EE212 Test 3

The weighting of each problem is not necessarily the same.

Test Instructions:

9. This is a closed book, closed notes examination. No additional tables, including integral tables, may be used.
10. Calculators, computers, and other electronic computational devices are not permitted.
11. You may work in the test booklet.
12. Provide only your final solutions on the test answer sheet.
13. Provide units on all answers.
14. The length of the examination is 2 hours.
15. For the final grade, only the answers on the answer sheet will be graded.
16. These problems are graded right or wrong. (In most cases, there is no partial credit.) If multiple solutions or intermediate work are provided, the solution is considered incorrect. Use parenthesis when needed.

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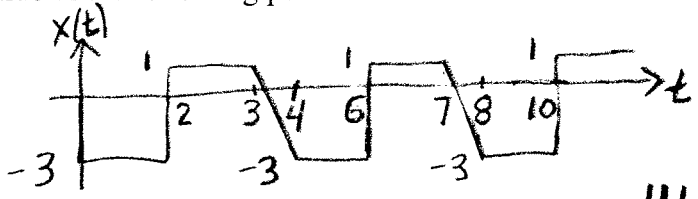
1. For the sinusoidal function $x(t) = 9\cos\left(6\pi t - 90^\circ\right)$, determine the frequency in Hz.

$\omega = 2\pi F$

2. Completely setup (but do not solve) the integral-based expression for the rms value of the following periodic waveform.



$T = 4$

$x_3 = -4t + b$

$-3 = -16 + b$

$b = 13$

3. Determine the rms value for the sinusoidal function $v(t) = \sqrt{6}\sin\left(9\pi t - 300^\circ\right)\text{V}$.

4. In the complex plane, sketch the phasor $-3 + 6j$.

5. Convert $5\angle 167^\circ$ to rectangular form. It is not necessary to evaluate the trigonometric functions.

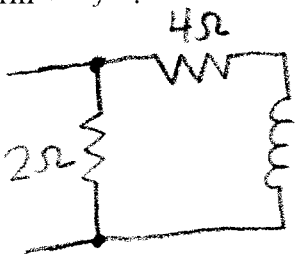
6. Convert $-4 - j8$ to polar form. It is not necessary to evaluate the trigonometric functions, but no j's should be present in the final answer.

7. Using complex algebra, simplify the following expression and place it in the polar form $A\angle\theta$. It is not necessary to evaluate the trigonometric functions, but no j's should be present in the final answer.

$$\frac{-3}{5+6j} \qquad \frac{-3\angle 0^\circ}{\sqrt{5^2+6^2}\,\angle \tan^{-1}\frac{6}{5}}$$

OR $$\frac{-3}{5+6j}\,\frac{5-6j}{5-6j} = \frac{-15+18j}{5^2+6^2}$$

8. Determine the impedance for the following network and place it in the rectangular form $c + jd$.

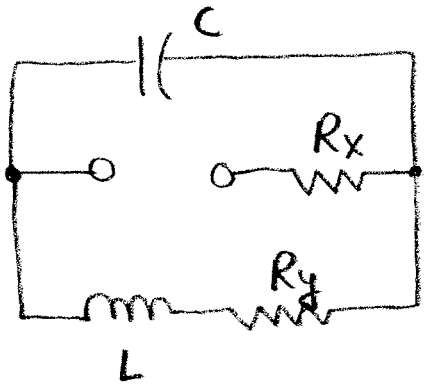


$$2\,/\!/\,(4+j3\omega) = \frac{2(4+j\omega 3)}{2+4+j\omega 3}$$

$$= \frac{8+j\omega 6}{6+j\omega 3} \times \frac{6-j\omega 3}{6-j\omega 3}$$

$$= \frac{48+18\omega^2}{6^2+(3\omega)^2} + j\,\frac{-24\omega+36\omega}{6^2+(3\omega)^2}$$

9. Determine the equivalent impedance seen by the two terminals at the frequency ω. Do not simplify the expression. If needed, the symbol for two elements in parallel (e.g., $R_s \| R_L$) may be used.



