

EMBRY-RIDDLE AERONAUTICAL UNIVERSITY  
Engineering Science

ES 312 – Fund. Of Energy Transfer  
Homework Assignment 4  
Due: 3/3/08

- 1) The outside of a copper wire having a diameter of 2 mm is exposed to a convection environment with  $h = 50 \text{ W/m}^2 \text{ K}$  and  $T_\infty = 100^\circ\text{C}$ . What current must be passed through the wire to produce a center temperature of  $150^\circ\text{C}$ ? Repeat for an aluminum wire of the same diameter.
- 2) Heat is generated uniformly in a stainless steel plate having  $k = 20 \text{ W/m K}$ . The thickness of the plate is 1.0 cm and the heat generation rate is  $500 \text{ MW/m}^3$ . If the two sides of the plate are maintained at  $100^\circ$  and  $200^\circ\text{C}$  respectively, calculate the temperature at the center of the plate.
- 3) A 3.2 mm diameter stainless-steel wire 30 cm long has a voltage of 10 V impressed on it. The outer surface temperature of the wire is maintained at  $93^\circ\text{C}$ . Calculate the center temperature of the wire. Take the resistivity of the wire as  $70 \mu\Omega \text{ cm}$  and the thermal conductivity as  $22.5 \text{ W/m K}$ .
- 4) A integrated circuit CPU measures 4cm x 4cm and generates 7 W of heat. An aluminum heat sink ( $k = 204 \text{ W/m K}$ ) which is 4cm x 4cm on it's base with 36 evenly spaced, 4 mm diameter pin fins is mounted on the top of the chip with a contact resistance of  $0.5 \times 10^{-4} \text{ m}^2 \text{ K/W}$ . If the pin fins are 2 cm in length, calculate the chip temperature if cooled by an air stream at  $20^\circ\text{C}$  and  $h = 20 \text{ W/m K}$ .

Problems from Book:

2-68, 2-71, 2-75, 2-93