Phys 321 – E & M II – Test 2 – Oct. 21, 2005

1.(25 pts) Consider a wire of radius *a* and length *L* carrying a uniform current *I*. There is a potential difference *V* between the ends of the wire.

a) Find the electric and magnetic fields on the surface of the wire.

b) Find the Poynting vector $\vec{S}$ at the surface of the wire and calculate the energy flow (power) into the wire.

2.(25 pts) Write down the (real) electric and magnetic fields for a monochromatic plane wave of amplitude E_0 , frequency ω, and phase angle zero that is traveling in the direction from the origin to the point (1, -2, 2), with polarization parallel to the *yz* plane.

3.(25 pts) Consider a monochromatic plane wave traveling in the *z* direction and linearly polarized in the *x* direction.

a) Determine the 3 ×3 matrix that represents the Maxwell stress tensor for this plane wave.

b) If the beam has a cross sectional area A and it is absorbed by the wall, determine the time-averaged force exerted on the wall.

Recall: $T_{ij} = \varepsilon_0 (E_i E_j - \frac{1}{2}\delta_{ij} E^2) + \frac{1}{\mu_0}(B_i B_j - \frac{1}{2}\delta_{ij} B^2)$

$$\vec{F} = \oint_S \vec{\vec{T}} \cdot d\vec{a} - \varepsilon_0 \mu_0 \frac{d}{dt} \int_V \vec{S} d\tau$$

4.(25 pts) Consider an electromagnetic wave at normal incidence on the interface between two non-magnetic media. The wave is traveling in medium #1 ($n_1 = 1.5$) in the *z*-direction and polarized in the *x*-direction. Medium #2 has $n_2 = 3.5$.

a) Write down the expressions for the complex electric and magnetic fields for the reflected wave.

b) Determine the reflection coefficient, *R*.

b) Is the reflected wave in-phase or out-of-phase with the incident wave?

Recall: $\tilde{E}_{0R} = \frac{(1-\beta)}{(1+\beta)} \tilde{E}_{0I}$, where $\beta = \frac{\mu_1 v_1}{\mu_2 v_2}$.