Printed Name: SOLN

52 pts total

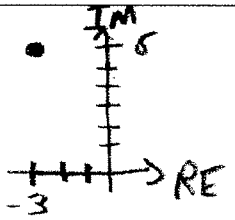
Signature:

Answer Sheet (Provide Units)

1 1. 3 Hz

3 2. $\sqrt{\frac{1}{4}\left[\int_6^2 (-3)^2 dt + \int_2^3 1^2 dt + \int_3^4 (-4t+13)^2 dt\right]}$

1 3. $\sqrt{6}/\sqrt{2}$ V rms

1 4. 

1 5. $5\cos(167^\circ) + j5\sin(167^\circ)$

1 6. $\sqrt{(4)^2+(-8)^2}\ \angle \tan^{-1}\frac{-8}{-4}$

2 7. $\frac{-3}{\sqrt{5^2+6^2}}\angle -\tan^{-1}\frac{5}{5}$ OR $\sqrt{\left(\frac{15}{5^2+6^2}\right)^2+\left(\frac{18}{5^2+6^2}\right)^2}\ \angle \tan^{-1}\frac{18}{-15}$

3 8. $\frac{48+18\omega^2}{6^2+(3\omega)^2} + j\frac{-24\omega+36\omega}{6^2+(3\omega)^2}$ Ω

1 9. $\left[(j\omega L + R_y)\,//\,\frac{1}{j\omega C}\right] + R_x$

EE212 Test 3

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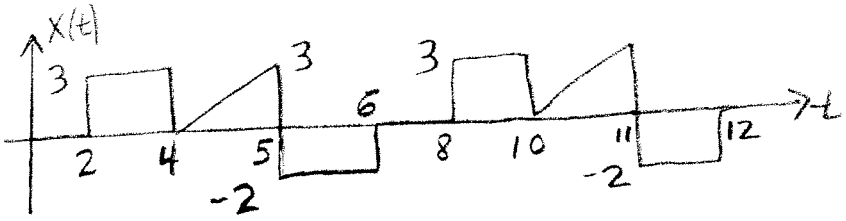
---

1. For the sinusoidal function $x(t) = 6\cos(9\pi t - 90^\circ)$, determine the frequency in Hz.

$\omega = 9\pi = 2\pi f$

2. Completely setup (but do not solve) the integral-based expression for the rms value of the following periodic waveform.



$T = 6$

$x_3 = 3t + b$

$0 = 3(4) + b$

$b = -12$

3. Determine the rms value for the sinusoidal function $v(t) = 5\sqrt{2}\cos(9\pi t - 200^\circ)\ \text{V}$.

4. In the complex plane, sketch the phasor $2 - 7j$.

5. Convert $6\angle -135^\circ$ to rectangular form. It is not necessary to evaluate the trigonometric functions.

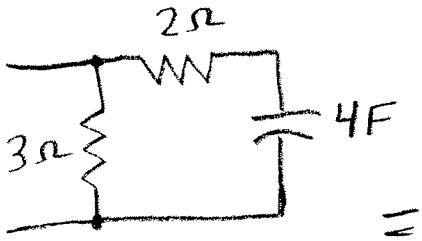
6. Convert $-3+j5$ to polar form. It is not necessary to evaluate the trigonometric functions, but no j's should be present in the final answer.

