※ 考生請注意：本試題 ☑可 ☐不可 使用計算機

1. Charge is distributed with density $\rho_0 e^{-r^2}$ C/m^3 in the cylindrical region $r<1$. Find displacement field density **D** everywhere. (10%)
2. For the electric field $\mathbf{E}=E_0\cos(\omega t-\alpha y-\beta z)\mathbf{a}_z$ in free space ($\mathbf{J}=\mathbf{0}$), show that $\alpha,\beta,\omega,\mu_0$ and ε_0 must satisfy the relation of $\alpha^2+\beta^2=\omega^2\mu_0\varepsilon_0$. (20%)
3. Region 1 ($z<0$) is free space, whereas region 2 ($z>0$) is a material medium characterized by $\sigma=10^{-4}$S/m, $\varepsilon=5\varepsilon_0$, and $\mu=\mu_0$. For uniform plane wave having the electric field

$$\mathbf{E}_i=E_0\cos(3\pi\times10^5 t-10^{-3}\pi z)\mathbf{a}_x \text{ V/m}$$

incident on the interface $z=0$ from region 1, obtain the expressions for the reflected and transmitted wave electric and magnetic fields. (20%) [Hint: propagation constant = $\sqrt{j\omega\mu(\sigma+j\omega\varepsilon)}$, intrinsic impedance = $\sqrt{j\omega\mu/(\sigma+j\omega\varepsilon)}$, $\varepsilon_0=\frac{10^{-9}}{36\pi}$ F/m^2, $\mu_0=4\pi\times10^{-7}$ H/m] (20%)

4. A space-charge density distribution in a medium with permittivity of ε is given by

$$\rho=\begin{cases}\rho_0\sin x & \text{for } -\pi<x<\pi\\ 0 & \text{otherwise}\end{cases}$$

where ρ_0 is a constant. Find and sketch the potential V versus x for all x. Assume $V=0$ for $x=0$. (20%)

5. A transmission line of characteristic impedance $Z_0=100\,\Omega$, phase velocity $v_p=2\times10^8$ m/s, and length $l=20$ cm is short-circuited at one end and terminated by an inductor of value 0.1μH at the other end. Find the three lowest resonant frequencies of the system. (15%)

(背面仍有題目,請繼續作答)

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6. The group pattern for a pair of antennas is given by

$$\cos\left(\frac{\beta d\cos\psi+\alpha}{2}\right)$$

where β is the propagation constant of radiating wave, d is the distance between the antennas, α is the phase difference of the fed sources on the antennas, and ψ is the angle measured from the axis connecting the antennas to the point of observation, Let us consider a linear arrays of four isotropic antennas spaced $\lambda/2$ apart and fed in phase, as shown below. Obtain and sketch the resultant group pattern. (15%)