M.E. MECHANICAL ENGINEERING
FIRST YEAR
SECOND SEMESTER EXAM 2025

Subject: CONDUCTION AND RADIATION HEAT TRANSFER

Time: 3 hours | Full Marks: **100**

Answer any four questions

1.	Outline the thermal conditions necessary for one-dimensional heat flow in a slab. Derive the energy equation for a one-dimensional slab experiencing transient response, assuming there is a constant volumetric internal energy source. This slab dissipates heat through Fourier heat transfer. One boundary is maintained at a constant temperature, while the other boundary experiences convective heat transfer. For the initial conditions, we can select a constant temperature to analyze the problem. Determine the heat transfer over a specified period from the analytical temperature response using the separation of variables. Use appropriate notations to address this problem.	25
2.	When is a trapezoidal fin applied to enhance heat transfer? Derive the fin heat transfer equation for a trapezoidal fin that dissipates heat due to convection and radiation through all exposed surfaces. Solve this equation by the Bessel function method to determine the temperature. Make suitable assumptions to develop the analytical model taken here. For the radiation energy, linearization can be adopted.	25
3.	Derive the heat conduction equation for an isotropic solid that is moving at a uniform velocity, using cylindrical polar coordinates.	25

4.	When can Duhamel's theorem be applied to conduction problems? List the steps to use this theorem in solving a partial differential equation, with an example of real-world applications.	25
5. (a)	Write a clear comparison between Green's functions and Laplace transforms, highlighting their definitions, uses, and how they complement each other.	13
(b)	Derive the equation of radiative transfer for an absorbing, emitting medium.	12