7. Using complex algebra, simplify the following expression and place it in the polar form $A\angle\theta$. It is not necessary to evaluate the trigonometric functions, but no j's should be present in the final answer.

$$\frac{7j}{-8+3j} \qquad \frac{7\angle 90^\circ}{\sqrt{-8^2+3^2}\,\angle \tan^{-1}\frac{3}{-8}}$$

OR $$\frac{7j}{-8+3j}\,\frac{-8-3j}{-8-3j} = \frac{21-j56}{64+9}$$

8. Determine the impedance for the following network and place it in the rectangular form $c+jd$.

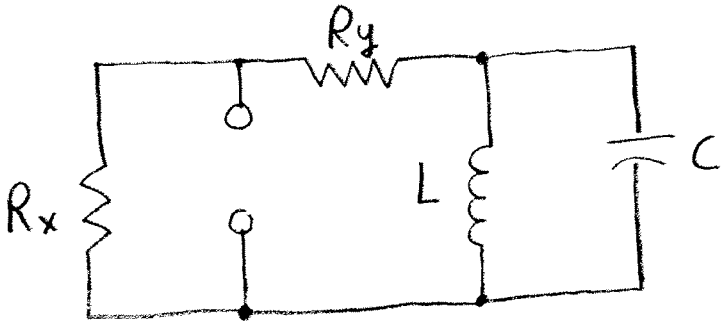


$$3\,\|\,\left(2+\frac{1}{j\omega 4}\right) = \frac{3\left(2+\frac{1}{j\omega 4}\right)}{5+\frac{1}{j\omega 4}}$$

$$= \frac{3(j\omega 8+1)}{1+j\omega 20}\times\frac{1-j\omega 20}{1-j\omega 20}$$

$$= \frac{3+24(20)\omega^2}{1^2+(\omega 20)^2} + j\,\frac{\omega 24-\omega 60}{1^2+(\omega 20)^2}$$

9. Determine the equivalent impedance seen by the two terminals at the frequency ω. Do not simplify the expression. If needed, the symbol for two elements in parallel (e.g., $R_s\|R_L$) may be used.



52 pts total

Printed Name: SOLN

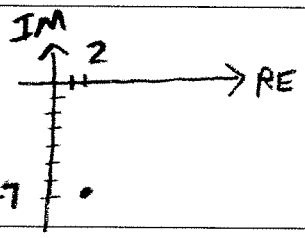
Signature: _____

Answer Sheet (Provide Units)

1 1. $9/2$ Hz

3 2. $\sqrt{\frac{1}{6}\left[\int_0^2 0^2\,dt + \int_2^4 3^2\,dt + \int_4^5 (3t-12)^2\,dt + \int_5^6 (-2)^2\,dt\right]}$

1 3. 5 V rms

1 4. 

1 5. $6\cos(-135^\circ) + j\,6\sin(-135^\circ)$

1 6. $\sqrt{(-3)^2+(5)^2}\ \angle \tan^{-1}\frac{5}{-3}$

2 7. $\frac{7}{\sqrt{8^2+3^2}}\ \angle 90^\circ - \tan^{-1}\frac{3}{-8}$ OR $\sqrt{\left(\frac{21}{73}\right)^2+\left(\frac{56}{73}\right)^2}\ \angle \tan^{-1}\frac{56}{21}$

3 8. $\frac{3+24/20)\omega^2}{1^2+(\omega 20)^2} + j\,\frac{\omega 24 - \omega 60}{1^2+(\omega 20)^2}$ Ω

1 9. $\left[R_y + (j\omega L \,//\, \frac{1}{j\omega C})\right] // R_x$

Ken Kaiser
Winter 2007

EE212 Test 3

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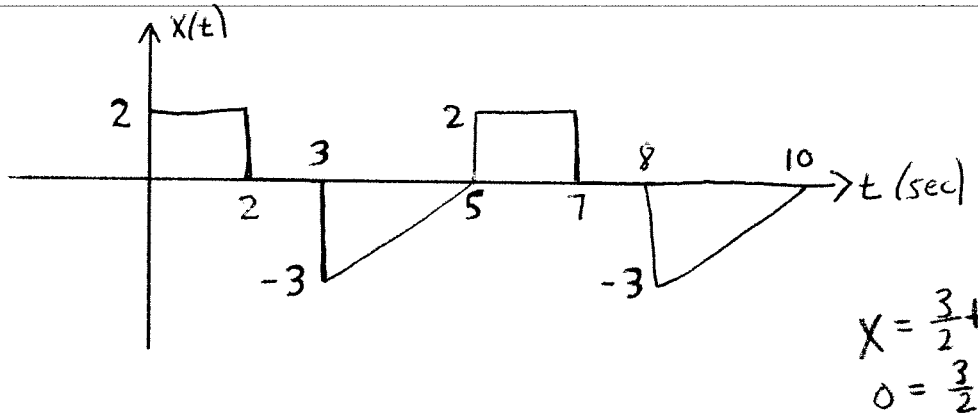
---

