國立中山大學100學年度碩士班招生考試試題

科目：電磁學【物理系碩士班】

1. 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. (8%) Verify poynting theorem. (8%)

2. The circuit in Fig.1 is situated in a magnetic field

$$\vec{B}(t) = \hat{z}B_0 cos\left(\omega t - \frac{2\pi}{3}x\right) \ (\mu T),$$

where $\omega=3\pi\times10^7$ /sec and $B_0=3\mu$T. Assume $R_1=30\ \Omega$, $R_2=15\ \Omega$ and $L_1=60\ cm$, $L_2=30\ cm$, find the current $i(t)$. (10%)

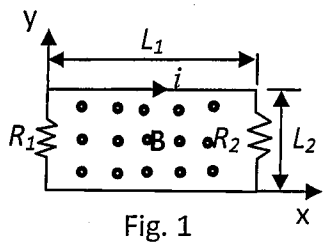

Fig. 1

3. When a spacecraft reenters the earth's atmosphere, its speed and temperature ionize the surrounding atoms and molecules, and create plasma. It has been estimated that the electron density is in the neighborhood of 2×10^8 per cm^3. Discuss the plasma's effect on frequency usage in radio communication between the spacecraft and the mission controllers on earth. (10%)

4. Two charges ($+q$ and $-q$) are arranged along the z-axis at $z=d/2$ and $z=-d/2$, respectively, as shown in Fig. 2. Determine the electric field and potential at a distance point p(r, θ, ϕ). (16%)

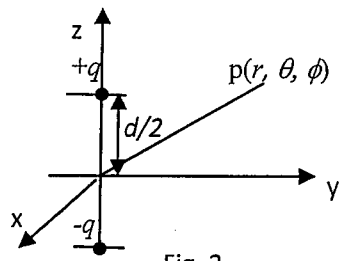

Fig. 2

5. An air coaxial transmission line has a solid inner conductor of radius a and a very thin outer conductor of inner radius b. (a) Determine the magnetic flux density in all space. (6%) (b) Determine the inductance per unit length of the line. (6%) (c) How much magnetic energy per unit length is stored in the system? (6%)

6. Two grounded, semi-infinite, parallel-plane electrodes are separated by a distance b. A third electrode perpendicular to and insulated from both is maintained at a constant potential V_0 (see Fig. 3). Determine the potential distribution in the region enclosed by the electrodes. (16%)

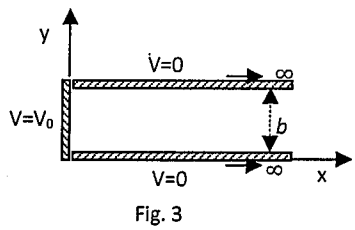

Fig. 3

7. A cylindrical bar magnet of radius b and length L has a uniform magnetization $\mathbf{M}=\hat{z}M_0$ along its axis. (a) Determine the equivalent magnetization charge density. (6%) (b) Determine the equivalent magnetization current density $\mathbf{J}_m$ and $\mathbf{J}_{ms}$. (8%)