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EE214000 Electromagnetics, Fall 2020

Your name: Chiehm ID: 109066551 Sep. 21, 2020

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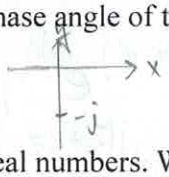
Quiz #2-2, Open books, notes (39 points), due in class, Monday, Sep. 21st, 2020

1. What is the phase angle of the imaginary unit $-\sqrt{-1}$. (2 points)

$-\sqrt{-1} = -j$



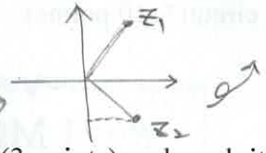
Ans: 270° or -90°

2. A and B are real numbers. What is the complex conjugate of $z = \dfrac{1 - Ae^{j\phi}}{A + jB}$. (2 points) "complex conjugate: 虛j變號即可"

Ans: $z^* = \dfrac{1 - Ae^{-j\phi}}{A - jB}$

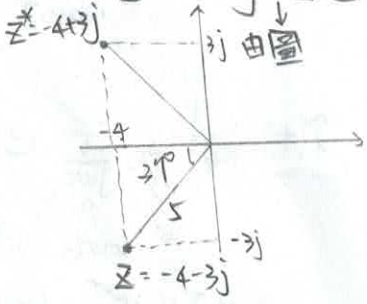
3. If you rotate the complex number $z_1 = x_1 + jy_1$ on the polar-coordinate plane by -90°, what is the resulting complex number z_2? (5 points)

旋轉-90° ⇒ z_1與z_2正交
幼稚園時學過一組正交 ⇒ 係數對調且其中一項加負號即可 (∵斜率相乘=-1)
⇒ $z_2 = y_1 - jx_1$ or $-y_1 + jx_1$ #



4. Express z = – 4–3j in the polar form (3 points) and mark it (2 points) and its complex conjugate (2 points) on the polar coordinate system.

$z = -4-3j = 5e^{j217°}$ or $5e^{-j143°}$ #



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5. Calculate the division $z_3 = z_1 / z_2$ and express the result in polar form, $z_2 = 1 + j$ and $z_1 = 4 + 3j$. (5 points)

$$z_3 = \frac{z_1}{z_2} = \frac{4+3j}{1+j} = \frac{5e^{j37^\circ}}{\sqrt{2}e^{j45^\circ}} = \frac{5}{\sqrt{2}}e^{-j8^\circ}$$ #

6. For a harmonic wave expressed as $A(z,t) = A_0 \sin(\omega t - kz + \phi)$, what is the phasor of this wave? (3 points)

$$A(z,t) = A_0 \cos\left(\frac{\pi}{2} - \omega t + kz - \phi\right) = \mathrm{Re}\left(A_0 e^{j(\frac{\pi}{2}+kz-\phi)} e^{-j\omega t}\right)$$

Ans: $\sin\theta = \cos(90^\circ - \theta)$ 很多人錯在這步!!

$$\therefore A_0 e^{j(\frac{\pi}{2}+kz-\phi)}$$ #

7. For a time-harmonic wave function expressed by A, what is the phasor expression of the wave equation $\nabla^2 A - \frac{1}{c^2}\cdot\frac{\partial^2 A}{\partial t^2} = 0$, where c is a constant? (5 points)

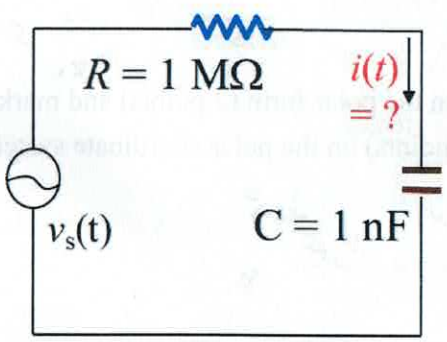
$$\nabla^2 \hat{A} - \frac{(j\omega)^2}{c^2}\hat{A} = 0$$

$$\Rightarrow \nabla^2 \hat{A} + \left(\frac{\omega}{c}\right)^2 \hat{A} = 0$$ #

8. For the RC circuit shown below, if the driving voltage is a sinusoidal input with a frequency of 60 Hz, given by

$$\tilde{v}_s(t) = 100\cos(2\pi \times 60t + \pi/6) \text{ volts}$$

what is the current in the circuit? (10 points)



$$\tilde{V}_s(t) = \mathrm{Re}\left(\underbrace{100e^{\frac{\pi}{6}}}_{\hat{V}_s} e^{2\pi\times 60t}\right)$$

$$\therefore \tilde{i}(t) = \mathrm{Re}\left[\frac{\hat{V}_s}{R + \frac{1}{j\omega C}} e^{j\omega t}\right]$$

($100e^{\frac{\pi}{6}}$ = $\hat{V}_s$; 10^6, $2\pi\times 60$, 10^{-9})

$$= 3.5\times 10^{-5}\cos(2\pi\times 60t + 99.3^\circ)$$

by KVL

$$\Rightarrow R\hat{i}(t) + \frac{\hat{q}(t)}{C} = \hat{V}_s(t)$$

$$\Rightarrow R\hat{i}(t) + \frac{1}{C}\int \hat{i}(t)\,dt = \hat{V}_s(t)$$ 皆以phaser作計算

$$\Rightarrow \hat{I}\left(R + \frac{1}{j\omega C}\right) = \hat{V}_s$$

$$\Rightarrow \hat{I} = \frac{\hat{V}_s}{R + \frac{1}{j\omega C}}$$