

**VIT**

Vellore Institute of Technology

(Autonomous Institute for Higher Education)

**SCHOOL OF MECHANICAL ENGINEERING****Continuous Assessment Test – I - Fall Semester 2019-2020****Programme Name & Branch:****B.Tech (BME, BEM, BMA)****Course Name & Code: Heat Transfer, MEE2005****Class Number: 1210 Slot: AI/TA1/V1 Exam Duration: 90 mins Maximum Marks: 50****General instruction(s):**

Use of Heat and Mass Transfer Data book is permitted

SEARCH VIT QUESTION PAPERS

ON TELEGRAM TO JOIN

Assume Suitable data if required

**Answer all questions (5 x 10 = 50 Marks)**

S.No.	Question	Course Outcome (CO)
1.	The inside of a furnace wall is at $1000^{\circ}\text{C}$ and with the existing wall of material with thermal conductivity of $1.7 \text{ W/mK}$ , loses $2.5 \text{ kW/m}^2$ when the outside is exposed to convection to air at $30^{\circ}\text{C}$ with $h = 27 \text{ W/m}^2\text{K}$ . Determine the wall thickness. Additionally $75 \text{ mm}$ thickness of insulation with $k = 0.15 \text{ W/mK}$ is added inside. The furnace wall temperature and the surrounding temperature and convection coefficient remain unchanged. Determine the reduction in heat flow and reduction in the outside surface temperature.	CO1
2.	Derive the expression of critical radius of insulation. Heat is generated at the constant rate of $2 \times 10^3 \text{ W/m}^3$ in a copper sphere ( $k = 386 \text{ W/mK}$ ) of $1 \text{ cm}$ radius. The sphere is cooled by convection from its outer surface into an ambient at $10^{\circ}\text{C}$ with a convection coefficient of $2000 \text{ W/m}^2\text{K}$ . What would be the maximum rate of heat transfer can be achieved by the insulation with the plastic material ( $k = 5 \text{ W/mK}$ )	CO1
3.	Derive a steady state temperature profile ( $T=f(x)$ ) for a semi-infinite slab (width $2L$ ) with constant heat generation ( $g$ ), cooling in the environment ( $T_{\infty}$ ). Assume the other parameters as constant.	CO2
4.	Consider a homogeneous spherical piece of radioactive material of radius $r_0 = 0.04 \text{ m}$ that is generating heat at a constant rate of $q_{\text{gen}} = 4 \times 10^7 \text{ W/m}^3$ . The heat generated is dissipated to the environment steadily. The outer surface of the sphere is maintained at a uniform temperature of $80^{\circ}\text{C}$ and the thermal conductivity of the sphere is $k = 15 \text{ W/m}^{\circ}\text{C}$ . Assuming steady one dimensional heat transfer, (a) Express the differential equation and the boundary conditions for heat conduction through the sphere, (b) Determine the temperature at the centre of the sphere.	CO2
5.	An egg with mean diameter of $40 \text{ mm}$ and initially at $20^{\circ}\text{C}$ is placed in a boiling water pan for $4 \text{ minutes}$ and found to be boiled to the consumers taste. For how long should a similar egg for same consumer be boiled when taken from a refrigerator at $5^{\circ}\text{C}$ ? Take the following properties for egg: Thermal conductivity = $50 \text{ W/m}^{\circ}\text{C}$ , density = $1200 \text{ kg/m}^3$ , Specific heat = $2 \text{ kJ/kg}^{\circ}\text{C}$ and heat transfer coefficient = $100 \text{ W/m}^2\text{C}$ .	CO3