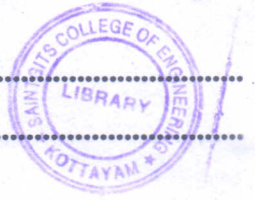


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Reg. No.....

Name.....



**B.TECH. DEGREE EXAMINATION, MAY 2015**

**Sixth Semester**

Branch : Automobile Engineering/Mechanical Engineering/Production Engineering  
AU 010 602/ME 010 602/PE 010 602—HEAT AND MASS TRANSFER (AU, ME, PE)  
(Regular/Improvement/Supplementary)

Time : Three Hours

Maximum : 100 Marks

*Use of Approved data-book is permitted.  
Assume any missing data if required.*

**Part A**

*Answer all questions.*

*Each question carries 3 marks.*

1. Define thermal conductivity, thermal resistance and thermal conductance ?
2. Differentiate between mechanisms of heat transfer by free and forced convection.
3. How does a fin enhance heat transfer at a surface ?
4. State Kirchoff's law of radiation ?
5. State the different modes of mass transfer ?

(5 × 3 = 15 marks)

**Part B**

*Answer all questions.*

*Each question carries 5 marks.*

6. Derive the equation for overall thermal resistance to heat flow through multilayer composite cylindrical wall.
7. Distinguish between thermal boundary layer and hydrodynamic boundary layer ?
8. Derive the effectiveness — NTU relationship for a counter flow heat exchanger.
9. Explain Stefan Boltzmann Law.
10. Explain Fick's law of diffusion.

(5 × 5 = 25 marks)

**Turn over**

**Part C**

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

11. (a) Derive an expression for heat transfer through a composite wall of three layers of different materials.

*Or*

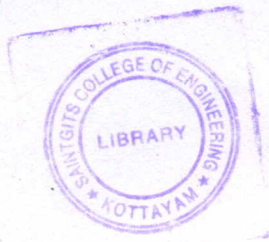
- (b) Two insulation materials A and B, in powder form, with thermal conductivities of  $0.005 \text{ W/m}\cdot\text{deg}$  and  $0.03 \text{ W/m}\cdot\text{deg}$  were purchased for use over a sphere of  $40 \text{ cm}$  diameter. Material A was to form the first layer  $4 \text{ cm}$  thick and material B was to be the next layer  $5 \text{ cm}$  thick. Due to oversight during installation, whole of material B was applied first and subsequently there was a layer formed by material A. Investigate how the conduction heat transfer would be affected.
12. (a) An electrically heated square plate  $50 \text{ cm} \times 50 \text{ cm}$ , has one of its surface thermally insulated and the other surface dissipates heat by free convection into atmospheric air at  $20^\circ\text{C}$ . The heat flux over the surface of the plate is uniform and results in a mean temperature of  $60^\circ\text{C}$ . If the plate is inclined at an angle of  $50$  degree from the vertical, make calculations for the heat loss from the plate for the heated surface facing up.

*Or*

- (b) Explain in detail the mechanism of free convection? Show by dimensional analysis that problems in heat transfer involving free convection only, the Nusselt number can be expressed as a function of the Prandtl number and Grashof number.
13. (a) A rod of  $10 \text{ mm}$  square section and  $160 \text{ mm}$  length with thermal conductivity of  $50 \text{ W/m}\cdot\text{deg}$  protrudes from a furnace wall at  $200^\circ\text{C}$ , and is exposed to air at  $30^\circ\text{C}$ , with convection coefficient  $20 \text{ W/m}^2\cdot\text{deg}$ . Make calculations for the heat convected upto  $80 \text{ mm}$  and  $158 \text{ mm}$  lengths and comment on the result. Adopt a long fin model for the arrangement.

*Or*

- (b) A steam condenser is transferring  $250 \text{ kW}$  of thermal energy at a condensing temperature of  $65^\circ\text{C}$ . The cooling water enters the condenser at  $20^\circ\text{C}$  with a flow rate of  $7500 \text{ kg/hr}$ . Calculate the log mean temperature difference. If overall heat transfer coefficient for the condenser surface is  $1250 \text{ W/m}^2\cdot\text{deg}$ , what surface area is required to handle this load? What error would be introduced if the arithmetic mean temperature difference is used rather than the log mean temperature difference?



14. (a) Explain : (a) intensity of radiation ; (b) Wein's displacement law ; (c) Planck's law ; and (d) Radiosity.

*Or*

- (b) The net radiation from the surface of two parallel plates maintained at temperature  $T_1$  and  $T_2$  is to be reduced by 79 times. Calculate the number of screens to be placed between the two surfaces to achieve this reduction in heat exchange, assuming the emissivities of the screens on 0.5 and that of the surfaces on 0.8.
15. (a) Discuss in detail the various regimes in boiling and explain the condition for the growth of bubbles. What is the effect of bubble size on boiling ?

*Or*

- (b) Explain two dimensional steady state heat conduction.

