93學年度國立成功大學研究所招生考試 醫學工程研究所 乙組 電磁學 試題 共 1 頁 第 1 頁

1. Two very small conducting spheres, each of a mass 1.0 x 10^{-3} (kg), are suspended at a common point by very thin non-conducting threads (with negligible mass) of a length 0.4 (m). A charge Q is placed on each sphere. The electric force of repulsion separates the spheres, and an equilibrium is reached when the suspending threads make an angle of 10°. Find Q. (10%)
2. A z-directed electric dipole is placed at the origin in a free space. Find the value of angle θ with respect to z-axis, at which the electric field intensity has no z-component. (10%)
3. For Helmholtz coils (each of N turns and radius b, and separated by a distance d), the connecting line of the centers for two coils is called as the x-axis. The current I flows in each coil is in the same direction. (a) Find the magnetic flux density $\mathbf{B} = \mathbf{a}_x B_x$ at a point midway between the coils, and (b) show that dB_x/dx vanishes at that midpoint. (20%)
4. Determine the self-inductance of a toroidal coil of N turns of wire wound on an air frame with mean radius r_o and a circular cross section of radius b. Obtain an approximate expression assuming $b << r_o$. (15%)
5. Determine the mutual inductance between a very long, straight wire and a conducting circular loop, as shown in Fig. 1. (15%)
6. (a) Assuming the relative permittivity $\varepsilon_r = 1$ and the conductivity $\sigma = 6 \times 10^7$ (S/m) for copper, compute the ratio of magnitudes between the displacement current density and conduction current density at 100 GHz, and (b) write the governing differential equation for magnetic field intensity $\mathbf{H}$ in a source-free good conductor. (20%)
7. Neglecting fringe fields, prove analytically that a y-polarized TEM wave that propagates along a parallel-plate transmission line in $+z$-direction has the following properties: $\partial E_y / \partial x = 0$ and $\partial H_x / \partial y = 0$. (10%)

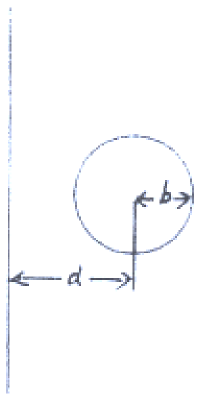

Fig. 1

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