NE 281
Practice Questions for Midterm II
Spring 2007

1. A 4.0 GHz wave is launcehd form the outside edge of a tokamak. The density is parabolic, i. e.

$$n(r) = n_0 \left(1 - \left(\frac{r}{a}\right)^2\right)$$

, with $n_0 = 1.0 \times 10^{20}\mathrm{m}^{-3}$. The magnetic field is 4.0 T in the center of the plasma, and 3.0 T at the outer edge. The field intensity scales like $1/(R_0 + a)$, with $R_0/a = 3.0$.

   (a) Draw a rough "trajectory" of this wave on the CMA diagram. Assume that the launch point is inside the plasma so that $w > \omega_{pe}$ locally.

   (b) If $a = 1.0$ m, how far in is this point?

   (c) Describe the type of wave propagation.

   (d) Is there a lower hybrid resonance for this case? Use $m_i/m_p = 2.5$.

2. A Z-pinch has a current

$$\vec{J}(r) = \hat{z} J_0 \left(1 - \left(\frac{r}{a}\right)^2\right)$$

with $a = 0.1m$. The edge azimuthal field $B_\theta(a) = 10.0$ kG.

   (a) Find J_0.

   (b) If a straight magnetic field $\hat{z}B_0$ is added, dos this change the pressure balance? how?

   (c) If a straight magnetic field $\hat{z}B_0$ is added, dos this change the particle drifts? how?

   (d) If a straight magnetic field $\hat{z}B_0$ is added, dos this change the MHD stability? how?

   (e) If the plasma is 30 cm long, find the stabilizing value of B_0. (Hint: $q > 1$ everywhere for stability.

3. Using the Bessel function model for a cylindrical screw pinch,

$$\vec{B}(r) = B_0 \left(\hat{z} J_0(\lambda r) + \hat{\theta} J_0(\lambda r) \right)$$

show a graph of a magnetic perturbation δB_r allowed in the resistive MHD hierarchy which will result from a choice of λ which is stable to ideal MHD modes but unstable to resistive MHD modes. Calculate an approximate growth rate for this mode for a 1 keV electron temperature with $B_0 = 4.0\text{T}$ and a density of 10^{20}m^{-3} with $m/m_p = 2.5$. Assume that $\Delta' = +25$.