



PAPER ID-310540

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Subject Code: BME501

Roll No:

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BTECH
(SEM V) THEORY EXAMINATION 2025-26
HEAT & MASS TRANSFER

TIME: 3 HRS

M.MARKS: 70

Note: Attempt all Sections. In case of any missing data; choose suitably.

Steam table is allowed.

NTU-Effectiveness graph is allowed if required.

SECTION A

1. Attempt all questions in brief.

02 x 7 = 14

Q no.	Question	CO	Level
a.	Define conduction, convection and radiation with one example each. ✓	1	K2
b.	Thermal conductivity of copper is 400 W/mK. What heat flux occurs across 5mm thickness when $\Delta T = 30^\circ\text{C}$? ✓	1	K2
c.	A composite wall has thermal resistances R_1 and R_2 . Write expression for overall heat transfer coefficient.	2	K3
d.	Define the Lumped Capacitance Method ✓	2	K3
e.	Give expression for Reynolds number and calculate for air flow $V = 20\text{m/s}$, $D = 40\text{mm}$, $\nu = 1.5 \times 10^{-5}$.	4	K3
f.	What is the Stefan-Boltzmann law, and how does it relate to the emissive power of a blackbody?	5	K3
g.	What is LMTD and how is it used in heat exchanger design?	6	K4

SECTION B

2. Attempt any three of the following:

07 x 3 = 21

a.	Derive general heat conduction equation in rectangular coordinates and solve heat flux for a wall 0.2m thick and $k = 25\text{W/mK}$ with $\Delta T = 80^\circ\text{C}$.	2	K2
b.	Write expressions for the overall heat-transfer coefficient (U) for a composite wall under steady-state conduction.	2	K3
c.	Using transient conduction relations and Heisler chart, estimate center temperature of a steel plate (20mm) initially 25°C placed in 200°C furnace for 5 min (given α).	2	K3
d.	Air at 1 atm and 25°C flows over surface at 50°C . Using Colburn analogy determine heat transfer coefficient if friction coefficient = 0.005.	4	K3
e.	Radiation emissivity of a surface is 0.6. Calculate heat emitted at 800K compared with blackbody.	5	K3

SECTION C

3. Attempt any one part of the following:

07 x 1 = 07

a.	Derive expression of critical insulation radius for cylinder and compute the radius for insulation $k = 0.12\text{W/mK}$, air film $h = 10\text{W/m}^2\text{K}$.	2	K3
b.	A cylinder of diameter 40mm is insulated with material ($k = 0.08\text{W/mK}$). Calculate critical radius and heat transfer rate for surface temperature 120°C , ambient 30°C .	2	K3

4. Attempt any one part of the following:

07 x 1 = 07

a.	Derive temperature distribution in a uniform fin and calculate fin efficiency for $L = 120\text{mm}$, $k = 200\text{W/mK}$, $h = 25$, $t = 4\text{mm}$.	3	K3
b.	A pin fin of diameter 10mm, length 100mm loses heat to air at 25°C , base	3	K3

At 120°C , $h = 22\text{W/m}^2\text{K}$, $k = 150\text{W/mK}$ find heat dissipation.



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Section C

4 (a) Derive temperature distribution in a **Straight (Rectangular)** uniform fin and calculate fin efficiency for $L=120\text{mm}$, $k=200\text{W/mK}$, $h=25$, $t=4\text{mm}$.

5(b) A vertical plate at 100°C exposed to air at 25°C . Using Churchill–Chu correlation, estimate heat transfer coefficient (properties given).

- **Thermal conductivity (k):** $0.026\text{ W/m}\cdot\text{K}$
- **Kinematic viscosity (v):** $1.57 \times 10^{-5}\text{ m}^2/\text{s}$
- **Prandtl number (Pr):** 0.71

(assume length of plate as 1 m).

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5. Attempt any *one* part of the following:

07 x 1 = 07

a.	Derive laminar flat plate heat transfer expression and using it calculate h for air at 25°C flowing at 2m/s , $x=0.4\text{m}$. What is average coefficient?	4	K3
b.	A vertical plate at 100°C exposed to air at 25°C . Using Churchill-Chu correlation, estimate heat transfer coefficient (properties given).	4	K3

6. Attempt any *one* part of the following:

07 x 1 = 07

a.	Explain shape factor and determine shape factor between two parallel plates of 1m^2 area separated by 0.1m .	5	K3
b.	A radiation shield ($\epsilon=0.1$) is placed between two plates at 600K and 300K . Calculate reduction in radiation heat transfer.	5	K3

7. Attempt any *one* part of the following:

07 x 1 = 07

a.	A counter flow heat exchanger cools water from $80 \rightarrow 40^{\circ}\text{C}$ using oil from $30 \rightarrow 60^{\circ}\text{C}$. Calculate NTU and effectiveness for $U=400\text{W/m}^2\text{K}$ and area= 20m^2 .	6	K4
b.	Draw the heat flux curve for various regions of flow boiling.	6	K4

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