Lebanese American University
School of Engineering and Architecture
Department of Mechanical Engineering

MEE 304 HEAT TRANSFER
Midterm I, Duration 1.5 hrs

Name: **April. 27, 2006** **ID:**

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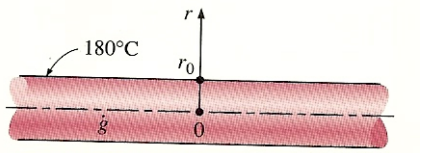
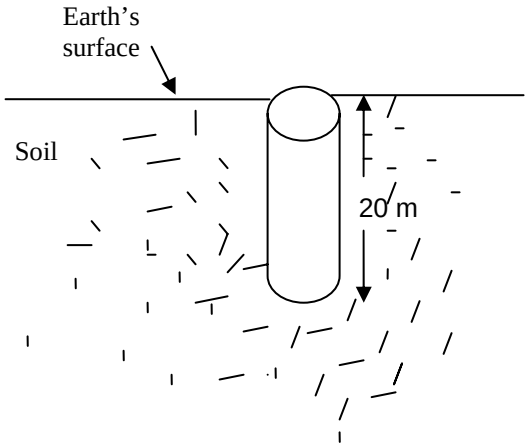
1) (25 pts) A long homogenous resistance wire of radius r_o= 5 mm is being used to heat the air in a room by the passage of electric current. Heat is generated in the wire uniformly at a rate of $\dot{q} = 5 \times 10^7 W/m^3$ as a result of resistance heating. If the temperature of the outer surface of the wire remains at 180°C, determine the temperature of at *r*= 2 mm after steady state operation conditions are reached. Take the thermal conductivity of the wire to be $k(T) = k_o(1+\beta T)$ where k_o=8 W/m°C and β= 8.7×10^{-4} K^{-1} .



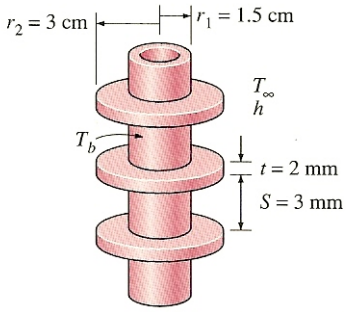
2) (20 pts) A 20-m long, 10-cm-diameter hot pipe of district heating system is buried in the soil as shown below. The outer surface temperature of the pipe is 80°C. Taking the surface temperature of the earth to be 10°C and the thermal conductivity of the soil at that location to be 0.9 W/m.°C, determine the rate of heat loss from the pipe.



3) (30 pts.) Steam in a heating system flows through tubes whose outer diameter is D_1= 3 cm and whose walls are maintained at a temperature of 120°C. Circular aluminum fins (k= 180 W/m.°C) of outer diameter D_2=6 cm and constant thickness t=2mm are attached to the tube, as shown below. The space between the fins is 3 mm, and thus there are 200 fins per meter length of the tube. Heat is transferred to the surrounding air at T_∞=25°C, with a combined heat transfer coefficient of h=60 W/m^{2o}C.

a) Determine the increase in heat transfer from the tube per meter if its length as a result of adding fins.(25 pts)

b) The overall effectiveness of the finned tube (5pts)



4) (25 pts.) Radioactive wastes are packed in a thin-walled spherical container. The wastes generate thermal energy non-uniformly according to the relation $\dot{q} = \dot{q}_o\left[1-\left(r / r_o\right)^2\right]$, where $\dot{q}$ is the local rate of energy generation per unit volume, $\dot{q}_o$ is the constant, and r_o is the radius of the container. Steady-state conditions are maintained by merging the container in a liquid that is at T_∞ and provides a uniform convection coefficient h. Determine the temperature distribution, $T(r)$, in the container. Express your result in terms of $\dot{q}_o, r_o, T_\infty, h$, and the thermal conductivity k of the radioactive wastes.