Nuclear Engineering 180
Fall Semester 2001
Second Examination

SEVENTY-FIVE MINUTES, CLOSED BOOK. ONE $8 - \frac{1}{2}$" $\times$ 11" SHEETS OF NOTES ALLOWED.

1. A plasma has an ion temperature profile given by:

$$T_i(x) = T_0(1 - (\frac{x}{a}))$$

and $T_0 = 15.0$ KeV, and $a = 1.0$ m. The magnetic field $B_z(x = 0)$ is 4.0 T. The plasma my be considered infinite in the y and z directions.

   a. Find the classical ion heat flux at $x = 0$. Assume that the density at $a = 0$ is 10^{20} m^{-3} and that the ions are deuterium.

   b. If the electrons are at a temperature of 10.0 keV at $x = 0$, then find the volumetric ion-to-electron heat exchange rate. (Hint: the formula is $Q_{ei} = 3n(T_e - T_i)/\tau_e$.)

   c. If the electron temperature gradient is zero, find the current carried in the plasma through the pressure balance. Give magnitude, direction, and sign.

   d. Find the volumetric heating from ohmic heating at $a = 0$. Give the answer in megawatts per cubic meter.

2. A DT ICF target is compressed to 100$\times$ liquid density. ($\rho_{liq} = 0.25$g/cc). The electron temperature is 10.0 keV. Find:

   a. The electron plasma frequency ω_{pe}

   b. The yield of the target if $\rho R = 10$ g cm^{-2} and the burnup fraction is fifty percent,

   c. The minimum energy of photons which can penetrate into the plasma,

   d. The density at which the phase velocity for laser light at 3530$\mathring{A}$ is twice the speed of light, expressed as a fraction of the compressed density.