※ 考生請注意：本試題可使用計算機，並限「考選部核定之國家考試電子計算器」機型

1. Answer the following questions:

   (a) Summarize Maxwell's equations in differential form. (5%)

   (b) What is the Poynting vector? Interpret Poynting's theorem. (5%)

   (c) Briefly describe the phenomenon of polarization in a dielectric material. What are the different kinds of polarization? (5%)

   (d) What is the basis behind the construction of the Smith chart? (5%)

   (e) Explain TE, TM and TEM waves. (5%)

   (f) State Poisson's equation. How is it derived? (5%)

2. Charge is distributed with density $\rho = \rho_0 (r/a)^2$, where ρ_0 is a constant, in the sphere $r < a$. Find displacement field **D** everywhere and plot D_r versus r. (16%)

3. For the electric field $\mathbf{E} = E_0 \mathbf{a}_y \cos\left[3\pi \times 10^8 t + 0.2\pi(4x + 3z)\right]$ in free space, find the associate magnetic field intensity vector. (10%)

4. A boundary separated free space from a perfect dielectric medium. At a point on the boundary, the electric field intensity on the free space side is $\mathbf{E}_1 = E_0(4\mathbf{a}_x + 2\mathbf{a}_y + 5\mathbf{a}_z)$, whereas on the dielectric side, it is $\mathbf{E}_2 = 3E_0(\mathbf{a}_x + \mathbf{a}_z)$, where E_0 is a constant. Find the permittivity of the dielectric medium. (16%)

5. An infinitely long, uniformly wound solenoid of radius a and having N turns per unit length carries a current I. Find the inductance per unit length of the solenoid. Assume air core ($\mu = \mu_0$). (10%)

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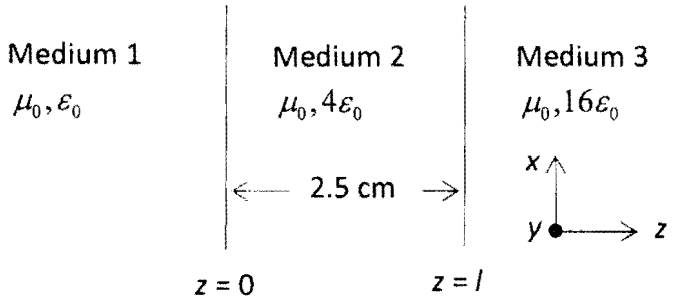
6. In the arrangement shown below, a uniform plane wave having the electric field

$$\mathbf{E}_i = E_0 \cos\left(45\pi \times 10^8 t - 15\pi z\right)\cos\left(15\pi \times 10^8 t - 5\pi z\right)\mathbf{a}_x \text{ V/m}$$

is incident on the interface at $z = 0$. Find the fraction of the incident time-average power reflected back into medium 1 and the fraction transmitted into medium 3. [Hint: You may use the properties of quarter-wave and half-wave sections in a transmission line system.] (18%)



Some formula for your reference:

$$\cos\alpha\cos\beta = \frac{1}{2}\left[\cos\left(\alpha+\beta\right)+\cos\left(\alpha-\beta\right)\right]$$