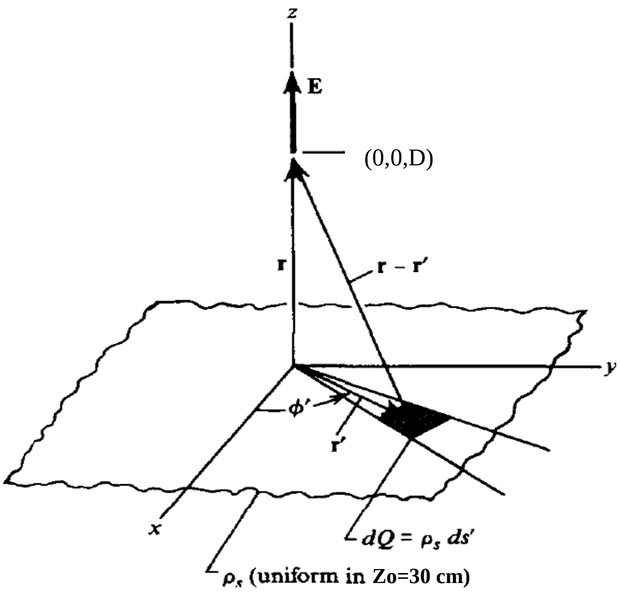
國立彰化師範大學 97 學年度碩士班招生考試試題

系所：顯示技術研究所碩士班　　　　科目：電磁學

☆☆請在答案紙上作答☆☆　　　　共 3 頁，第 1 頁

1. Consider an infinite sheet of uniform surface charge density ρ_s, located in the Z_0= 30 cm plane and a field point located above it (at D) as shown in the following figure.
Please derive the electric field for D＞Z_0 and D＜Z_0. (10%)



$$r = a_z z$$
$$r' = a_{\rho'}\rho'$$
$$r - r' = a_z - a_{\rho'}\rho'$$
$$|r - r'| = [(\rho')^2 + z^2]^{1/2}$$

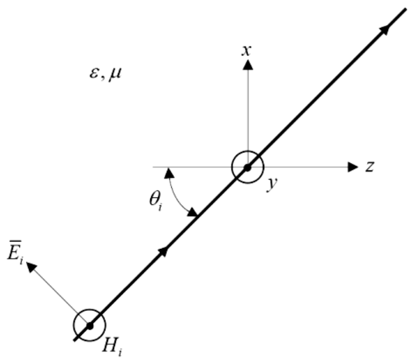
2. Consider the sphere with a charge density over the radius as $\rho(r) = \rho_o e^{-r}$. Please derive the electric field inside the sphere. (10%)

3. An electromagnetic wave is traveling at an angle θ with respect to the z axis within a medium with dielectric permittivity ε and magnetic permeability μ. The magnetic field is given as: (10%)

$$\overline{H}_i = H_0 \,\mathrm{Re}\left[e^{j\left(2\pi\times10^8 t - \pi\left(x+\sqrt{3}z\right)\right)} \right] \overline{i_y} \qquad \text{amperes/meter}$$

(a) Find the numerical value of the speed of light in the medium in meters/second.

(b) Find the angle θ_i.



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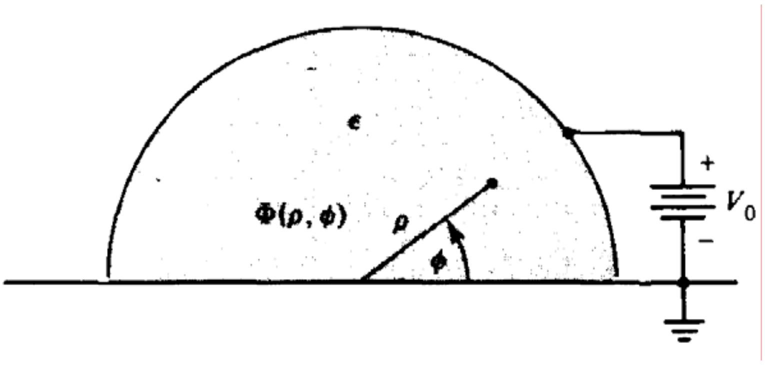
4. Consider the two-dimensional problem $\partial/\partial_z = 0$ and the boundary of the conducting plates as shown in the following figure. Please use the method of separation of variables to obtain the voltage $\Phi(\rho,\phi)$ inside the semi-circle. (20%)



5. The complex representation of the electric field for a certain electromagnetic wave in vacuum is:

$$\overline{E} = (\hat{y} - \hat{z})e^{+jx-2jy-2jz}$$

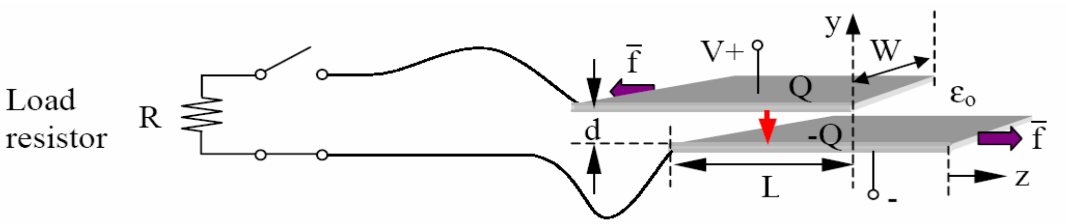
(a)What is the polarization for this wave (linear, circular, elliptical)?

(b)What is an equivalent time-domain expression E(t, x, y, z)?

(c)What is the time-average wave intensity I [Wm^{-2}]?

(d)What is the frequency f [Hz] for this wave? (20%)

6.(a) Calculate the force f [N] required to laterally displace two overlapping capacitor plates in vacuum charged to voltage V with charge Q, separated by distance d, and with width W >> d << L, as illustrated. Assume no battery is connected. Express your final answer in terms of V and the device dimensions. (10%)



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(b) We use the same configuration as an electrical generator providing power to a load resistor of value R ohms, i.e., we close the switch in the illustrated circuit. If force f moves the charged plates (voltage V) apart in the z direction at v m/s, what velocity v keeps the capacitor voltage V constant? (10%)

7. Using the complex form of Maxwell's equations, (10%)

$$\nabla \times \underline{\bar{E}} = -j\omega \underline{\bar{B}} \qquad \nabla \times \underline{\bar{H}} = \underline{\bar{J}} + j\omega \underline{\bar{D}} \qquad \nabla \bullet \underline{\bar{D}} = \underline{\rho} = 0 \qquad \nabla \bullet \underline{\bar{B}} = 0.$$

(a) Derive for free space ($\rho = \underline{J} = 0$) the complex form of the wave equation for $\underline{H}$: $[\nabla^2 + k^2]\underline{H} = 0$. Recall the identity $\nabla \times (\nabla \times A) = \nabla (\nabla \bullet A) - \nabla^2 A$.

(b) Derive the conservation of charge equation $\nabla \cdot \underline{J} = -j\omega\underline{\rho}$ for the case $\underline{J} = \sigma \underline{E}$.

Recall the identity $\nabla \bullet (\nabla \times A) = 0$.