國立臺灣科技大學 106 學年度碩士班招生試題

系所組別：電子工程系碩士班丙組

科　　目：電磁學

(總分為 100 分)

1. An infinitesimally thin metallic cylindrical shell of radius 0.05 m is centered on the z-axis and has a uniformly distributed charge of 100π nC per meter length of shell.

   (a) Find the value of the surface charge density on the metallic cylindrical shell. (10%)

   (b) Plot the electric flux density (D_r) versus radial distance from the z-axis over the range $0 \le r \le 0.1$ m. (10%).

2. Find the force of attraction in a parallel-plate capacitor with surface area ($A = 5\pi\times10^{-4}$ m^2), separated distance ($d = 5.0\times10^{-3}$ m), and $\varepsilon_r = 4.5$ if the voltage across it is 20 V. (10%)

   $\left(\varepsilon_0 = \dfrac{1}{36\pi}\times10^{-9}\ \text{(F/m)}\right)$

3. An electron beam shaped like a circular cylinder of radius r_0 carries a charge density given by

   $$\rho_v = -\frac{a}{1+r}\ \text{(C/m}^3\text{)},$$

   where a is a positive constant, r is the radial distance measured from the z-axis, and the axis of beam is coincident with the z-axis.

   (a) Find the total charge contained in length L of the beam. (10%)

   (b) If the electrons are moving in the $+z$ direction with uniform speed u, find the magnitude and direction of the current crossing the z-plane. (10%)

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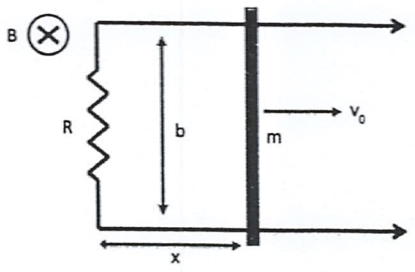
4. (20%)

For a conductor bar of mass, m, on a pair of rails separated by a distance, b, and connected by a resistor R, all embedded in a background magnetic field $\bar{B}$ which points into the page and with magnitude B.



(a) (10%) Find the magnetic flux, the emf, the magnitude and direction of the force and the magnitude and direction of the current that flows through the circuit.

(b) (10%) Using Newton's 2nd law (F=ma), write down a differential equation for the velocity of the bar, v(t), as a function of time. Solve this differential equation and find the v(t), assuming at $v(t=0)=v_0$

5. (20%)

A uniform plane electromagnetic wave propagates $+x$ direction in a free space. Assuming its E-field is sinusoidal and polarized in the $+z$ direction, with a frequency 1GHz and has a maximum value of 0.002 (V/m) at t=0 and $x=0$.

(a) (10%) Write the instantaneous expression for the E-field for any t and x.

(b) (5%) Write the instantaneous expression for the corresponding H-field for any t and x.

(c) (5%) Rewrite the H-field if the wave propagates in a simple *lossless, nonmagnetic* medium with the relative permittivity $\epsilon_r=3$.

6. (10%)

A current I flows uniformly through a long cylinder conductor rod with a radius a. Find the magnetic flux density everywhere.