ENEE 381 Problem Set #3

10/1/02- due 10/15/02

Questions like (1) - (6) could be on the first examination.

(1) The electric vector of a wave propagating in the z-direction varies according to

$$E_y = E_0 \cos(\pi x/2a) e^{j\omega t},$$

where E_0=1V/m, a=1m. The frequency of the wave is ν=100MHz. How much energy flow per second passes through the region $-1 \leq x \leq 1$ (m), $-1 \leq y \leq 1$ (m).

(2) A point source transmitter at (0,0,0) emits a total power of 5W. What is the value of the Poynting vector at the point (10,10,10)? What is the total power flux into the surface bounded by the two concentric spheres R=5, and R=7?

(3) A point source transmitter at (0,0,0) emits a total power of 5W. What is the total power flux through the surface of a cube centered at (0,0,0) with sides of length 1m?

(4) A plane wave with magnetic field $H_y = 1$A/m and electric field E_x traveling in the z-direction through a vacuum strikes an infinite planar copper medium. What is the value of the electric field and magnetic field at the surface of the sheet? What is the value of the surface resistance R_s? How much energy is dissipated per unit area of the copper? For copper σ=5.8$\times 10^7$ S/m.

(5) How are the answers to question (4) modified if the wave is traveling through a dielectric with ϵ_r=30 when it strikes the copper

(6) A 50 ohm transmission line is terminated with an impedance of 20-j30. What is the magnitude and phase of the reflection coefficient?

(7) A 75 ohm transmission line is terminated with a load of $150 + j50$ ohm. Compute ρ in terms of both amplitude $|\rho|$ and ϕ. What fraction of incident power is absorbed in the load?

(8) Repeat (7) with the Smith Chart

The following questions are easiest with the Smith chart

(9) A 50 ohm transmission line is terminated with an inductor of 10μH and a capacitor of 0.005μF in series. The line is driven at 1MHz. Compute $|\rho|$, ϕ, the standing wave ratio, S, and the location of the nearest voltage maximum to the load.

(10) A 100 ohm transmission line is terminated with an inductor of 10μH and a capacitor of 10nF in parallel. Computer $|\rho|$, ϕ, S and the location of the nearest current maximum to the load. The line is being operated at 1MHz.

(11) A line of impedance 50 ohm is terminated in an impedance of $25 + j75$ ohm. Where on the line nearest to the load can the line be matched with a pure inductor in series, and what is the value of the inductor if the line is operated at 100MHz.

(12) Repeat (11) except where can the line be matched with an inductor in parallel, and what is the value of the inductor at 100MHz.

(13) Repeat (11) except do the matching with a capacitance in parallel.

(14) If the capacitance calculated in (13) is being determined by a length of shorted 50 ohm line, what is the minimum length that it must be.

(15) A 75 ohm transmission line is terminated with a load that gives an impedance of $50 + j50$ measured 0.3λ from the load. What is the load?