**SOUTH DAKOTA SCHOOL OF MINES AND TECHNOLOGY**

**DEPARTMENT OF METALLURGICAL ENGINEERING**

MET 422 Hour Exam #3 Nov 19,2012

open book- closed calculators and notes

**All needed physical constants are to be obtained from the text. Estimations are permissible if a needed constant is not available in the text.**

1. A composite wall is composed of an 12-cm thick silica brick, a 8-cm-thick medium density brick, and a 6-cm thick insulating brick. These three materials have thermal conductivities of 12, 4, and 1 Wm-1K1, respectively. The heat transfer coefficients inside and outside the furnace are both 10 Wm-2K1. Find

1. The heat flux through the wall
2. The effect on the Silica-Medium Duty interface temperature if 10 cm of glass wool with a thermal conductivity are added to the outside (adjacent to the insulating brick). The glass wool has a thermal conductivity of 0.02 Wm­-1K-1.

2. A steel cube 1ft on an edge and at uniform temperature of 1080 °F is withdrawn from a furnace and air cooled in a blowing air stream with a temperature of 80 °F.

a) Determine the temperature at the center of the cube after 1 hour for the following conditions:

h = 25 BTU/hr-ft2-°F

kFe = 10 BTU/hr-ft-°F

Fe = 490 lbm/ft3

CpFe = 0.165 BTU/lbm-°F

All six faces are cooled. Ignore radiation

b) Describe how would the above solution differ if the cube were placed on a perfectly insulating surface of zero heat capacity so that heat would be removed from only five surfaces?

3*.* A 1 cm diameter spherical drop of liquid lead is dropped at terminal velocity V. The flow of air past the droplet is turbulent. Assume the droplet's temperature is uniform at To . Show how to calculate the initial rate of convective heat transfer from the surface.

4. An electric heating element for a furnace is connected to the electric power source at each end by water-cooled clamps at 300 K as shown below. The rod's temperature is a function of the distance along the axis. There are no significant radial gradients. The temperature of the element at startup is 300 K

* The electric power generates heat within the element at a rate of S Watts/cm3.
* Heat is lost from the surface as shown

Derive a partial differential equation for the unsteady state axial temperature profile in a rod L in length. The rod's radius is R.

Show the initial and boundary conditions needed to solve the partial differential equation. .



Scratch

Scratch