八十六學年度 電子所乙電機系(所) 丙 組碩士班研究生入學考試

1. 單選題 (20%)，每題2分，1.3，1.4題答錯倒扣2分，其他答錯倒扣1分。

1.1 Which is not an example of convection current? (a) A moving charge belt (b) Electronic movement in a vacuum tube (c) An electron beam in a television tube (d) Electric current flowing in a copper wire.

1.2 If $\nabla \cdot \mathbf{D} = \epsilon \nabla \cdot \mathbf{E}$ and $\nabla \cdot \mathbf{J} = \sigma \nabla \cdot \mathbf{E}$ in a given material, the material is said to be (a) Linear (b) Homogeneous (c) Isotropic (d) Linear and homogeneous (e) Linear and isotropic (f) Isotropic and homogeneous.

1.3 The electric conditions (charge and potential) inside and outside an electric screening are completely independent of one another (a) True (b) False.

1.4 The capacitance of a capacitor filled by a linear dielectric is independent of the charge on the plates and the potential difference between the plates (a) True (b) False.

1.5 Two conducting plates are inclined at an angle 30° to each other with a point charge between them. The number of image charges is (a) 12 (b) 11 (c) 6 (d) 5 (e) 3.

1.6 One of the following is not a source of magnetostatic fields: (a) A dc current in a wire (b) A permanent magnet (c) An accelerated charge (d) An electric field linearly changing with time (e) A charged disk rotating at uniform speed

1.7 Which of these statements is not characteristics of a static magnetic field (a) It is solenoidal (b) It is conservative (c) It has no sinks or sources (d) Magnetic flux lines are always closed (e) The total number of flux lines entering a given region is equal to the total number of flux lines leaving the region.

1.8 Two identical coaxial circular coils carry the same current I but in opposite directions. The magnitude of the magnetic field $\mathbf{B}$ at a point on the axis midway between the coils is (a) Zero (b) The same as that produced by one coil (c) Twice that produced by one coil (d) Half that produced by one coil.

1.9 Which of these materials requires the least value of magnetic field strength to magnetize it? (a) Nickel (b) Silver (c) Tungsten (d) Sodium chloride.

1.10 Identify the statement that is not true of ferromagnetic materials (a) They have a large χ_m (b) They have a fixed value of μ_r (c) Energy loss is proportional to the area of the hysteresis loop (d) They lose their nonlinearity property above the Curie temperature.

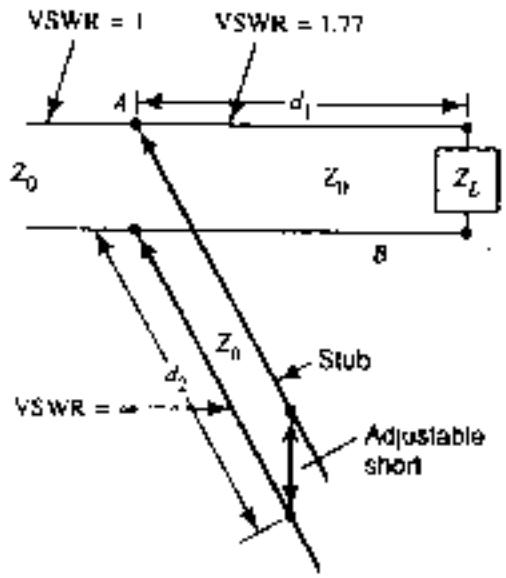
2. 一帶電粒子束往同一方向進行，每一粒子之速率皆不一定相同。
試設計一簡單實驗以分離不同速率之粒子。 (5%)

八十六學年度 電子所及電物系(所) 丙 組碩士班研究生入學考試

科目 電磁學 科號3203 共 3 頁第 2 頁 *請在試卷【答案卷】內作答

3. Consider a monochromatic plane wave. Prove that its electric field intensity **E**, magnetic field intensity **H**, and direction of propagation are mutually orthogonal. (10%)

4. The voltage standing-wave ratio (VSWR) of a lossless transmission is defined as $\text{VSWR} = (1 + |\Gamma|)/(1 - |\Gamma|)$, where Γ is called the reflection coefficient for voltage of the transmission line. Referring to the figure given below, explain why adjusting the adjustable short can achieve the result of no reflected wave at point A. Reflected wave is found between points A and B, but it does not go beyond point A. Explain why? Note that you are not asked to do any calculation here, you are asked to explain the principle of the given configuration. (15%)



5. Plot the following five normalized impedances with points A, B, C, D, E on the Γ_r-Γ_i complex plane or the Smith chart.
(a) $1 + j0$, (b) $0 + j1$, (c) $0 - j1$, (d) $0 + j0$, and (e) $\infty + j\infty$. (10%)

6. An eight-turn loop antenna of a 2 MHz radio receiver has an area of 0.1 m^2. If the loop develops an emf of 2 mV (rms) when oriented for maximum response. What is the rms fields for (a) **E** and (b) **H**. (7%)

7. The y-z plane is the boundary separating two dielectrics of relative permittivities $\epsilon_r = 2$ ($x > 0$) and 5 ($x < 0$). For $x < 0$, $\mathbf{E} = \hat{x}3 + \hat{z}2$ V/m. (a) Find **D** for $x > 0$ (b) Draw both **E** and **D** at $x = 0^+$ and 0^-. (8%)

8. The amount of power propagating along a waveguide depends on the operating frequency. Consider an air-filled waveguide has inside dimensions of 3 cm × 1 cm. Assume the transverse electric field of a guided mode is given as

$$\mathbf{E}(x, y, z) = \hat{y} \sin\left(\frac{\pi}{0.03} x\right) e^{-j\beta z}, \quad (\text{V/m})$$

Neglecting the attenuation, find the time-average power $P(z)$ propagating along the waveguide at axial position z for the following three cases of operating frequency. (a) $f = 2$ GHz; (b) $f = 5$ GHz; and (c) $f = 10$ GHz. (15%)

9. Consider a microwave communication link, through which two elevated parabolic reflector dishes transmit and receive signal at 300 MHz. The two antennas are identical and spaced at a distance of 10 km. The transmitted power is 1 kW. Suppose the required received power P_L is 1 mW, determine the size of the dish antennas. Assume that the antennas are lossless and the effective area A_e of the dish antenna is equal to its physical size. (10%)

Constants and Formulas for Reference

$\varepsilon_0 \simeq \frac{1}{36\pi} \times 10^{-9}$ F/m

$\mu_0 = 4\pi \times 10^{-7}$ H/m

$A_e(\theta, \phi) = \frac{\lambda^2}{4\pi} G_D(\theta, \phi)$