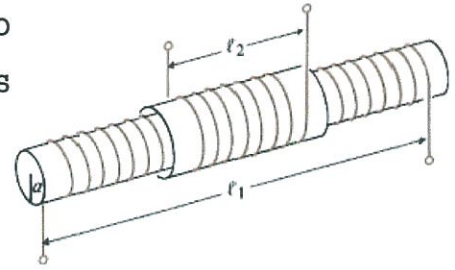


전자기학/초고주파 분야
2015 박사과정자격시험 (2015. 7. 29)

1. (10 pts) Find the mutual inductance between two air coaxial solenoids of radius "a" with lengths l_1 and l_2 , and N_1 and N_2 turns, respectively.



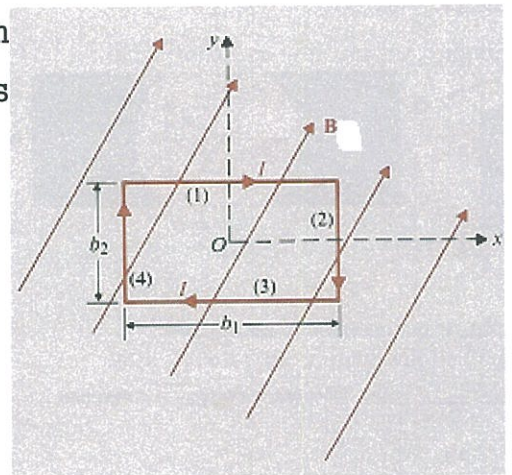
2. (a) (5 pts) Solve Laplace's equation to find potential V as a function of angle ϕ . The boundary conditions are given as two infinite radial conducting planes, $V = 100$ (V) at $\phi = 0$ (rad), and $V = 40$ (V) at $\phi = 0.2$ (rad).

- (b) (5 pts) Find \vec{E} when $\rho = 10$, using the result of (a).

$$(\nabla^2 V = \frac{1}{\rho} \frac{\partial}{\partial \rho} (\rho \frac{\partial V}{\partial \rho}) + \frac{1}{\rho^2} \frac{\partial^2 V}{\partial \phi^2} + \frac{\partial^2 V}{\partial z^2}), \quad \nabla V = \hat{\rho} \frac{\partial V}{\partial \rho} + \hat{\phi} \frac{1}{\rho} \frac{\partial V}{\partial \phi} + \hat{z} \frac{\partial V}{\partial z}$$

3. (15 pts) A rectangular loop in the xy-plane with sides b_1 and b_2 carrying a current I shown lies in a uniform magnetic field $\vec{B} = \hat{x}3 + \hat{y}6 - \hat{z}8$.

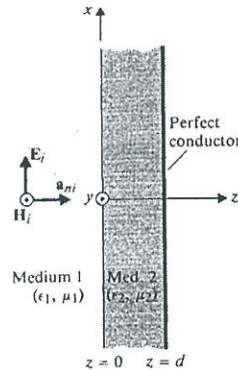
- (a) Determine magnetic dipole moment of the loop.
(b) Determine the torque on the loop.
(c) Determine the total force on the loop due to perpendicular component of \vec{B} .



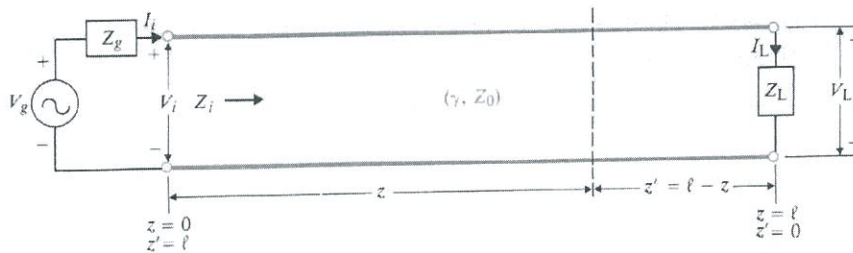
4. (15 pts) A perfectly conducting plane with zero potential is located in free space at $x=0$, and an infinite uniform line charge of $\rho_L = 10$ (nC/m) lies along the line $x=2, y=1$. Use the method of images to find potential at point $P(4, -1, 0)$.

$$(\epsilon_0 = \frac{1}{36\pi} 10^{-9})$$

5. [20pts] A uniform plane wave with $\vec{E}_i(z,t) = \hat{x} E_{i0} \cos \omega(t - \frac{z}{u_p})$ in medium 1 (ϵ_1, μ_1) is incident normally onto a lossless dielectric slab (ϵ_2, μ_2) of a thickness d backed by a perfectly conduction plane, as shown in the below figure. Find
- (a) [5pts] $\vec{E}_r(z,t)$ (b) [5pts] $\vec{E}_1(z,t)$ (c) [5pts] $(\vec{P}_{av})_1$
- (d) [5pts] Determine the thickness d that makes \vec{E}_1 the same as if the dielectric slab were absent.



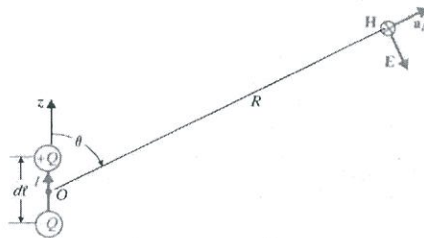
6. [20pts] Consider the following transmission line circuit.



- (a) [10pts] Derive the expressions of voltages and currents on the transmission line, $V(z')$ and $I(z')$ with $z' = l - z$.
- (b) [10pts] Derive the generator input impedance Z_i , looking into the transmission line at the source end of the line $z' = l$.

7. [10점] Consider the following Hertzian dipole antenna with its magnetic vector potential

$$\vec{A} = \hat{z} \frac{\mu_0 I d l}{4\pi} \left(\frac{e^{-j\beta R}}{R} \right)$$



- (a) [5pts] Find the magnetic field \vec{H} in spherical coordinate system.
- (b) [5pts] Find the magnetic field \vec{E} in spherical coordinate system.