BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION)

CLASS: BE **SEMESTER: IV**
BRANCH: CHEM. ENGG./CEP&PE **SESSION : SP/2019**

SUBJECT : CL4001 HEAT TRANSFER OPERATIONS

TIME: 1.5 HOURS **FULL MARKS: 25**

INSTRUCTIONS:
1. The total marks of the questions are 30.
2. Candidates may attempt for all 30 marks.
3. In those cases where the marks obtained exceed 25 marks, the excess will be ignored.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. The missing data, if any, may be assumed suitably.

Q1 (a) Describe the Fourier's law of heat conduction with their assumptions. [2]
(b) Derive an expression for the temperature distribution in a plane wall having uniformly distributed heat sources and one face maintained at a temperature T_1 while the other face is maintained at a temperature T_2. The thickness of the wall may be taken as $2L$. [3]

Q2 (a) Derive the expression for critical radius of insulation for sphere. [2]
(b) A certain material has a thickness of 30cm and a thermal conductivity of 0.04 W/m.^{0}C. At a particular instant in time, the temperature distribution with x, the distance from the left face, is $T = 150x^2 - 30x$, where x is in meters. Calculate the heat-flow rates at x=0 and x=30 cm. Is the solid heating up or cooling down? [3]

Q3 (a) Describe the newton's law of cooling and thermal boundary layer. [2]
(b) One end of a copper rod 30cm long is firmly connected to a wall that is maintained at 200^{0}C. The other end is firmly connected to a wall that is maintained at 93^{0}C. Air is blown across the rod so that a heat-transfer coefficient of 17 W/m^2. ^{0}C is maintained. The diameter of the rod is 12.5 mm. The temperature of the air is 38^{0}C. What is the net heat lost to the air in watts? [3]

Q4 (a) Give the significance of these dimensionless numbers: Nusselt number, Prandtl number, Grashof number and Stanton number. [2]
(b) Derive the expression for local and average heat transfer coefficient Nusselt number for flat plate. [3]

Q5 (a) What is significance of view factor? When is view factor from a surface to itself zero? [2]
(b) A small surface of area A_1 = 3 cm^2 emits radiation as a black body at T_1 = 600 K. Part of the radiation emitted by A_1 strikes another small surface of area A_2 = 5 cm^2. Angle between normal to surface 1 and line of propagation is 55° whereas angle between normal to surface 2 and line of propagation is 40°. Length of line of propagation between surfaces is 75 m. Determine solid angle subtended by A_2 when viewed from A_1, and rate at which radiation emitted by A_1 strikes A_2. [3]

Q6 (a) How many types of resistances occur in radiation? Write expressions for them? [2]
(b) A grey surface of emissivity 0.348 and area 10 m^2 radiates 1000 kW at 1500 K. What would be the effect of increasing the temperature to 1600°C? [3]

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