4/15/2005. **Due:** Thursday, April 22, 2005 (in class).

Physics 302/572: Electromagnetic Theory II

Read: Griffiths 11.1-11.2

"**G**, **PS**" refer to Griffiths and Pollack & Stump books respectively.
Problems with stars are not for credit and will NOT be graded.

Homework 9

Exercise 1 (G 11.25 corrected)

When a charged particle approaches (or leaves) a conducting surface, radiation is emitted, associated with the changing electric dipole moment of the charge and its image. If the particle has mass m and charge q, find the total radiated power, as a function of its height z above the plane. [*Answer*: $(\mu_0 c q^2/4\pi)^3/12m^2z^4$]

Exercise 2

A beam of 2 keV electrons is stopped in a distance of 0.01 cm
(1 eV $= 1.6 \times 10^{-19}$ J).

a) Calculate the total energy of the radiation emitted by each electron. (Assume constant decceleration.)

b) Find the ration of the emitted energy to the initial electron energy.

Exercise 3

A neutron star (pulsar) of mass M and radius R has a magnetic moment $\vec{m}$. It is rotating with angular velocity ω about an axis perpendicular to $\vec{m}$.

a) Find the electromagnetic power it radiates.

b) Find the energy radiated in one rotation, and compare this with the rotational kinetic energy of the star ($K = \frac{1}{5}MR^2\omega^2$).

c) Find the fractional change $\Delta\omega/\omega$ in one year.

For numerical estimates use $f = 100$ Hz, $M = 3 \times 10^{30}$ kg, $R = 10$ km, and $m = 10^{27}$ A·m^2.

Exercise 4

Consider two perfect oscillating electric dipoles $\vec{p}_1(t) = p_0 \cos(\omega t)\hat{z}$ and $\vec{p}_2(t) = p_0 \cos(\omega t + \alpha)\hat{z}$, positioned at $x = 0$, $y = 0$ and $z = \pm a$ respectively.

a) Find the radiation electric field at the point (r, θ, ϕ) (spherical coordinates) assuming $r \gg \omega/c$, a.

b) Find the Poynting vector at the same point.

c) What is the direction of maximal radiation if $\alpha = \pi$ and a is very small?

*d) What is the total radiated power?