1. Write down the Maxwell's equations in integration and differential forms, respectively. And for each of the Maxwell's equations, write down the corresponding boundary condition in vector form for two different media and the corresponding equation in terms of the scalar potential and the vector potential. (20 分)

2. The electric field of a uniform plane wave propagating in a perfect dielectric medium having $\mu = \mu_0$ is given by

$$\mathbf{E} = 10\cos\left(3\pi \times 10^7 t - 0.2\pi x\right)\mathbf{a}_z$$

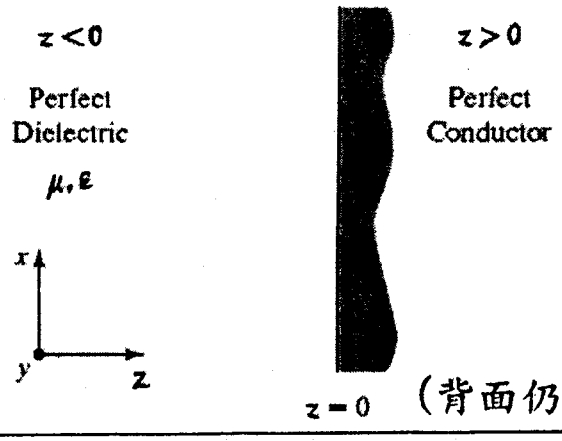
Find: (a) the frequency; (b) the wavelength; (c) the phase velocity; (d) the relative permittivity of the medium; and (e) the associated magnetic-field vector **H**. (10 分)

3. The region $z < 0$ is a perfect dielectric, whereas the region $z > 0$ is a perfect conductor, as shown below. For a uniform plane wave having the electric and magnetic fields

$$\mathbf{E}_i = E_0\cos\left(\omega t - \beta z\right)\mathbf{a}_x$$

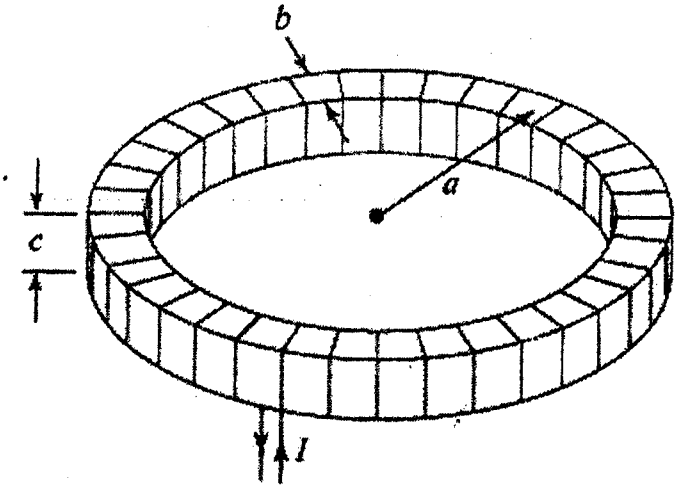
$$\mathbf{H}_i = \frac{E_0}{\eta}\cos\left(\omega t - \beta z\right)\mathbf{a}_y$$

where $\beta = \omega\sqrt{\mu\varepsilon}$ and $\eta = \sqrt{\mu/\varepsilon}$, obtain the expressions for the reflected wave electric and magnetic fields and hence the expressions for the total (incident + reflected) electric and magnetic fields in the dielectric, and the current density on the surface of the perfect conductor. (15 分)

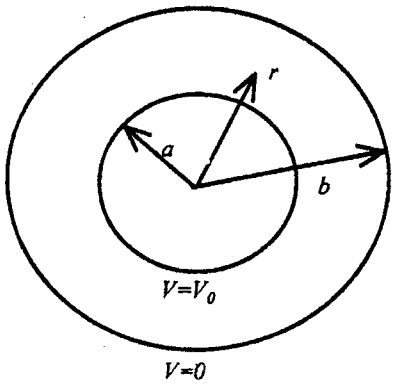


(背面仍有題目,請繼續作答)

4. A filamentary wire carrying current I is closely wound around a toroidal magnetic core of rectangular cross section, as shown below. The mean radius of the toroidal core is a and the number of turns per unit length along the mean circumference of the toroid is N. Find the inductance of the toroid. (15 分)



5. Assume that the region between the coaxial cylindrical conductors shown below is filled with a dielectric of nonuniform permittivity $\varepsilon = \varepsilon_0 b/r$. Obtain the solution for the potential between the conductors and the expression for the capacitance per unit length of the cylinders. (20 分)



6. An open-ended stepped impedance resonator consisting of three sections of transmission lines is shown below. The characteristic impedances are Z_1 and Z_2, associated with the propagation constants β_1 and β_2 and the lengths $2l_1$ and l_2, respectively. Show that the resonant conditions for the resonator can be expressed as

$Z_1 \tan \beta_1 l_1 = Z_2 \cot \beta_2 l_2$ and $Z_1 \cot \beta_1 l_1 = -Z_2 \cot \beta_2 l_2$. (20 分)