國立嘉義大學九十五學年度
光電暨固態電子研究所碩士班招生考試試題

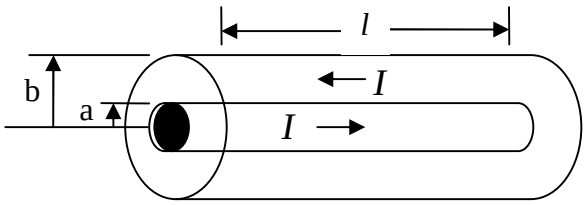
科目：電磁學

1. (Fig. 1) A spherical conductor, of radius a, carries a charge Q. It is surrounded by linear dielectric material of susceptibility χ_e (permittivity ε), out to radius b.
   (a) Find the potential at the spherical center (relative to infinity). (10%)
   (b) Find the energy of this configuration. (10%)

Fig. 1 

2. Two large metal plates (each of area A) are held a distance d apart. Suppose we put a charge Q on each plate, what is the electrostatic pressure on the plates. (20%)

3. (Fig. 2)A long coaxial cable carries current *I* (the current flows down the surface of the inner cylinder, radius *a*, and back along the outer cylinder, radius *b*) as shown in Fig. 2.
   (a) Find the magnetic energy stored in a section of length *l*, and (10%)
   (b) calculate the self-inductance *L* of the cable. (10%)

Fig. 2 

4. A direct current *I* flows in a straight wire of length 2*L*. Find the magnetic flux density ***B*** at a point located at a distance *r* from the wire in the bisecting plane:
   (a) the first method is by determining the vector magnetic potential ***A***,(10%)
   (b) the second method is by applying Biot-Savart law.(10%)
   (Hint : the curl of a vector field $\vec{A}$ in cylindrical corordinates (r,ϕ,z) can be expressed as

$$\vec{\nabla}\times\vec{A}=\hat{a}_r\left(\frac{\partial A_z}{r\partial\phi}-\frac{\partial A_\phi}{\partial z}\right)+\hat{a}_\phi\left(\frac{\partial A_r}{\partial z}-\frac{\partial A_z}{\partial r}\right)+\hat{a}_z\frac{1}{r}\left[\frac{\partial}{\partial r}(rA_\phi)-\frac{\partial A_r}{\partial\phi}\right]\ )$$

5. The far field of a short vertical current element *Idl* located at the origin of a spherical coordinate system in free space is

$$\vec{E}(R,\theta)=\hat{a}_\theta E(R,\theta)=\hat{a}_\theta\left(i\cdot\frac{60\pi\cdot Idl}{\lambda R}\cdot\sin\theta\right)e^{-i\beta R}\qquad (V/m)$$

and
$$\vec{H}(R,\theta)=\hat{a}_\phi\frac{E(R,\theta)}{\eta_o}=\hat{a}_\phi\left(i\cdot\frac{Idl}{2\lambda R}\cdot\sin\theta\right)e^{-i\beta R}\qquad (A/m)$$

   Where $\lambda = 2\pi/\beta$ is the wavelength, β is the propagation constant, and *i* is the imaginary number.
   (a) Explain the physical meaning of the average value of Poynting vector P_{av}. (10%)
   (b) Write the expression for the instantaneous Poynting vector. (5%)
   (c) Find the total average power radiated by the current element. (5%)