1. For the sinusoidal function $x(t) = 5\cos\left(3t + 20^\circ\right)$, determine the frequency in Hz.

$\omega = 3 = 2\pi f$

2. Completely setup (but do not solve) the integral-based expression for the rms value of the following periodic waveform.



$X = \frac{3}{2}t + b$

$0 = \frac{3}{2}5 + b$

3. Determine the rms value for the sinusoidal function $v(t) = 5\cos\left(3t + 20^\circ\right)$ V.

4. In the complex plane, sketch the phasor $-2 + 3j$.

5. Convert $5\angle 123^\circ$ to rectangular form. It is not necessary to evaluate the trigonometric functions.

6. Convert $-3 + j6$ to polar form. It is not necessary to evaluate the trigonometric functions, but no j's should be present in the final answer.

7. Using complex algebra, simplify the following expression and place it in the polar form $A\angle\theta$. It is not necessary to evaluate the trigonometric functions, but no j's should be present in the final answer.

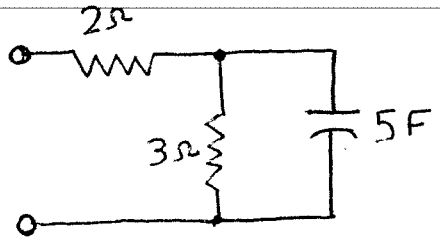
$$\frac{4+j6}{3-j8}$$

$$\frac{\sqrt{4^2+6^2}\ \angle \tan^{-1}\frac{6}{4}}{\sqrt{3^2+8^2}\ \angle -\tan^{-1}\frac{8}{3}}$$

OR

$$\frac{4+j6}{3-j8}\,\frac{3+j8}{3+j8} = \frac{(12-48)+j(18+32)}{3^2+8^2}$$ too much work!

8. Determine the impedance for the following network and place it in the rectangular form $c + jd$.



$$2 + 3 \,\|\, \frac{1}{j5\omega}$$

$$2 + \frac{3\,\frac{1}{j5\omega}}{3+\frac{1}{j5\omega}}$$

$$2 + \frac{3}{1+j15\omega}$$

OR ← easier

$$2 + \frac{3}{1+j15\omega}\,\frac{1-j15\omega}{1-j15\omega}$$

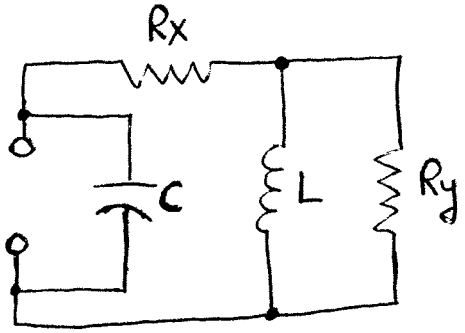
$$2 + \frac{3}{1+(15\omega)^2} - \frac{j15\omega(3)}{1+(15\omega)^2}$$

$$2 + \frac{3}{1+j15\omega} = \frac{2+j30\omega+3}{1+j15\omega} = \frac{5+j30\omega}{1+j15\omega}$$

$$\frac{5+j30\omega}{1+j15\omega}\,\frac{1-j15\omega}{1-j15\omega}$$

$$\frac{5+30(15)+j30-j75}{1^2+15^2}$$

9. Determine the equivalent impedance seen by the two terminals at the frequency ω. Do not simplify the expression. If needed, the symbol for two elements in parallel (e.g., $R_s \| R_L$) may be used.



