

國立臺北科技大學九十六學年度碩士班招生考試

系所組別：1901、1902 光電工程系碩士班

第二節 電磁學 試題

第一頁 共一頁

注意事項：

1. 本試題共七題，配分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

$\epsilon_0 = 10^{-9}/(36\pi) \text{ F/m}$, $\mu_0 = 4\pi \times 10^{-7} \text{ H/m}$

1. (10%)

Two small identical metal spheres are 3 cm apart and attract each other with a force of 150 N. They are momentarily connected by a wire. Find the original charges if they now repel each other with a force of 10 N. (Assume the original charge on each sphere is uniformly distributed.)

2. (10%)

The inside of a grounded spherical metal shell (inner radius R_1 and outer radius R_2) is filled with space charge of uniform charge density ρ . Find

- (1) the potential at the center, (5%)
- (2) the electrostatic energy of the system. (5%)

3. (15%)

Two conductors are embedded in a material of conductivity $10^{-5} \Omega/\text{m}$ and permittivity $\epsilon = 80\epsilon_0$. The resistance between the two conductors is measured to be $10^6 \Omega$. Calculate the capacitance between the two conductors.

4. (10%)

A time-dependent magnetic field given by $B(t) = 0.2t - 0.5t^2$ is directed perpendicular to the plane of a circular coil containing 50 turns of radius 2 cm and whose resistance is 1.5Ω . Find the power dissipation at $t = 3 \text{ s}$.

5. (20%)

- (1) Write down the Maxwell's equations. Clearly explain the symbols you use. (8%)
- (2) Show that the following equation holds in a medium with permittivity ϵ , permeability μ , and the conductivity σ :

$$-\oint_s (\vec{E} \times \vec{H}) \cdot d\vec{s} = \frac{\partial}{\partial t} \int_v \left(\frac{1}{2} \epsilon E^2 + \frac{1}{2} \mu H^2 \right) dv + \int_v \sigma E^2 dv$$

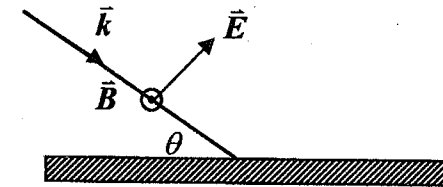
What is the meaning of this equation? (12%)

6. (20%)

A linearly polarized electromagnetic wave is incident on a perfect conductor at an angle θ . The electric field is given by

$$\vec{E} = \vec{E}_0 \text{ Re } \exp[i(\vec{k} \cdot \vec{r} - \omega t)]$$

Assume \vec{E} is in the plane of incidence, as shown in the figure. Starting with the boundary conditions imposed on an electromagnetic field by a conductor, derive the following properties of the reflected wave: direction of propagation, amplitude, polarization, and phase.



7. (15%)

The waves propagating in an air-filled parallel-plate waveguide are characterized by the electric field $\vec{E} = \hat{x}E_0 \cos(\omega t - z) \sin y$ (V/m), as shown in the figure below.

- (1) What is the separation d (in meters) between the two conducting plates if this field exactly corresponds to the TE_1 mode? (8%)
- (2) What is the cutoff frequency for this mode in this waveguide? (7%)

