Name: **Enrolment No:**	

UPES

End Semester Examination, May 2024

Program Name: B. Tech-Mechanical Engineering **Semester : IV**

Course Name : Heat Transfer **Time : 03 hrs.**

Course Code : MECH2058 **Max. Marks: 100**

Nos. of page(s) : 02

Instructions: Attempt All Questions. One question from section B and C have an internal choice. Assume any missing data if required and mention it clearly.

SECTION A

(5Qx4M=20Marks)

S. No.	Statement of question	Marks	CO
Q1	What is the critical thickness of insulation? Explain it for spherical coordinates.	**4**	**CO1**
Q2	Discuss Grashof's Number and mention its applicability.	**4**	**CO1**
Q3	What is lumped approximation. State its importance and implications.	**4**	**CO2**
Q4	Discuss Fick's law of diffusion.	**4**	**CO3**
Q5	Elaborate the rules applied for calculating the shape factor while measuring the radiative heat transfer.	**4**	**CO4**

SECTION B

(4Qx10M= 40 Marks)

S. No.	Statement of question	Marks	CO
Q6	A composite cylinder is made of 6 mm thick layers each of two materials of thermal conductivities of 30 W/m°C and 45 W/m°C. The inside is exposed to a fluid at 500°C with a convection coefficient of 40 W/m^2 °C and the outside is exposed to air at 35°C with a convection coefficient of 25 W/m^2K. Determine the heat loss for a length of 2 m and the surface temperatures. Inside diameter is 20 mm.	**10**	**CO2**
Q7	Explain the mechanism of film condensation heat transfer on vertical surface.	**10**	**CO3**
Q8	Engine oil at 80°C flows over a flat surface at 40°C for cooling purpose, the flow velocity being 2 m/s. Determine at a distance of 0.4 m from the leading edge the hydrodynamic and thermal boundary layer thickness. Also determine the local and average values of friction and convection coefficients. Take the following properties kinetic viscosity = 83 × 10^{-6} m^2/s, Pr= 1050. Thermal conductivity = 0.1407 W/m K.	**10**	**CO3**
Q9	Deduce mathematical formulation for three-dimensional heat conduction equation with internal heat generation in cylindrical coordinates. **OR**	**10**	**CO4**

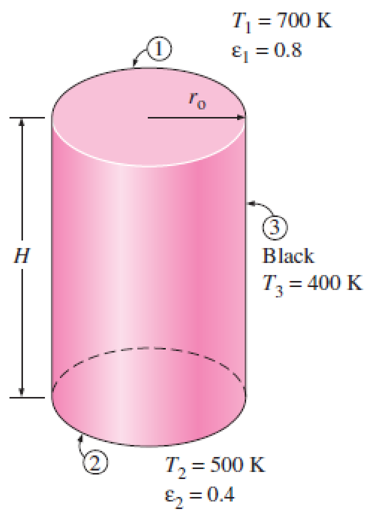
Deduce mathematical formulation for three-dimensional heat conduction equation with internal heat generation in spherical coordinates.

SECTION-C

(2Qx20M=40 Marks)

Q10

Consider a cylindrical furnace with a radius and height of 1 m, as shown in figure. The top (surface 1) and the base (surface 2) of the furnace has emissivity ε_1=0.8 and ε_2=0.4, respectively, and are maintained at uniform temperatures T_1=700 K and T_2=500 K. The side surface closely approximates a blackbody and is maintained at a temperature of T_3=400 K. Determine the net rate of radiation heat transfer at each surface during steady operation and explain how these surfaces can be maintained at specified temperatures.



20 **CO3**

Q11

An economizer in a boiler has flow of water inside the pipes and hot gases on the outside flowing across the pipes. The flow rate of gases is 2,000 tons/hr and the gases are cooled from 390°C to 200°C. The specific heat of the gas is 1005 J/kg K. Water is heated (under pressure) from 100°C to 220°C. Assuming an overall heat transfer coefficient of 35 W/m^{2}K, determine the area required. Assume that the air flow is mixed.

OR

Water flows at a velocity of 1 m/s through a pipe of 25 mm ID and 30 OD and 3 m length. Air at 30°C flows across the tube, with a velocity of 12 m/s. The inlet temperature of the water is 60°C. Determine the exit temperature. The thermal conductivity of the tube material is 47 W/m K.

Fluid	**Density (kg/m^3)**	**Kinematic Viscosity (m^2/s)**	**Prandtl Number**	**Thermal Conductivity (W/m k)**
Water	990	0.5675*10^{-6}	3.68	0.63965
Air	1.2	16.96*10^{-6}	0.699	0.02756

20 **CO4**