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B – 5947

Reg. No. : ....

Name : ....

Sixth Semester B.Tech. Degree Examination, April 2017
(2013 Scheme)
13.604 : HEAT AND MASS TRANSFER (MSU)

Time : 3 Hours Max. Marks : 100

Instruction : Use** of data book is **allowed.

PART – A

Answer **all** questions; **each** carries **2** marks.

1. State the laws governing conduction and convection.
2. Write the general heat conduction equation in 3 dimensional Cartesian co-ordinates and reduce the equation to steady state one dimensional equation without heat generation.
3. State and explain Newton's law of cooling.
4. What is the physical significance of Prandtl number ?
5. What is a Heat exchanger ? Among counter flow and Parallel flow type which possess more LMTD ?
6. What is the difference between condenser and evaporator ?
7. Define Pin-fin. What is the purpose of using fins ?
8. State Stefan Boltzmann law of radiation and represent it mathematically.
9. Define Wien's displacement law.
10. What is the analogy between heat and mass transfer ? **(10×2=20 Marks)**

PART – B

Answer **any one full** question from **each** Module; **each** carries **20** marks and **each** sub-question carries **10** marks.

Module – I

11. a) Derive general 3D heat conduction equation in cylindrical co-ordinates.

    b) A furnace wall consists of 25 cms of fire brick, 15 cms of common brick, 5 cm layer of magnesia insulation and 3 mm thick steel plate on the outside. If the inside surface temperature of the furnace is 1600°C and outside surface temperature is to be 80°C, calculate the temperatures between layers and the heat loss per unit area of furnace wall. Take k for fire brick = 1.28 W/m-k, k for steel = 69.78 W/m-k, k for common brick = 0.85 W/m-k, k for magnesia = 0.0697 W/m-k.

OR

P.T.O.

12. a) Explain briefly the physical significance of critical thickness of insulation and derive the condition for the same for a hollow cylinder.

b) An exterior wall of a house may be approximated by a 0.1 m layer of common brick (k = 0.7 W/m°C) followed by a 0.05 m layer of gypsum plaster (k = 0.48 W/m°C). What thickness of loosely packed rock wool insulation (k = 0.065 W/m°C) should be added to reduce the heat loss or gain through the wall by 80% ?

Module – II

13. a) Air is flowing over a flat plate of 5 m long and 2.5 m wide with a velocity of 4 m/s at 15°C. If $\rho = 1.208$ kg/m^3 and kinematic viscosity = 1.47×10^{-5} m^2/s, calculate

i) length of plate over which the boundary layer is laminar, and thickness of the boundary layer (Laminar)

ii) Shear stress at the location where the boundary layer ceases to be laminar and

iii) total drag force on the both sides on that portion of plate where boundary layer is laminar.

b) Write a note on

i) Hydrodynamic boundary layer and

ii) Thermal boundary layer.

OR

14. a) Show by Buckingham pi theorem that Nusselt number is a function of Grashoff's no. and Prandtl no. in case of natural convection heat transfer.

b) A wall 80 cm height and 400 cms wide is maintained at 40°C in an atmosphere of 20°C. Determine the heat lost by natural convection neglecting end effects. Also find the variation in heat transfer if the wall is made 400 cms height and 80 cms wide.

Module – III

15. a) The flow rates of hot and cold water streams running through a parallel flow heat exchanger are 0.2 kg/s and 0.5 kg/s respectively. The inlet temperatures on the hot and cold sides are 75°C and 20°C respectively. The exit temperature of hot water is 45°C. If the individual heat transfer coefficients on both sides are 650 w/m^2°C, calculate the area of the heat exchanger.

b) Derive an expression for the temperature distribution and heat flow for a long fin.

OR

16. a) Derive an expression for effectiveness in terms of NTU and heat capacity rates for parallel flow heat exchanger.

b) A counter flow heat exchanger is employed to cool 0.55 kg/s (c_p = 2.45 kJ/kg°C) of oil from 115°C to 40°C by the use of water. The inlet and outlet temperatures of cooling water are 15°C and 75°C, respectively. The overall heat transfer coefficient is expected to be 1450 W/m^2°C. Using NTU method, calculate the

i) The mass flow rate of water

ii) The effectiveness of heat exchanger

iii) The surface area required.

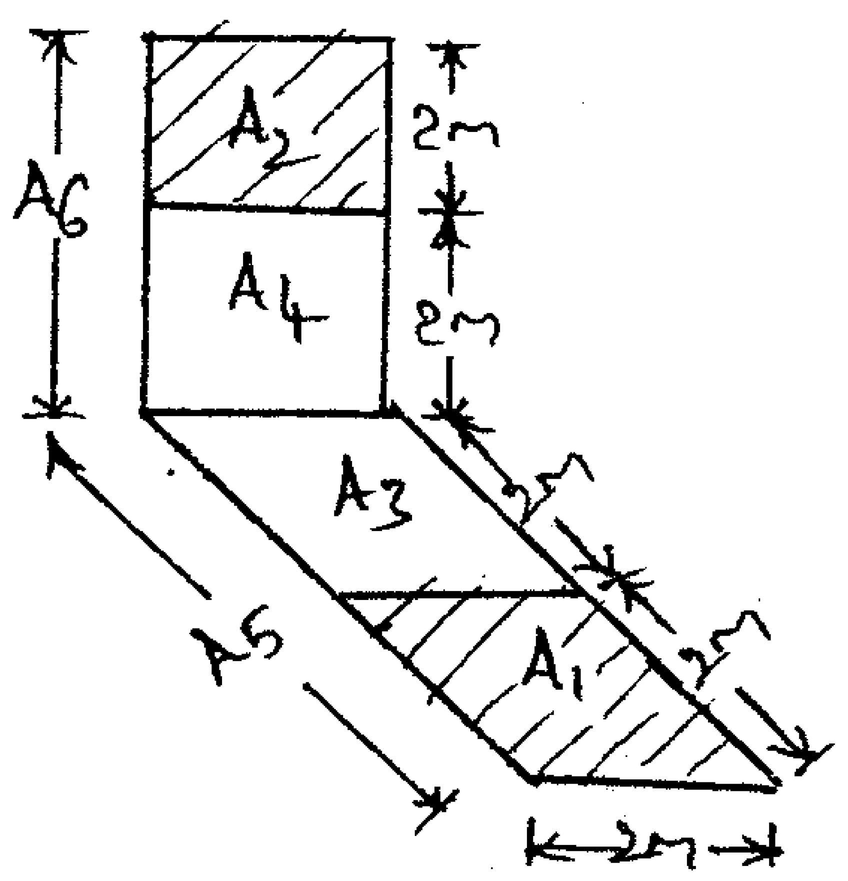
Module – IV

17. a) Derive an expression for radiation heat exchange between two infinite gray parallel plates.

b) Derive Ficks law of diffusion.

OR

18. a) In the figure shown below the areas A_1 and A_2 are perpendicular but do not share the common edge. Find the shape factor F_{1-2} for the arrangement shown.



b) Explain the phenomenon of equimolar counter diffusion. Derive an expression for equimolar counter diffusion between two gases or liquids.