國立臺灣科技大學

八十九學年度碩士班招生考試試題

系所組別： 電子工程系乙三組、電子工程系丙組

科　目： 電磁學

(總分共 100 分)

1). Two lossy homogeneous dielectric media with dielectric constants $\varepsilon_{r1} = 2$, $\varepsilon_{r2} = 3$ and conductivities $\sigma_1 = 20$ (mS), $\sigma_2 = 15$(mS) are in contact at the z = 0 plane. In the z >0 region (medium 1) a uniform electric field $\mathbf{E}_1 = \mathbf{a}_x\, 20 - \mathbf{a}_z\, 50$ (V/m) exists. Find

(a) $\mathbf{E}_2$ in medium 2, (5%)

(b) the current densities $\mathbf{J}_1$ and $\mathbf{J}_2$ in two media,(5%)

(c) the angles that $\mathbf{J}_1$ and $\mathbf{J}_2$ make with the z = 0 plane.(5%)

2). The upper and lower conducting plates of a large parallel - plate capacitor are separated by a distance d and maintained at potential V_0 and 0, respectively. A dielectric slab of dielectric constant 6.0 and uniform thickness 0.8d is placed over the lower plate. Assume that the area of both conducting plates is S and the fringing effect is negligible.

(a) .Prove that the potential distribution $V_s(y)$ in the dielectric slab is $V_0(y/2d)$ and the potential distribution $V_a(y)$ in air is $V_0(3y/d - 2)$ if y = 0 at the conducting lower plate of zero potential. (5%) [Hint: solve Laplace's equation both in air and in the dielectric slab.]

(b) Find the surface charge densities on the upper and lower plates from the potential distributions in (a). (5%)

(c) Find the capacitance of this parallel - plate capacitor in terms of ε_0, d, S and V_0. (5%)

3). A uniform plane wave in air with $\mathbf{E}_i(z,t) = \mathbf{a}_x 10 \cos(18*10^8\, t - 6\, z)$ (V/m) is incident normally on an interface at z = 0 with a lossless non-magnetic medium having a dielectric constant 2.25. Find the following:.

(a). The wavelength and phase velocity of the plane waves in air and in the lossless medium, (5%)

(b) The reflection coefficient at the interface and the standing-wave ratio for the wave in air, (5%)

(c) The reflected and transmitted electric plane waves $\mathbf{E}_r(z,t)$ and $\mathbf{E}_t(z,t)$, (5%)

(d) The expressions for time-average Poynting vectors in air and in the lossless medium. (5%)

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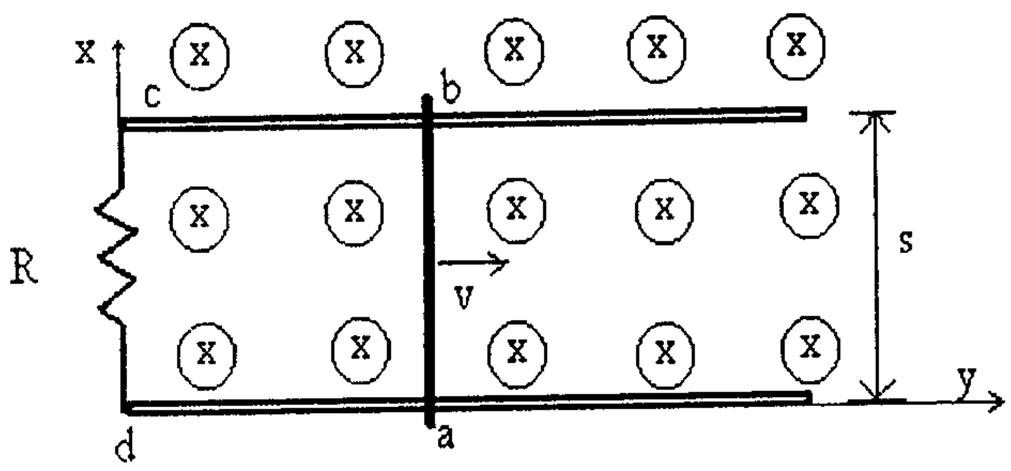
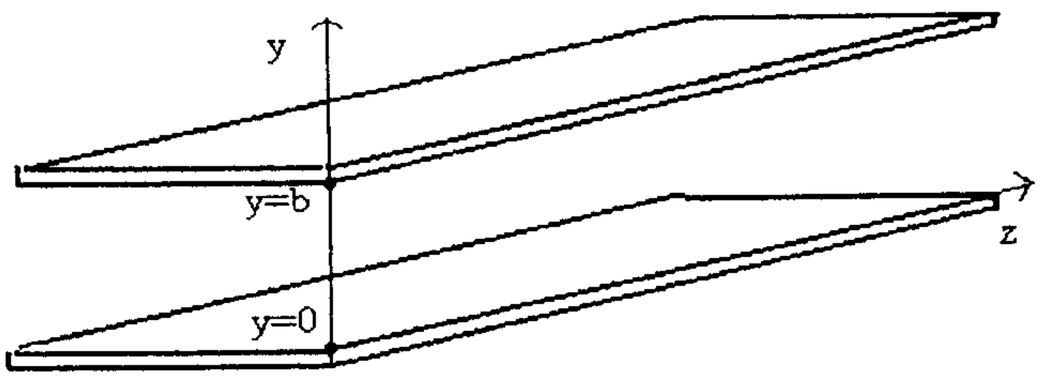
4). A movable perfectly conducting bar of mass m and length s rests on two frictionless, perfectly conducting rails which are connected to a resistor R as shown. A uniform magnetic field B_0 in the z-direction exists normal to the plane of two rails. (A) Describe and explain in detail the direction and magnitude of the induced current if the bar moves with velocity **v** in the y-direction. (B) If the initial velocity of the rod is $\mathbf{v}_0$, show that the velocity decreases as a function of time according to $\mathbf{v}(t)= \mathbf{v}_0 e^{-t/\tau}$ and find τ. {10% & 8%}



5). The electric field of an electromagnetic wave of frequency f is described by $E_z(y,z,t)=A\sin(2\pi y/b)\cos(\omega t- \beta z)$ in the z-direction, and $E_y(y,z,t)=[\beta b/(2\pi)]A\cos(2\pi y/b)\sin(\omega t- \beta z)$ in the y-direction, with $\beta=[\omega^2\varepsilon_0\mu_0-(2\pi/b)^2]^{1/2}$ and $\omega=2\pi f$. The wave propagates in air between two perfectly conducting, parallel plates of great extent. The inner surfaces of the plates are located at y=0 and y=b. Determine (A) the surface charge densities on the two conductors, and (B) the equation for the electric field lines in the yz-plane at t=0. {5% & 5%}



6). A two-wire line consists of two long, parallel conducting wires of length s that carry currents in opposite directions. The wires are perfect conductors with permeability μ_0 and permittivity ε_0. The conductivity, permeability, and permittivity of the medium outside the wires are σ, μ and ε, respectively. The radii of the wires are a_1 and a_2. The axes of the wires are separated by a distance D, ($D>>a_1$, $D>>a_2$). Determine (A) the internal and external inductances, and (B) the leakage resistance between the two wires. {14% & 8%}