Ken Kaiser
Winter 2007

31 pts Total

Printed Name: SOLUTION

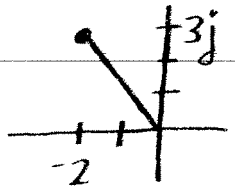
Signature: _____

Answer Sheet (Provide Units)

1 1. $3/2\pi$ Hz

2 2. $\sqrt{\frac{1}{5}\left[\int_0^2 2^2 dt + \int_2^3 0^2 dt + \int_3^5 \left(\frac{3}{2}t - \frac{15}{2}\right)^2 dt\right.}$

1 3. $5/\sqrt{2}$

1 4. 

1 5. $5\cos 123^\circ + j5\sin 123^\circ$

1 6. $\sqrt{3^2+6^2}\ \angle \tan^{-1}\frac{6}{-3}$

1 7. $\frac{\sqrt{4^2+6^2}}{\sqrt{3^2+8^2}}\ \angle \tan^{-1}\frac{6}{4} - \tan^{-1}\frac{-8}{3}$

2 8. $\frac{5+30(15)\omega^2}{1+(15\omega)^2} + j\,\frac{30\omega - 15(5)\omega}{1+(15\omega)^2}$ Ω OR $2 + \frac{3}{1+(15\omega)^2} - j\frac{15\omega(3$

1 9. $\left[(R_y /\!/ j\omega L) + R_x\right] /\!/ \frac{1}{j\omega C}$ Ω

Ken Kaiser
Winter 2009

EE212 Test 3

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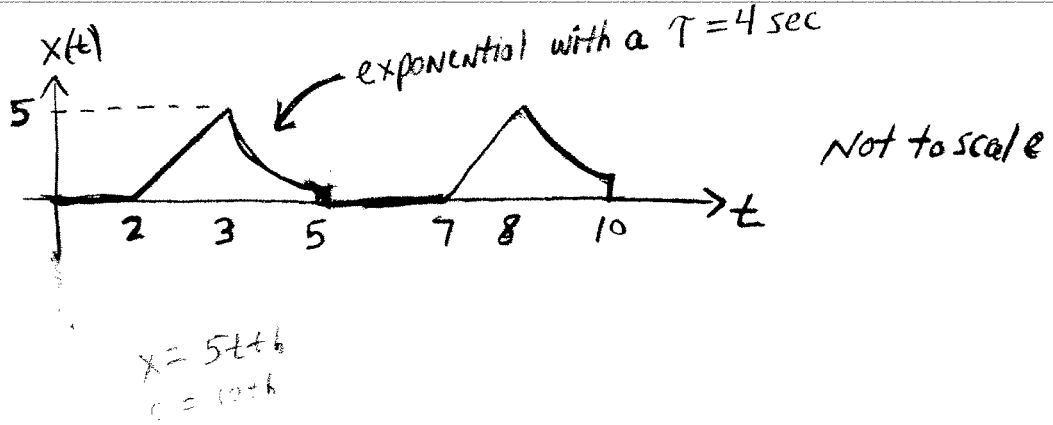
1. For the sinusoidal function $x(t) = 2\cos(5t - 50^\circ)$, determine the frequency in Hz.

$\omega = 2\pi f$
$5 = 2\pi f$

2. Completely setup (but do not solve) the integral-based expression for the rms value of the following periodic waveform.



