

**B.Tech. MECHANICAL ENGINEERING  
(BTMEVI)****Term-End Examination****December, 2012****BIME-034 : HEAT AND MASS TRANSFER***Time : 3 hours**Maximum Marks : 70*

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*Note : Attempt **any five** questions. Assume suitable missing data if any.*

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1. (a) Derive the fourier three dimensional heat conduction equation in Cartesian coordinate. 7
- (b) A solid sphere of radius 0.5m has an internal heat generation rate of  $2 \times 10^6$  W/m<sup>3</sup>. If the thermal conductivity of the material is 40 W/mk and the conductive heat transfer coefficient at the surface sphere is 10W/m<sup>2</sup>K. Calculate the temperature at the outer surface and at the centre. Take the ambient temperature as 30°C. 7
2. (a) Determine the optimum shape of a fin having the minimum weight for a given heat flow. Explain how the triangular fin is of the best shape ? 7

- (b) Define thermal conductivity and explain its significance in heat transfer. How do thermal conductivity of gases and liquids vary with temperature ? 7
3. (a) What is significance of critical thickness of insulation? Derive an expression for critical radius of a cylinder. 7
- (b) Derive an expression for temperature distribution and rate of heat transfer in a spherical vessel. Assume suitable boundary condition. 7
4. (a) When one of two fluids undergoes phase change, show that the effectiveness values for both parallel flow and counter flow heat exchangers are equal and given by : 7
- $$E = 1 - \exp(-NTU)$$
- (b) A flow of 0.1kg/s exhaust gases at 700k from a gas turbine is used to preheat the incoming air, which is at the ambient temperature of 300K, It is desired to cool the exhaust to 400K and it is estimated that an overall heat transfer coefficient of 30W/m<sup>2</sup>k can be achieved in an appropriate exchanger. Determine the area required for a counter flow heat exchanger. Take the specific heat of exhaust gases, same as air, which is 1000J/kgK. 7

5. (a) Drive the expression for boundary layer thickness and rate of heat transfer for laminar film condensation on a vertical surface 7
- (b) Two black discs 1m in diameter are placed directly opposite to each other at a distance of 0.5m. The discs are maintained at 1000K and 500K respectively. Calculate the heat flow between the discs 7
- (i) when no other surfaces are present ?  
and
- (ii) when the discs are connected by a cylindrical refractory no-flux surface ?
6. (a) Explain partial or unstable boiling. 7
- (b) Explain the operation of a heat pipe. Why is it called a super conductor? 7
7. Write short note on the following. 3.5x4=14
- (a) Gray body
- (b) Stefan-Boltzmann law
- (c) Biot Number
- (d) Prandtl Number
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