

中央大學八十九學年度碩士班研究生入學試題卷

空科學研究所 不分組 科目:

電磁學

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Terminology and short question. (35%)

- (i) Child-Langmuir law
- (ii) Earnshaw's Theorem
- (iii) Cyclotron frequency and radius
- (iv) The continuity equation
- (v) The Joule heating law
- (vi) Give equations to express the relationship between ρ , V , and E .
- (vii) Give equations to express the relationship between J , B , and A .
- (viii) Write Maxwell's equations; give their names and physical meanings.

A metal sphere of radius a carries a charge Q . It is surrounded, out to radius b , by linear dielectric material of permittivity ϵ . Find the electric field, the displacement, and the polarization at (i) $r < a$, (ii) $a \leq r \leq b$, and (iii) $r > b$. (iv) Evaluate the location and amount of all bound charge. (v) Find the capacitance of the system. (20%)

Put a magnetic dipole moment at the origin and let it point in the $-z$ direction.
(i) Derive the magnetic field of a (pure) dipole and (ii) the field line equation.
(15%)

An l -meter long metal bar of mass m lying in the east-west direction follows from an altitude h meters above the Earth's surface. If the earth's magnetic field B lying on the meridional plane has an inclination angle θ and the gravitational acceleration is g , (i) find the electric field between the two ends when the bar reaches the surface. (ii) What is the magnetic force on the bar? In what direction? (15%)

Assume an electromagnetic plane wave has the electric field,

$$\vec{E} = E_1 \hat{x} \cos(kz - \omega t) + E_2 \hat{y} \sin(kz - \omega t)$$

where $k = \omega/c$, c is the speed of light and E_1 , E_2 are real.

- (i) Determine the polarization of the wave and plot the trace of the tip of \vec{E} in the plane $z=0$.
- (ii) What is the magnetic field of the wave?
- (iii) Calculate the energy density of the wave.
- (iv) If the wave vertically strikes a perfect absorber, what pressure does it exert? (15%)