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VASAVI COLLEGE OF ENGINEERING *(Autonomous)*, HYDERABAD

B.E. (Mech. Engg.: CBCS) VI-Semester Advanced Supplementary Examinations, July-2019

Heat Transfer

Time: 3 hours Max. Marks: 70

Note: i) Answer ALL questions in Part-A and any FIVE from Part-B

ii) Heat and Mass Transfer data book is allowed

iii) Symbols and abbreviations have their regular meaning.

Part-A (10 × 2 = 20 Marks)

1. Define thermal conductivity?
2. A metallic plate 3cm thick is maintained at 400^{0}C on one side and 100^{0}C on other. Calculate heat transfer. (k= 370W/m K).
3. Define fin effectiveness? When is the use of fin not justified?
4. Write the importance of Lumped Heat Capacity Analysis.
5. What are the generally accepted values of critical Reynolds numbers for (a) flow over a flat plate (b) flow over a circular tube (c) flow in a tube
6. Write the significance of thermal entrance length in internal flow through pipes.
7. Draw the velocity and temperature profiles for film condensation over a vertical flat plate.
8. Why is counter-flow Heat Exchanger more effective than a parallel flow heat exchanger.
9. Define Stefan Boltzmann's law?
10. What are radiation shields?

Part-B (5 × 10 = 50 Marks)

11. a) Derive the generalized three dimensional heat conduction equation in Cartesian coordinates. [6]

b) Heat is uniformly generated in a stainless steel plate having k = 20 W/m°C. The thickness of the plate is 1.2 cm and the heat generation rate is 512 MW/m^3. If the two sides of the plates are maintained at 102°C and 210°C respectively, calculate the maximum temperature in the plate and temperature at its centre. [4]

12. a) Derive an expression for temperature distribution and heat transfer along a fin with infinite length. [5]

b) An aluminum sphere of radius 7.80cm is initially at a temperature of 325°C is suddenly immersed in a fluid at 18°C. The convection heat transfer coefficient is 62 W/m^{2}K. Calculate the time required to cool the aluminum to 92°C using lumped capacity method of analysis. (Take ρ = 2700 kg/m^3, Cp= 900 J/kg K, k= 205 W/m K) [5]

13. a) Distinguish between laminar and turbulent flow.. [4]

b) Air at 20^{0}C is flowing along a heated flat plate at 134^{0}C at a velocity of 3m/s. plate is 2m long and 1.5m wide. [6]

i). Calculate Reynolds number at 40cm from leading edge of the plate.

ii). Calculate thickness of hydrodynamic boundary layer and skin friction coefficient at 40 cm from leading edge of the plate.

Contd... 2

14. a) Discuss briefly the various regimes in boiling heat transfer. [5]

b) Hot oil with a capacity rate of 2500W/K (Cp) flows through a double pipe heat exchanger. It enters at 360^0C and leaves at 300^0C, cold fluid enters at 30^0C and leaves at 200^0C. If overall heat transfer coefficient is 800 W m^2K, determine heat transfer area required for i) parallel flow and ii) counter flow. [5]

15. a) What is Kirchoff's law? Clearly explain. [4]

b) Emissivities of two large parallel plates maintained at 820°C and 313°C are 0.32 and 0.56 respectively. Calculate the net radiant heat exchanger per m^2 for these plates. Find the percentage reduction in heat transfer if a polished shield of emissivity $\in$= 0.05 is placed in between and also calculate the temperature of the shield. [6]

16. a) Derive the expression for critical radius of insulation for a cylindrical system. [5]

b) Estimate the time required to cook a carrot in boiling water at atmospheric pressure. The carrot is initially at room temp 32 °C and the cooking requirement stipulates that a minimum temperature of 97 °C is reached at the center of carrot. Treat the carrot as a long cylinder of 18 mm diameter and having the following properties: ρ=1025 kg/m^3, C_p = 4000 J/kg K, k = 3.45 W/m-K, convective heat transfer coefficient h = 60 W/m^2-K. [5]

17. Answer any ***two*** of the following:

a) Define Grashoff's number and explain its significance in free convection heat transfer. [5]

b) Sketch and discuss the general arrangement of parallel flow, counter flow and cross flow heat exchangers and to which arrangement LMTD correction factor is applied. [5]

c) Define radiation shape factor and calculate radiation shape factor of hemispherical bowl of diameter 'D' with respect to itself. [5]

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