Massachusetts Institute of Technology

Subject 6.651J/8.613J/22.611J
21 November 2006

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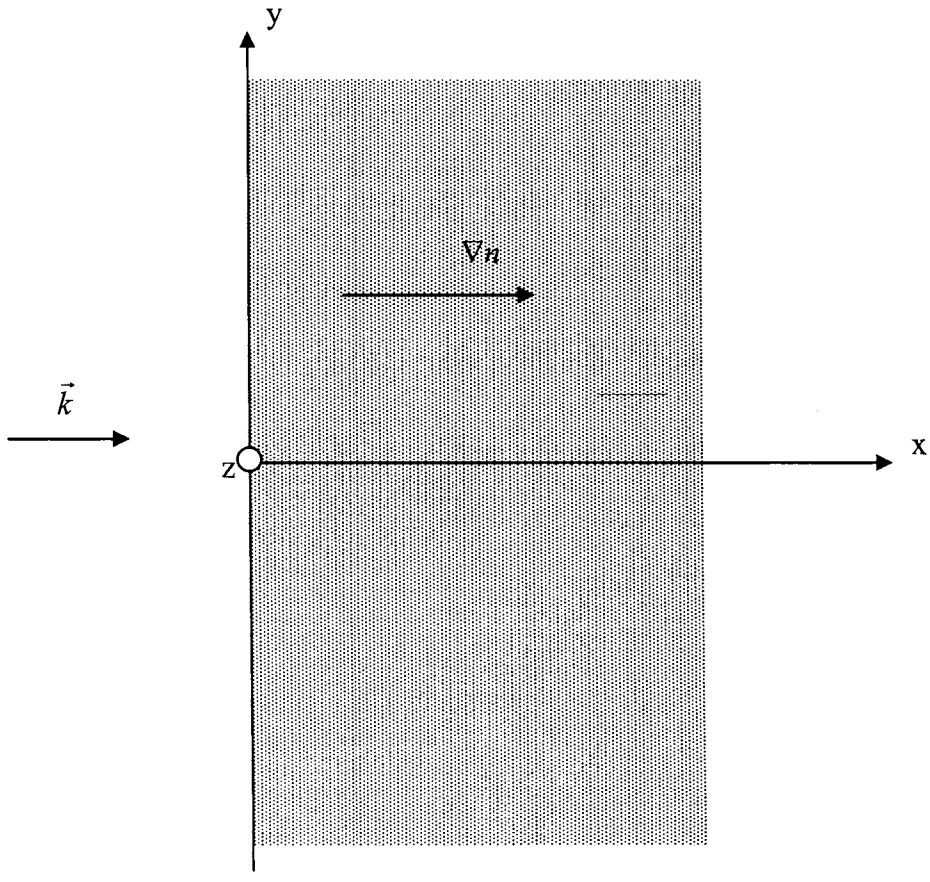
Problem Set 8

Problem 1.

Using your favorite plotting software (Matlab, IDL, etc.) prepare a graph accurately depicting regions of propagation and cutoff in the $\log n^2 - \log(\omega/\omega_{ci})$ plane for two sets of Alcator C-Mod parameters: a) $n_e=2x10^{20}$ m^{-3}, B = 5.5 T and b) $n_e = 5x10^{20}$ m^{-3}, B = 5.5 T. In both cases assume that the ions are deuterium. In the plots, set the abscissa range to $-2 < \log(\omega/\omega_{ci}) < 4$ and the ordinate range to $-2 < \log n^2 < 3$.

Problem 2.

A plane wave is incident on a plasma slab, as indicated schematically in the figure below.



The plasma density is uniform an the y- and z-directions, but varies in the x-direction and is given by

$$n = n_0 \frac{x}{\ell}$$

where ℓ, the gradient scale length, is long compared to the wavelength. i.e., $k\ell >> 1$, so that the local dispersion relation can be used in solving this problem. There is a magnetic field in the z-direction, $\vec{B} = \hat{z}B_0$ where B_0 is constant. The parameters are such that

$$\omega_{pe}(n = n_0) = \omega_{ce}.$$

Throughout this problem, consider only the electron response to the wave field.

a) On the left graph below, indicate the region(s) of propagation up to $x/\ell = 4$ for the ordinary mode.

b) On the right graph below, indicate the region(s) of propagation up to $x/\ell = 4$ for the extraordinary mode.

c) What is the maximum depth of propagation of the extraordinary mode for frequencies less than the electron cyclotron frequency?