CARLETON UNIVERSITY
DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

AERO 4446-
HEAT TRANSFER FOR AEROSPACE APPLICATIONS

MIDTERM EXAMINATION
October 26, 2010

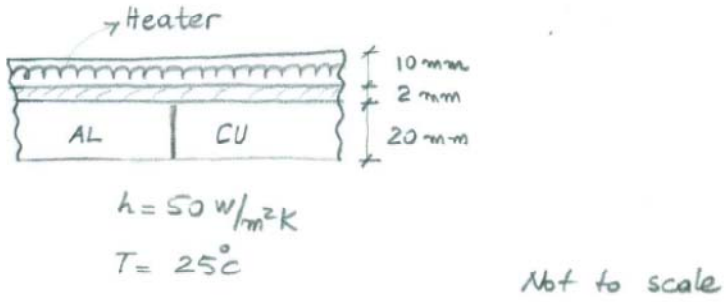
DURATION: 80 MINUTES

Course notes, hand written Problem Set solutions, hand calculators are permitted.

QUESTION 1 (30 Marks)

An aluminium plate of 20 mm thickness is attached to a copper plate of same thickness as shown in the figure below. These 20-mm thick plates are covered with a thin contact layer of 2 mm at one side. Another copper plate of 10 mm thickness is heated electrically with a uniform heat flux of 3000 W/m^2 and attached to these two 20-mm thick plates through the contact layer. All these plates are very long. The lower surface is exposed to convection heat transfer with a convection heat transfer coefficient of 50 W/m^2 K and the surrounding temperature is 25^{o}C. If the surface of the heater copper plate that is attached to the cover layer has a temperature of 200^{o}C, determine the thermal contact conductance of the contact layer in W/m^{2}K.

k_{al}=210 W/mK, k_{cu}=380 W/mK



Answer: 20.7 W/m^{2}K

QUESTION 2 (30 Marks)

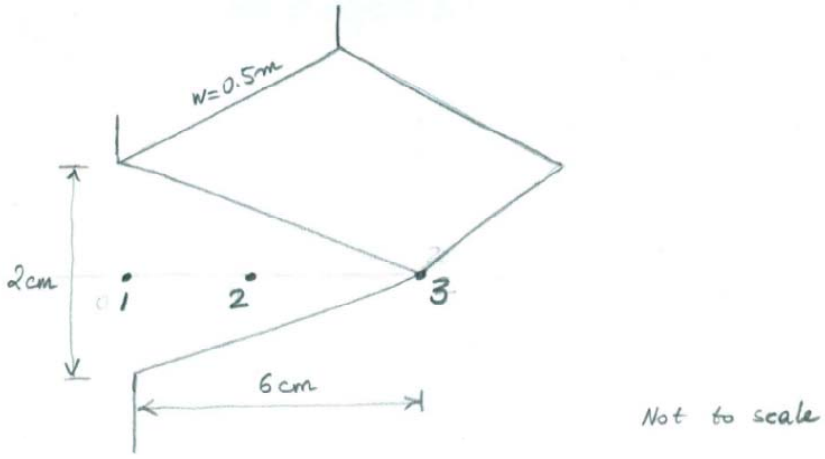
An aluminum block with a cylindrical cross section is initially at the ambient temperature of 90 ^{o}F. The block has a height of 5 in and a diameter of 2.5 in. In order to cool the block, a person grabs the block and starts shaking it in the iced water at 32^{o}F. If the heat transfer coefficient between the iced water and the aluminum block is 30 Btu/h ft^2 · ^{o}F.

a) Calculate how long it will take for the block to cool to 40 ^{o}F.
b) Clearly state the two main assumptions required to solve this problem.

Use the following properties for the block,
ρ = 168 lbm/ft^3, c_p = 0.216 Btu/lbm ^{o}F, and k = 130 Btu/h ft ^{o}F
Answer: 5.99 min

QUESTION 3 (40 Marks)

An aluminum alloy fin (k= 180 W/m °C) of triangular cross section has a length L = 6 cm, a width of w = 0.5 m and a base thickness b = 2 cm as shown in the figure. The base of the fin is maintained at a temperature of T_1=100°C. The fin is losing heat to the surrounding medium at T=20°C with a heat transfer coefficient of h =20 W/m^2 °C. Using the finite difference method with three equally spaced nodes along the fin in the x-direction and knowing that the temperature of node 2 is T_2=90^{o}C, determine the temperature at node 3.



Answer: 88.61 C