Biomedical Engineering Program

Midterm exam. In Heat and Mass Transfer (MPE271) 2019-2020

Time Allowed 60 minutes (20 total marks)

Name : .....

Section : .....

Question (1): (4 marks) For Finite fin with insulated end , derive the following relation

$$Q_{fin} = \sqrt{phkA}\,(t_0 - t_\infty)\tanh ml.$$

Question (2):(6 marks) A current of 200 A is passed through a stainless-steel wire[k=19 W/m· °C] 3 mm in diameter. The resistivity of the steel may be taken as $\rho = 70 \times 10^{-6}$ Ω·cm, and the length of the wire is 1 m. The wire is submerged in a liquid at t_∞=110 °C and experiences a convection heat-transfer coefficient of 4000 W/m^2 °C. Calculate the wall and center temperature of the wire.

Question (3):(5 marks) A steel steam pipe (k=40 W/m.K) 10 *cm I.D.* and 12 *cm O.D.* is covered with insulation having a thermal conductivity of 0.6 *W/m. K.* If the convective heat transfer coefficient between the insulation surface and the surrounding air is 8 $W/m^2 \cdot K$, determine the critical radius of insulation and plot the relation between Q versus r_3. If the temperature difference between the inside surface of the pipe and the surrounding air is 75 °C.

Question (4) :(7 marks) A 1*m* long, *10-cm.* dia, cylinder placed in an atmosphere of *40°C* is provided with *12* longitudinal straight fins (*40 W/m.K) 12 mm* thick. The fins protrude *30 mm* from the cylinder surface. The heat transfer coefficient from the cylinder and fins to the ambient air is *40* W/m^2K. Calculate: (a) the rate of heat transfer if the surface temperature of cylinder is *200° °C*. Take the fins efficiency = 0.95.