考生注意: 1. 依次序作答,只要標明題號,不必抄題。
2. 答案必須寫在答案卷上,否則不予計分,並限以藍黑色筆作答。
3. 試題隨卷繳回。(餘請詳閱試場規則)

Electromagnetics

April 27, 2003

1. Consider the structure of a strip inside a grounded metallic enclosure, as shown in Figure 1. The structure extends to $\pm\infty$ in z direction. Determine the line capacitance per unit length of the transmission line. (20%)

2. The vector magnetic potential established by a magnetic dipole can be expressed as $\mathbf{A} = \frac{\mu_0 \mathbf{m} \times \hat{r}}{4\pi r^2}$, where $\mathbf{m}$ is the magnetic dipole moment. Based on the definition for the magnetization vector $\mathbf{M}$ of a magnetic material,

$$\mathbf{M} = \lim_{\Delta v \to 0} \frac{\sum_{k=1}^{\Delta N} \mathbf{m}_k}{\Delta v},$$

derive the expressions for the equivalent magnetization current densities $\mathbf{J}_m$ and $\mathbf{J}_{ms}$ of the magnetic material in terms of $\mathbf{M}$. (15%)

3. Consider two separated conductors in a lossy dielectric medium. These conductors may be of arbitrary shapes. The dielectric medium is characterized by ϵ, μ, and σ. Prove the following relationship,

$$\frac{C}{G} = \frac{\epsilon}{\sigma},$$

where C and G are the capacitance and conductance between the conductors. (10%)

4. The reflection coefficient for plane waves incident on a plane dielectric boundary at an incidence angle of θ_i for certain polarization (perpendicular or parallel) is denoted by R. Consider the case described in Figure 2. Derive the expressions for the reflection coefficient at $z = 0$ and transmission coefficient at $z = -d$ for plane waves incident on the dielectric slab of the same dielectric constant at the same incidence angle and polarization. (20%)

5. The input impedance of a transmission line can be measured experimentally (by *Network Analyzers*). Given a transmission line with unknown characterization impedance Z_0 and propagation constant γ, figure out a method to determine these unknown parameters, theoretically or experimentally. (15%)

6. Consider waves propagating in the $+z$ direction of the circular waveguide shown in Figure 3. The wall of the waveguide is assumed to be a perfect conductor. With the information provided in Tables 1 and 2 and time-harmonic fields assumed inside the waveguide, determine the expressions for the phasors of the surface charge density and surface current density on the wall of the fundamental mode. An arbitrary constant C_n can be added to the expressions for the phasors of the longitudinal field components. (20%)

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	$n=0$	$n=1$	$n=2$
$p=1$	2.405	3.832	5.136
$p=2$	5.520	7.016	8.417

Table 1: Zeros of $J_n(x)$, x_{np}.

	$n=0$	$n=1$	$n=2$
$p=1$	3.832	1.841	3.054
$p=2$	7.016	5.331	6.706

Table 2: Zeros of $J_n'(x)$, x'_{np}.

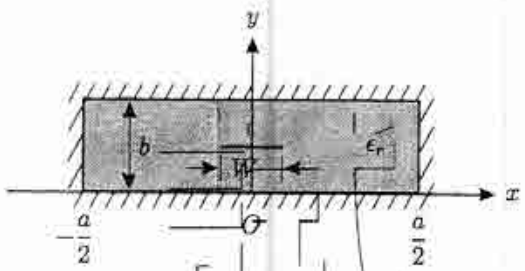

Figure 1: Figure for Problem 1.

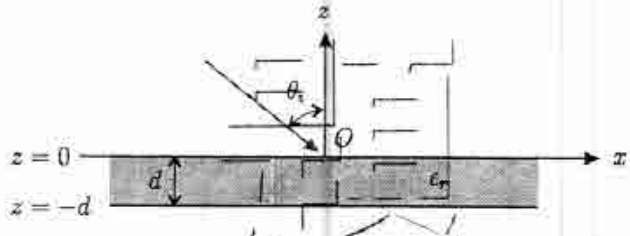

Figure 2: Figure for Problem 4.

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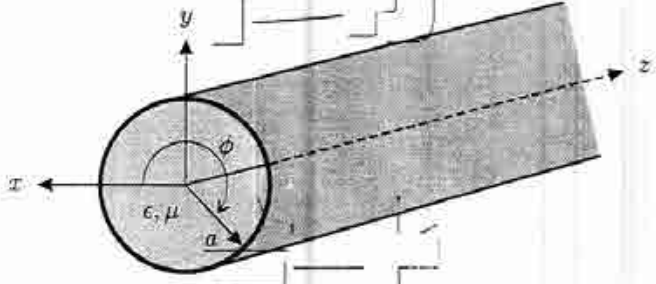

Figure 3: Figure for Problem 6.