Prof. Yen-Chieh Huang
Dept of Electrical Engineering
National Tsing-Hua University

office: Delta 856
ext: 62340
email:ychuang@ee.nthu.edu.tw

EE214000 Electromagnetics, Fall 2020

Your name: 陳傑儒 ID: 109066551 Oct.19th, 2020

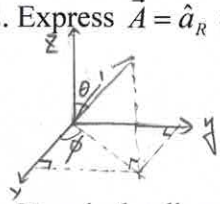
EE214000 Electromagnetics, Fall, 2020
Quiz #6-2, Open books, notes (21 points), due in class, Monday, Oct. 19th, 2020

1. What is the angle between the two vectors $\vec{A} = \hat{a}_x$ and $\vec{B} = 4\hat{a}_y - 3\hat{a}_z$? (3 points)

$\vec{A}\cdot\vec{B} = |\vec{A}||\vec{B}|\cos\theta = 0$

$\Rightarrow \cos\theta = 0 \quad \therefore \theta = 90^\circ$

2. Express $\vec{A} = \hat{a}_R$ as $\vec{A} = A_x\hat{a}_x + \hat{A}_y\hat{a}_y + A_z\hat{a}_z$. Find $A_x, \hat{A}_y, A_z$. (5 points)



$A_x = 1\cdot\sin\theta\cdot\cos\phi$ $A_z = 1\cdot\cos\theta$

$A_y = 1\cdot\sin\theta\cdot\sin\phi$

3. How is the direction of dipole moment defined? (2 points) What is the crossing angle between an electric field line and an equipotential line? (2 points)

由負到正

90°

4. Explain why the electric field in a perfect conductor has to be zero. (3 points)

導体中具有無窮多電子，且會受外加電場所影響而產生移動，進而產生反向的E_{in}與外加電場相抵消，故導体內電場為0。

5. In the example of Sec. 6.2, what are the total polarization charges induced at spherical surfaces of $R = a$ and b. Do the answers agree with or violate the charge conservation? Take the relative permittivity of the dielectric to be ε_r. (6 points)

① for $R = a$

$\vec{D} = \frac{q}{4\pi a^2}\hat{a}_R$

$\vec{E} = \frac{q}{4\pi\epsilon a^2}\hat{a}_R$

b/ $\vec{D} = \epsilon_0\vec{E} + \vec{P}$

$\Rightarrow \vec{P} = \vec{D} - \epsilon_0\vec{E}$

$= \frac{q}{4\pi a^2}\left(1 - \frac{1}{\epsilon_r}\right)\hat{a}_R$

$\rho_{PS} = \vec{P}\cdot(-\hat{a}_R) = \frac{-q}{4\pi a^2}\left(1 - \frac{1}{\epsilon_r}\right)$

$\therefore$ Polarization charge $= \rho_{PS}\cdot 4\pi a^2 = -q\left(1 - \frac{1}{\epsilon_r}\right)$

② for $R = b$

$\vec{D} = \frac{q}{4\pi b^2}\hat{a}_R$

$\vec{E} = \frac{q}{4\pi\epsilon b^2}\hat{a}_R$

$\vec{P} = \vec{D} - \epsilon_0\vec{E}$

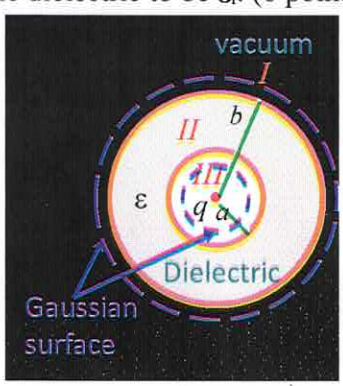
$= \frac{q}{4\pi b^2}\left(1 - \frac{1}{\epsilon_r}\right)\hat{a}_R$

$\rho_{PS}' = \vec{P}\cdot(\hat{a}_R)$

$= \frac{q}{4\pi b^2}\left(1 - \frac{1}{\epsilon_r}\right)$

$\therefore$ polarization charge $= \rho_{PS}'\cdot 4\pi b^2$

$= q\left(1 - \frac{1}{\epsilon_r}\right)$



$\because \left[-q\left(1 - \frac{1}{\epsilon_r}\right)\right] + \left[q\left(1 - \frac{1}{\epsilon_r}\right)\right] = 0$

$\therefore$ agree with the charge conservation