

國立中央大學100學年度碩士班考試入學試題卷

所別：太空科學研究所碩士班 不分組(一般生)

科目：電磁學

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本科考試禁用計算器

\*請在試卷答案卷(卡)內作答

1. Answer the following 12 questions briefly:
  - (a) Under which condition,  $\vec{F}$  is said to be a conservative vector field? (5 points)
  - (b) A point charge produces electric fields around the charge in a vacuum medium. If the medium is replaced with a dielectric medium, will the produced electric fields become higher or lower? Explain the reason for your answer. (5 points)
  - (c) If the same amount of electrons and ions are moving together with the same velocity, will it produce a non-zero electric current? Explain the reason for your answer. (5 points)
  - (d) What is the physical meaning of the equation of continuity for electric currents? (5 points)
  - (e) For an electric dipole, what is the proportionality between the electric field intensity at any place and its distance from the center of the dipole? (5 points)
  - (f) Explain the method of images for calculating the potential and electric fields for a point charge and a conducting plane? (5 points)
  - (g) Write down the expression for the Biot-Savart law and explain its physical meaning. (5 points)
  - (h) What is the definition of the magnetic flux? (5 points)
  - (i) What are the boundary conditions for magnetic fields in a condition without electric currents flowing at the interface between the two regions? (5 points)
  - (j) Write down the definition of the Poynting vector  $\vec{S}$  and explain its physical meaning. (5 points)
  - (k) What does the term "dispersionless electromagnetic waves" mean? (5 points)
  - (l) Explain how Faraday's law of induction led to the development of electric generators. (5 points)
2. A parallel-plate capacitor is formed by two metal plates having an area  $S$  and a separation  $d$ . The lower plate is held at a potential of  $V_0$ , and the upper plate is grounded. Determine
  - (a) the potential distribution, (4 points)
  - (b) the electric flux density, (4 points)
  - (c) the total charge on the upper plate, (4 points)
  - (d) the capacitance of the parallel-plate capacitor, (4 points) and
  - (e) the electric energy stored in the system. (4 points)
3. A proton with mass  $M$  and charge  $e$  is revolving in a uniform magnetic field  $B\vec{a}_z$  (where  $B > 0$ ) with a velocity  $\vec{u} = u_p\vec{a}_z + u_n\vec{a}_\phi$ , where  $u_p$  is the velocity component parallel and  $u_n$  is the velocity component perpendicular to the ambient magnetic field in the cylindrical coordinate system  $(\vec{a}_r, \vec{a}_\phi, \vec{a}_z)$ . Determine
  - (a) the magnetic force acting on the proton, (4 points)
  - (b) the direction of rotation for the proton viewed from  $+\vec{a}_z$ , (4 points)
  - (c) the radius of the circular orbit for the proton, (4 points)
  - (d) the time required for the proton to complete one cycle, (4 points)
  - (e) the distance traveled in one period. (4 points)

