

G 1063

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Reg. No.....

Name.....

**B.TECH. DEGREE EXAMINATION, MAY 2016**

**Sixth Semester**

Branch : Mechanical Engineering/Automobile Engineering

**HEAT AND MASS TRANSFER (MU)**

(Old Scheme—Prior to 2010 Admissions—Supplementary/Mercy Chance)

Time : Three Hours

Maximum : 100 Marks

**Part A**

*Answer all questions.  
Each question carries 4 marks.*



1. Explain the term over all heat transfer coefficient.
2. Explain critical radius of Insulation for cylindrical surface.
3. Explain Reynolds analogy.
4. Explain with a neat diagram development of laminar velocity profile inside a pipe.
5. Define the term Fouling factor.
6. What are compact heat exchangers ? Give an example.
7. Define : (a) Black body ; (b) white body ; (c) gray body.
8. Differentiate between Specular and Diffuse surfaces ?
9. Differentiate between film and drop wise condensation.
10. Define Fick's law of diffusion.

(10 × 4 = 40 marks)

**Part B**

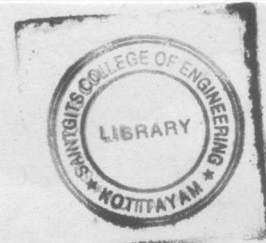
*Answer all questions.  
Each full question carries 12 marks.*

11. (a) Derive the one-dimensional heat conduction equation in a cylinder with density  $\rho$ , specific heat  $C$  and outer radius  $R$ .

*Or*

- (b) A composite cylinder consist of 10 cm radius steel pipe of 25 mm thickness over which two layers of insulation 30 mm and 35 mm are laid. The conductivities are 25 W/m K, 0.25 W/m K and 0.65 W/m K. The inside is exposed to convection at 300°C with  $h = 65 \text{ W/m}^2\text{K}$ . The outside is exposed to air at 30°C with  $h = 15 \text{ W/m}^2\text{K}$ . Determine the heat loss/m. Also find interface temperatures.

**Turn over**



12. (a) A solar concentrator causes a heat flux of  $2000 \text{ W/m}^2$  on tube of 60 mm ID. Pressurized water flows through the tube at a rate of  $0.01 \text{ kg/s}$ . If the bulk temperature at inlet is  $20^\circ\text{C}$ , what will be the length required to heat the water to a bulk temperature of  $80^\circ\text{C}$ . Also find the wall temperature at exit.

Or

- (b) A flat-plate solar collector contains a number of copper tubes that are painted black to enhance the absorptance of thermal radiation from the sun. Consider one such copper tube that is  $\frac{1}{2}$  standard type M and is 3 m long. It conveys ethylene glycol at a volume flow rate of  $3.25 \times 10^{-6} \text{ m}^3/\text{s}$ . The liquid enters the tube at a (bulk) temperature of  $20^\circ\text{C}$ . Determine the fluid outlet temperature and the tube-wall temperature at the outlet. Take the incident heat flux to be  $2200 \text{ W/m}^2$ .
13. (a) The inlet and outlet temperature of hot and cold fluids in a double pipe heat exchanger are  $220^\circ\text{C}$ ,  $100^\circ\text{C}$  and  $80^\circ\text{C}$  and  $120^\circ\text{C}$ . Determine whether the exchanger is parallel flow or counter flow. Also determine the LMTD and effectiveness of the exchanger and the capacity ratio.

Or

- (b) Derive an expression for effectiveness for counter flow heat exchangers.
14. (a) Two circular disks of 1m diameter are placed coaxially, parallel and symmetrically at a distance of 1 m. The disks have an emissivity of 0.6 and are at 1000 K and 500 K. Determine the reduction in radiation in heat flow due to the introduction of a shield of equal diameter midway  $n =$  between the two. The shield of equal diameter midway between the two. The shield has an emissivity of 0.1 on both sides. (Neglect interactions to the outside pipe).

Or

- (b) Two large parallel planes are at 1000 K and 600 K. Determine the heat exchange per unit area, (i) if surface are black ; (ii) if the hot one has an emissivity of 0.8 and the cooler one 0.5 ; (iii) if a large plate is inserted between these two, the plate having an emissivity of 0.2.
15. (a) The condenser of a steam power plant operates at a pressure of 7.38 kPa. Steam at this pressure condenses on the outer surface of horizontal tubes through which cooling water circulates. The outer diameter of the pipe is 3 cm, and the outer surfaces of tube are maintained at  $30^\circ\text{C}$ . Determine ; (i) rate of heat transfer to the cooling water circulating in the tubes and (ii) the rate of condensation of steam per length of horizontal tube.

Or

- (b) A square plate of side 1m has one of its sides coated with naphthalene and stands vertically in still air at  $53^\circ\text{C}$ . Determine diffusion rate.  $M = 128$ ,  $D = 6.11 \times 10^{-6} \text{ m}^2/\text{s}$ , kinematic viscosity =  $18.8 \times 10^{-6} \text{ m}^2/\text{s}$   $Sc = 3.077$ . The vapour pressure at  $53^\circ\text{C}$  is  $1.333 \times 10^{-3} \text{ bar}$ ,  $R_v = 8315/128 = 64.91 \text{ J/kg K}$ ,  $T = 326 \text{ K}$ .

(5 × 12 = 60 marks)