CIRCUITS
ASSIGNMENT #2

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① $L = 0.8H$

$i_L = \sin(100t + \pi/4)$

$$V_L(t) = L\left(\frac{di_L(t)}{dt}\right)$$

$$= 0.8\left(\frac{d(\sin(100t + \pi/4))}{dt}\right)$$

$$= 0.8\cos(100t + \pi/4)(100)$$

$$V_L(t) = 80\cos(100t + \pi/4)$$

② $x(t) = 3\cos(7\omega t) + 4$

$\omega = \frac{2\pi}{T}$

AVERAGE

$$\bar{x}(t) = \frac{1}{T}\int_0^T x(t)\,dt$$

$$= \frac{1}{T}\int_0^T (3\cos(7\omega t) + 4)\,dt$$

$$= \frac{1}{T}\left(\frac{3\sin(7\omega t)}{7\omega}\right)\Big|_0^T + \frac{1}{T}(4t)\Big|_0^T$$

SUB IN

$$= \frac{1}{T}\left(\frac{3\sin(7\omega t)}{7\omega} - \left(\frac{3\sin(7\omega(0))}{7\omega}\right)\right) + \frac{1}{T}(4T - 0)$$

$$= \frac{1}{T}\left(\frac{3\sin(7\omega t)}{7\omega}\right) + 4$$

$$= \frac{1}{T}\left(\frac{3\sin\left(7\left(\frac{2\pi}{T}\right)T\right)}{7\left(\frac{2\pi}{T}\right)}\right) + 4$$

$$= \frac{1}{14\pi}\,3\sin(14\pi) + 4$$

$$= 4$$

ROOT-MEAN-SQUARED (RMS)

$$x_{rms} = \sqrt{\frac{1}{T}\int_0^T x^2(t)\,dt}$$

$$= \sqrt{\frac{1}{T}\int_0^T (3\cos(7\omega t) + 4)^2\,dt}$$

$$= \sqrt{\frac{1}{T}\int_0^T 9\cos^2(7\omega t) + 24\cos(7\omega t) + 16\,dt}$$

$$= \sqrt{\frac{1}{T}\int_0^T \left(9\left(\frac{1 + \cos(14\omega t)}{2}\right) + 24\cos(7\omega t) + 16\right)dt}$$

$$= \sqrt{\frac{1}{T}\left(\frac{9}{2}T + \frac{1}{28\omega}(\sin(14\omega t) + \frac{24}{7\omega}(\sin(7\omega t)) + 16T\right)}$$

$$= \sqrt{\frac{1}{T}\left(\frac{9}{2}T + \frac{1}{28\left(\frac{2\pi}{T}\right)}\left(\sin\left(14\left(\frac{2\pi}{T}\right)T\right) + \frac{24}{7\left(\frac{2\pi}{T}\right)}\left(\sin\left(7\left(\frac{2\pi}{T}\right)T\right)\right) + 16T\right)\right)}$$

$$= \sqrt{\frac{1}{T}\left(\frac{9}{2}T + 16T\right)}$$

$$= \sqrt{\frac{41}{2}}$$

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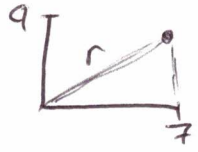
(3a) $7 + j9$

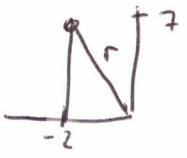


$r = \sqrt{7^2 + 9^2}$ $\quad \theta = \tan^{-1}\left(\frac{9}{7}\right)$

$r = \sqrt{130}$ $\quad \theta = 52.1$

$\rightarrow \sqrt{130} \angle \pm 52.1°$

(3b) $-2 + j7$



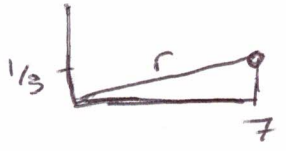
$r = \sqrt{7^2 + (-2)^2}$ $\quad \theta = \tan^{-1}\left(-\frac{7}{2}\right)$

$r = \sqrt{53}$ $\quad \theta = 105.9$

$\Rightarrow \sqrt{53} \angle \pm 105.9°$

(3c) $j\frac{2}{3} + 4 - j\frac{1}{3} + 3$

$= 7 + j\frac{1}{3}$



$r = \sqrt{7^2 + (1/3)^2}$ $\quad \theta = \tan^{-1}\left(\frac{1/3}{7}\right)$

$r = 7.01$ $\quad \theta = 2.8$

$\Rightarrow 7.01 \angle \pm 2.8°$

(4a) $j^j = e^{(j\pi/2)^j}$ $\quad e^{-\pi/2} = \cos(-\pi/2) + j\sin(-\pi/2) = -j$

(4b) $e^{-j\pi} = \cos(-\pi) + j\sin(-\pi) = -1$

(4c) $e^{j\pi} = \cos(2\pi) + j\sin(2\pi) = 1$

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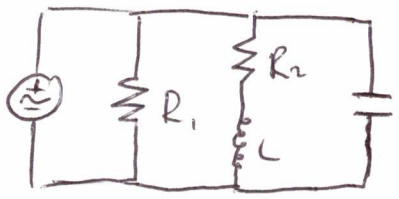
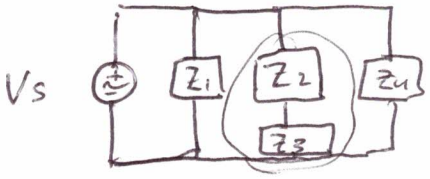
(5)



$V_s(t) = 10\cos(4000t + 60°)$
$\omega = 4000$
$R_1 = 800\Omega$
$R_2 = 500\Omega$
$L = 200mH$
$C = 70nF$



$Z_1 = 800\Omega$
$Z_2 = 500\Omega$
$Z_3 = j\omega L = 800j$
$Z_4 = \frac{1}{\omega C} = -3571.4j$

$Z_{23} = 500\Omega + 800j$

$$Z_T = \frac{1}{1/Z_1 + 1/Z_{23} + 1/Z_4}$$

$$= \frac{1}{1/800 + 1/(500+800j) + 1/-3571.4j}$$

$$= \frac{1}{(0.00181 - 0.000619j)}$$

$Z_T = 494.3 + 168.8j$

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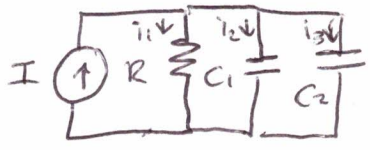
(6)



$I = 20\angle -\pi/4 = 14.14 - 14.14j$
$R = 3\Omega$
$Z_1 = -j3\Omega$
$Z_2 = -j7\Omega$

$$Z_{12} = \frac{1}{1/-j3 + 1/-j7}$$

$$= \frac{1}{0.476j}$$

$$= -j2.1$$

$$I_{Z_{12}} = \frac{-2.1j}{-2.1j + 3\Omega}(20\angle -\pi/4)$$