - (Summer 2023, 04 Marks) - Q3(b) OR
 - (Winter 2022, 04 Marks) - Q3(b)
2. **Differentiate between Free/Natural and Forced Convection.**
 - (Summer 2023, 03 Marks) - Q1(a)
 - (Summer 2024, 03 Marks) - Q5(a)
 - (Winter 2022, 04 Marks) - Q3(b)
3. **Using Dimensional Analysis (Buckingham π -theorem) to derive correlations.**
 - Forced Convection: $Nu = f(Re, Pr)$ (Summer 2024, 07 Marks - Q5(c))
 - Free Convection: $Nu = f(Gr, Pr)$ (Summer 2023, 07 Marks - Q3(c) OR; Winter 2022, 07 Marks - Q3(c) OR)
4. **Numericals on Free/Forced Convection using given correlations.**
 - (Summer 2022, 07 Marks) - Q5(b,c)
 - (Summer 2023, 07 Marks) - Q5(c) OR
 - (Winter 2023, 07 Marks) - Q4(c)

Other Important Questions:

- Explain Velocity and Thermal Boundary Layer. (Summer 2023, 07 Marks - Q3(c) OR)
- Explain Von-Karman integral momentum equation/Blasius solution. (Summer 2025, 04 Marks - Q4(b); Winter 2023, 07 Marks - Q4(c) OR)

Unit 5: Radiation

Repeated Questions:

1. **State and Prove Kirchhoff's Law of Radiation.**
 - (Summer 2023, 07 Marks) - Q4(c)
 - (Winter 2023, 03 Marks) - Q4(a)
2. **Define and explain terms: Absorptivity, Reflectivity, Transmissivity, Emissivity, Black/Grey Body.**
 - (Summer 2023, 03 Marks) - Q4(a)
 - (Summer 2024, 04 Marks) - Q2(b)
 - (Summer 2025, 07 Marks) - Q4(c) OR
3. **Prove that Total Emissive Power, $E_b = \pi \times I_b$ (Intensity).**
 - (Summer 2022, 07 Marks) - Q4(c)
 - (Winter 2022, 07 Marks) - Q4(c)
4. **Radiation Shields: Concept and Numerical Problems.**
 - (Summer 2024, 03 Marks) - Q2(a)
 - (Summer 2025, 03 Marks) - Q4(a)
 - (Winter 2022, 07 Marks) - Q4(c) OR
 - (Winter 2024, 07 Marks) - Q4(c)
5. **State and explain the laws (Planck's, Wien's, Stefan-Boltzmann).**
 - (Summer 2022, 03 Marks) - Q4(a)
 - (Summer 2025, 07 Marks) - Q4(c) OR

Other Important Questions:

- Numericals on monochromatic energy and total energy using Planck's law. (Summer 2022, 07 Marks - Q4(c))
- Numericals on radiation heat exchange between two surfaces. (Winter 2023, 07 Marks - Q5(c))

Unit 6: Heat Exchangers

Repeated Questions:

1. **Derive LMTD for Parallel Flow/Counter Flow Heat Exchanger.**
 - (Winter 2022, 07 Marks) - Q5(c)
 - (Winter 2024, 07 Marks) - Q1(c)
2. **Define and Explain: Effectiveness, NTU, Heat Capacity Ratio.**
 - (Summer 2022, 07 Marks) - Q3(c)
 - (Summer 2024, 07 Marks) - Q1(c)
 - (Winter 2023, 07 Marks) - Q3(c) OR
3. **Derive the expression for Effectiveness (ϵ) for Parallel Flow.**
 - (Summer 2022, 07 Marks) - Q3(c)
 - (Summer 2025, 07 Marks) - Q2(c) OR
 - (Winter 2023, 07 Marks) - Q3(c) OR
4. **Classification of Heat Exchangers and their Applications.**
 - (Summer 2023, 04 Marks) - Q4(b)
 - (Summer 2025, 04 Marks) - Q2(b)
 - (Winter 2024, 07 Marks) - Q4(c)
5. **Fouling Factor: Definition and Causes.**
 - (Summer 2023, 03 Marks) - Q5(a)
 - (Summer 2024, 03 Marks) - Q1(c)
 - (Winter 2022, 03 Marks) - Q5(a)

Other Important Questions:

- Draw temperature distribution for Condenser and Evaporator. (Summer 2022, Q3(b); Winter 2024, 04 Marks - Q1(b))
- Numericals on Heat Exchanger sizing (finding Area/Number of Tubes). (Winter 2023, 07 Marks - Q3(c))

Unit 7: Boiling & Condensation

Repeated Questions:

1. **Explain different regimes of Pool Boiling (Pool Boiling Curve).**
 - (Summer 2023, 07 Marks) - Q5(c)
 - (Winter 2024, 07 Marks) - Q3(c)
2. **Differentiate between Filmwise and Dropwise Condensation.**
 - (Summer 2023, 04 Marks) - Q5(b)
 - (Summer 2024, 07 Marks) - Q3(c) OR
 - (Winter 2023, 04 Marks) - Q5(b)

Other Important Questions:

- Explain the physical mechanism of boiling. (Winter 2023, 03 Marks - Q5(a))
- Applications of boiling heat transfer. (Winter 2023, 03 Marks - Q5(a) OR)
