

國立臺北科技大學

九十六學年度四年制二、三年級轉學生招生考試

系所組別：四技三年級光電工程系

第三節 專業科目 (二) 電磁學 試題

第一頁 共一頁

注意事項：

1. 本試題共五題，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。

1. (15%)

A capacitor consists of two concentric conducting spherical shells. The inner sphere, of radius R_1 , has charge Q_1 . The charge on the outer shell of radius R_2 is Q_2 . Determine (1) the potential of the inner sphere; (5%)(2) the potential of the outer sphere; (5%) (3) the capacitance of this capacitor. (5%)

2. (20%)

A voltage V is applied across a parallel-plate capacitor of area S . The space between the conductive plates is filled with two different lossy dielectrics of thicknesses d_1 and d_2 , permittivities ϵ_1 and ϵ_2 , and conductivities σ_1 and σ_2 , respectively. Determine (1) the current density between the plates, (6%) (2) the electric field intensities in both dielectrics, (7%) and (3) the surface charge at the interfaces. (7%)

3. (30%)

- (1) Write down the Maxwell's equations. Clearly explain the symbols you use. (10%)
- (2) Show that the following equation (Poynting's theorem) holds in a medium with permittivity ϵ , permeability μ , and the conductivity σ :

$$-\oint_S \vec{P} \cdot d\vec{s} = \frac{\partial}{\partial t} \int_V \left(\frac{1}{2} \epsilon E^2 + \frac{1}{2} \mu H^2 \right) dv + \int_V \sigma E^2 dv ,$$

where \vec{P} denotes the Poynting vector. What is the physical meaning of this equation? (10%)

- (3) Find the Poynting vector on the surface of a long, straight conducting wire (of radius b and conductivity σ) that carries a direct current I . Verify Poynting's theorem in this case. (10%)

4. (15%)

It is known that the electric field intensity of a spherical wave in free space is

$$\vec{E} = \vec{e}_\theta \frac{E_0}{r} \sin \theta \cos(\omega t - kr),$$

where r and θ , etc., denote the spherical coordinates. Determine the magnetic field intensity \vec{H} .

5. (20%)

As in the following figure, an electromagnetic wave is propagating in the TE mode in the rectangular waveguide. The walls of the waveguide are conducting and the inside is vacuum.

- (1) What is the cutoff frequency in this mode? (You must explain how you get the answer.)

(12%)

- (2) If the inside is filled with a material with permittivity ϵ , how does the cutoff frequency change? (8%)