3. Determine the rms value for the sinusoidal function $v(t) = 3\sin(9t + 200^\circ)$ V.

4. In the complex plane, sketch the phasor $-2 - 5j$.

5. Convert $3\angle 241^\circ$ to rectangular form. It is not necessary to evaluate the trigonometric functions.

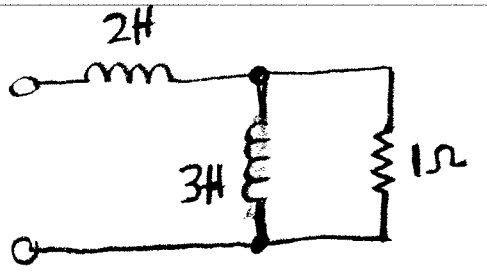
6. Convert $4 - j5$ to polar form. It is not necessary to evaluate the trigonometric functions, but no j's should be present in the final answer.

7. Using complex algebra, simplify the following expression and place it in the polar form $A\angle\theta$. It is not necessary to evaluate the trigonometric functions, but no j's should be present in the final answer.

$$\frac{3j}{4(-5+j8)}$$

$$\frac{3\angle 90^\circ}{(4\angle 0^\circ)(5^2+8^2)^{1/2}\angle \tan^{-1}\frac{8}{-5}}$$

8. Determine the impedance for the following network and place it in the rectangular form $c + jd$.



$$j\omega 3 /\!/ 1 = \frac{j\omega 3}{1+j\omega 3}$$

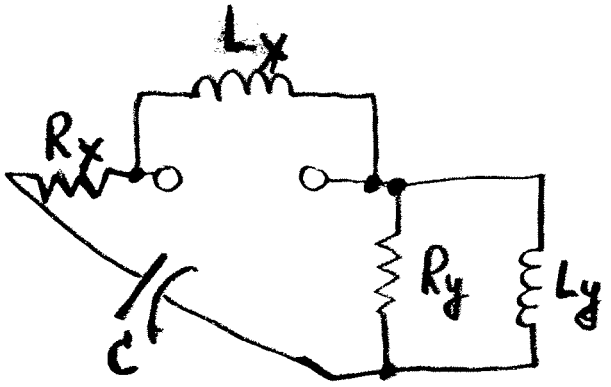
$$= \frac{j\omega 3}{1+j\omega 3}\,\frac{1-j\omega 3}{1-j\omega 3}$$

$$= \frac{j\omega 3 + \omega^2 9}{1+9\omega^2}$$

$$j\omega 3 /\!/ 1 = \frac{\omega 3\angle 90^\circ}{\sqrt{1+9\omega^2}\angle \tan^{-1}\omega 3}$$

$$= \left(3\omega/\sqrt{1+9\omega^2}\right)\angle 90^\circ - \tan^{-1}3\omega$$

9. Determine the equivalent impedance seen by the two terminals at the frequency ω. Do not simplify the expression. If needed, the symbol for two elements in parallel (e.g., $R_s \| R_L$) may be used.



Ken Kaiser

Winter 2009

Printed Name: SOLN

Signature: _____

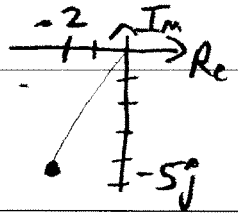
45 pts (2 for units)

Answer Sheet (Provide Units)

1 1. $5/2\pi$ Hz

3 2. $\sqrt{\frac{1}{5}\left[\int_0^2 0\,dt + \int_2^3 (5t-10)^2\,dt + \int_3^5 \left(5e^{-(t-3)/4}\right)^2 dt\right]}$

1 3. $3/\sqrt{2}$ V_{rms}

1 4. 

1 5. $3\cos(241°) + 3j\sin(241°)$

1 6. $\sqrt{4^2+5^2}\ \angle \tan^{-1}\frac{-5}{4}$

2 7. $\frac{3}{4\sqrt{5^2+8^2}}\ \angle 90° - \tan^{-1}\frac{8}{-5}$

3 8. $\frac{\omega^2 9}{1+9\omega^2} + j\left(\frac{3\omega}{1+9\omega^2} + 2\omega\right)$

1 9. $\left[(R_y \| j\omega L_y) + \frac{1}{j\omega C} + R_x\right] \| j\omega L_x$