PAPER ID-310540

Subject Code: BME501

Roll No: | | | | | | | | | | | | | |

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 ΔT=30°C?	1	K2
c.	A composite wall has thermal resistances R1 and R2. 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=20m/s, D=40mm, $\nu=1.5\times10^{-5}$.	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=25W/mK with ΔT=80°C.	1	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=0.12W/mK, air film h=10W/m²K.	2	K3
b.	A cylinder of diameter 40mm is insulated with material (k=0.08W/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=120mm, k=200W/mK, h=25, t=4mm.	3	K3
b.	A pin fin of diameter 10mm, length 100mm loses heat to air at 25°C, base at 120°C, h=22W/m²K, k=150W/mK. Find heat dissipation.	3	K3

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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=0.4m. 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 1m² area separated by 0.1m.	5	K3
b.	A radiation shield (ε=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→40°C using oil from 30→60°C. Calculate NTU and effectiveness for U=400W/m²K and area=20m².	6	K4
b.	Draw the heat flux curve for various regions of flow boiling.	6	K4