NEEP 602 -- Engineering Problem Solving II
Homework 6
Due Tuesday 4/19/05
Parabolic Partial Differential Equations

12. Nuclear Fuel Pellet (15 points)

Consider an annular nuclear reactor fuel pellet, which has an inner radius of 1 mm and an outer radius of 7.5 mm. The pellet is initially at 1000 C, there is no heat flow into the center of the pellet, and the outside surface temperature of the pellet is held at 1000 C. Using Excel, determine the temperature of the inner surface as a function of time if the thermal conductivity is 0.03 W/cm-K, the heat capacity is 300 J/kg-K, the density is 10,000 kg/m^3, and the volumetric heating is 250 W/cm^3. The governing equation for the temperature in a cylinder (ignoring axial variations) is

$$\frac{1}{r}\frac{d}{dr}\left(rk\frac{dT}{dr}\right)+q'''=\rho c_p\frac{\partial T}{\partial t}$$

13. Boundary Layer on an Infinite Plate Started From Rest (15 points)

An infinite liquid layer (in the *x*-*z* plane) with thickness h = 0.100 m is bounded by a rigid plate at y = 0 and a free surface at $y = h$. Both plate and fluid are initially at rest. At t = 0, the plate is instantaneously accelerated to a speed U in the positive x-direction, so that the resulting fluid motion is only in the x-direction. Use Matlab to determine and plot $u = u(y,t)$ for U = 0.05 m/s. Do this from t = 0 to 20 s. The Navier-Stokes equations reduce, for this case, to

$$\frac{\partial u}{\partial t}=\nu\frac{\partial^2 u}{\partial y^2}$$

This fluid has a kinematic viscosity ν = 1.0 cm^2/s, and the boundary conditions are no slip at the plate, or

$$u(y,0) = 0$$

and zero shear stress at the free surface, or

$$\left.\frac{\partial u}{\partial y}\right|_{y=h}=0$$