國立臺灣科技大學
八十八學年度碩士班招生考試試題

系所別：電子工程系碩士班 組別：乙三組 科目：電磁學

成績總分 100 分，答案請註明單位，否則扣分。

1. A positive charge q=30 nC is generated at the center of an air filled spherical metal shell of an inner radius 10 cm and an outer radius 20 cm at t=0. When electric field intensity $\vec{E}$ and potential V are stabilized, (a) determine $\vec{E}$ and V as functions of the radial distance r (equations), (b) draw $\vec{E}$ and V as functions of r. (Indicate all corresponding values on your diagram for r=0, r=10 cm, r=20 cm and r=1 m.) (c) Given that the metal shell is silver with conductivity 6.17×10^7 S/m, how long is the time period before $\vec{E}$ and V are stabilized within 1%. (8%, 8%, 3%)

2. An air coaxial transmission line has a solid inner conductor of radius r_i and a very thin outer conductor of inner radius r_o , as shown in Fig. 1. (a) Determine the capacitance unit length of the line, and (b) determine the inductance per unit length of the line. In between the inner conductor and outer conductor, concentric layers of polystyrene (relative permittivity ε_{rp}=2.6) and rubber (relative permittivity ε_{rr}=3.2) with same thickness are used as insulating materials, as shown in Fig. 2. (c) Determine the capacitance per unit length of the line with insulating materials. (d) The dielectric strengths of polystyrene and rubber are 20×10^6 (V/m) and 25×10^6 (V/m). Is Fig. 2 a design for coaxial cable to avoid breakdown to the highest possible voltage using these two insulating materials? (yes, or no) and why? (4%, 8%, 8%, 4%)

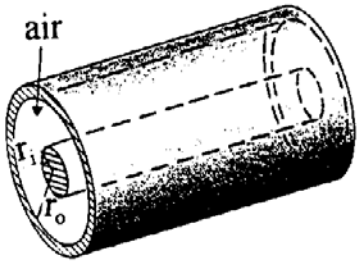

Fig. 1.

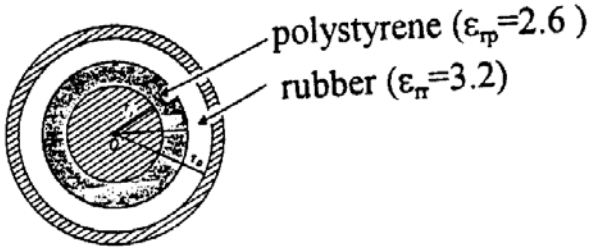

Fig. 2.

3. Two extensive homogeneous isotropic dielectrics meet on plane z=0. For z>0, relative permittivity ε_r =2, and for z<0, relative permittivity ε_r =5. A uniform electric field $\vec{E}_1 = 4\,\hat{a}_x - 3\,\hat{a}_y + 5\,\hat{a}_z$ V/m exists for z>0. Find (a) electric displacement $\vec{D}_2$ in z<0, (b) the angles $\vec{E}_1$ and $\vec{E}_2$ make with the interface, (illustrate these two angles with a figure, and calculate their values) (c) the energy densities in both dielectrics. (2%, 4%, 4%)

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4. A 5MHz linearly polarized plane wave propagates in the + z direction. (a) When the wave propagates in air, determine wave-number, wavelength, intrinsic impedance and phase velocity. (b) When it propagates in sea water (conductivity equals to 4 S/m, relative permeability equals to 1, and relative permittivity equals to 81) , determine the attenuation constant, phase constant, wavelength, intrinsic impedance, phase velocity, and skin depth. (c) With ocean surface at z=0, z<0 in air region, and z>0 in sea water region. Magnetic field intensity is $\vec{H}=\hat{a}_y 100\cos(10^7\pi t)$ (A/m) at z=0, write instantaneous expressions for electric field intensity $\vec{E}$ and magnetic field intensity $\vec{H}$ at z=0.8 (m). (d) Find the distance at which the amplitude of $\vec{H}$ is 1% of its value at z=0. (8%, 12%, 10%, 2%)

5. The voltage along a transmission line has magnitude shown in Fig. 3. The frequency is 3×10^8 Hz, characteristic impedance Z_o of the transmission line is 100 Ω. Find : (a) the standing wave ratio VSWR and wavelength, (b) the magnitude and phase of voltage reflection coefficient Γ at the load, (c) the load impedance Z_L, and (d) input impedance Z_{in} at the source. (4%, 4%, 4%, 3%)

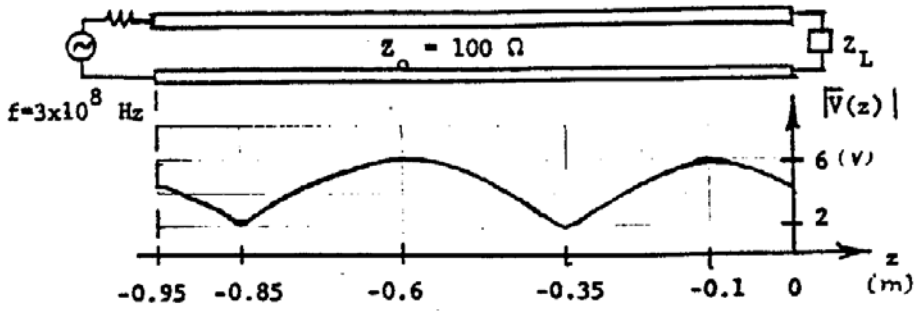

Fig. 3