Code Number :.....

HEAT TRANSFER QUALIFYING EXAM

January 2007

OPEN BOOK (only one book allowed), CLOSED NOTES

Answer all four questions

All questions have equal weight

TIME: 3.0 hrs

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- **Take any required property from your book, approximate values if necessary.**
- **If you make any assumption to reach a solution state it clearly**

Question # 1

A solid cylinder made of brass, 5cm in diameter and 5cm long, is initially at uniform temperature of 316°C. It is suddenly immersed in a tank of water maintained at 21°C. For brass the density, specific heat and conductivity coefficients are 8520 kg/m^3, 385 J/(kg.K), and 111 W/(m.K), respectively. The heat transfer coefficient h can be taken as 2000W/(m^2.K).

a) Calculate the temperature, after it cools for 15s, inside the brass, assuming a uniform temperature (lumped model) in the brass.

b) Calculate the temperature, after it cools for 15s, at the center and at a radial position of 2cm and a distance of 2cm from one end of the cylinder.

Question # 2

Water enters a long thick-walled tube with temperate of 20°C, density of 1000 kg/m^3 and average velocity of 0.3183 m/s and leaves with higher temperature of 60°C. The water is heated by electrical heating within the tube wall with a uniform generation rate of 10,000,000 W/m^3 . The inner and outer diameters of the tube are 2cm and 4cm. The outer side of the tube is well insulated. For water the density and specific heat coefficients are 1000 kg/m^3 and 4179 J/(kg.K), respectively.

a) Calculate the tube length.

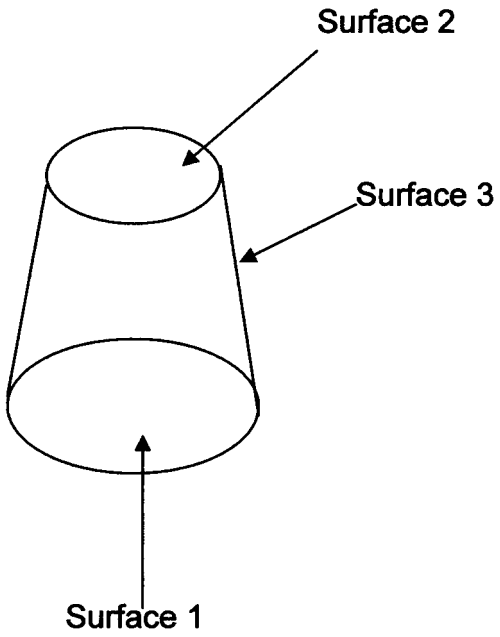
b) Calculate local convection coefficient at the outlet.

c) Explain how you solve this problem when the outer surface of the tube is not insulated and heat is lost through this surface by free convection and radiation.

Question # 3

Consider the three-surface enclosure shown below. The lower plate (A_1) is a gray diffuse surface with $\varepsilon = 0.5$. The disk has a diameter of 1.2 m, a temperature of 500 K, and is supplied with a heat rate of 1400 W. The upper plate (A_2), a disk parallel to A_1, is a diffuse gray surface with $\varepsilon = 0.7$, a diameter of 1.2m and is maintained at 650K. The separation distance between the two surfaces, created by the side surface is 1.2 m. The emissivity of surface 3 is 0.4. Assume convection is negligible.

a) Draw the equivalent electrical network, and properly label each element
b) Determine the angle factor between the bottom plate and the side wall, and the bottom plate and the top plate
c) Derive all appropriate equations necessary to determine the temperature of surface 1



Question # 4

Air at 10 °C and 1 atm blows with a velocity of 10 m/s across a 1 meter long section of a power transmission wire that has a diameter equal to 6mm. The wire carries an electric current of 50 amp and has a resistance of 0.002 ohm per meter of length. Answer the following:

a. Determine the heat transfer coefficient for the wire
b. Determine the heat transfer rate per meter for the wire
c. Determine the temperature of the wire
d. Determine the drag on the 1 meter section of wire