Microwave Physics and Techniques

IU/UPSAS P671D – Homework 2
Due Wednesday 6-18-03

Problem1. The intense friction around a space craft reentering the atmosphere generates a plasma which is 1 meter thick and is characterized by an electron density of $N_e = 10^{13} cm^{-3}$, and a collision frequency of $\nu=10^{11}$ s^{-1}. What frequency is required in order to transmit plane waves through the plasma sheath with minimum power loss of 10dB?

Problem2.A Hertzian dipole antenna is excited by a sinusoidal current of 10-A amplitude. If the length of the dipole is L=10 cm=0.01λ, find the maximum radiated time-average power density at the following distances: (a) 100m, (b)1km. (c)10km.

Problem3. The time-average power density measured along the main beam of an antenna of 25 W input power at a distance of 10km from it is 20pW-$(cm)^{-2}$. Find the gain of this antenna. Assume isotropic radiation.

Problem4. What fraction of the total power radiated by the Hertzian dipole antenna is radiated between $\pm 45^0$ of the equatorial plane?

Problem5. Microwave heating is generally uniform over the entire body of the product being heated if the thickness of the product does not exceed about 1 to 1.5 times its penetration depth. (a) consider a hamburger patty to be heated in a microwave oven operating at 2.45 GHz. The dielectric properties of raw hamburger at 2.45 GHz and 25^0C are $\varepsilon_r' = 52.4$ and $\tan\delta_c = 0.33$. What is the maximum thickness of this hamburger for it to be heated uniformly? (b) Microwave ovens operating at 915 MHz are evidently more appropriate for cooking product with large cross sections and high dielectric loss factors. The dielectric properties of raw hamburger at 915 MHz and 25^0C are $\varepsilon_r' = 54.5$ and $\tan\delta_c = 0.411$. Find the maximum thickness of the hamburger at 915 MHz and compare it with the result in part (a).

Problem6. A uniform plane wave propagates from one dielectric into another at normal incident. Find the ration of the dielectric constants such that the magnitudes of the reflection and the transmission coefficients are both equal to 0.5. Assume lossless nonmagnetic materials.

Problem7: Collin 2.4

Problem 8 :Collin 2.5

Problem 9: Collin 2.15