Ref. No.: Ex/PG/ME/T/127E/2024

M.E. IN MECHANICAL ENGINEERING FIRST YEAR SECOND SEMESTER EXAMINATION-2024

Subject: CONVECTION HEAT TRANSFER

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

(Answer any FIVE questions)

Q.1	Derive an expression for the x-directional acceleration in the Cartesian coordinate considering the Eulerian frame of reference. Write the x- and y-momentum equations in the Cartesian coordinate. Explain each of the terms. Considering the Scale analysis, derive the expressions/ equations for the boundary layer or the external flow over a flat plate.	(4+4+6+6)
Q.2	Write the energy equation in the Cartesian coordinate. Explain each of its terms. Derive an expression/the energy equation in case of the boundary layer considering the Scale analysis. Define Eckert number. Explain the Reynolds analogy. Define Prandtl number.	(2+6+4 +2+4+2)
Q.3	Derive a suitable expression for the momentum integral equation. Find a cubic profile/expression for the flow over a flat plate assuming necessary boundary conditions.	(12+8)
Q.4	Derive a suitable expression for the energy integral equation. Find a cubic profile for the temperature over an isothermal flat plate assuming necessary boundary conditions.	(12+8)
Q.5	Consider an external flow over an isothermal flat plate. Considering cubic profile for both the velocity and temperature, derive an expression for the Nusselt number in terms of the local Reynolds and Prandtl numbers. Assume necessary conditions. Define Peclet number.	(18+2)
Q.6	State the conditions for the hydrodynamically and thermally fully developed flow. Show that the Nussle number in case of a fully developed flow through a pipe under the constant wall flux condition is 4.36.	(4+16)
Q.7	Consider a vertical hot flat plate. Derive corresponding boundary layer equations. Draw velocity and temperature profiles within the boundary layer. Define Grashof and Rayleigh numbers.	(12+4+4)