EE1002 Principles of Electronic Engineering Test 2

Part I: Multiple choice (16 questions, 3 points per question, total 48 minutes)

1. If $(z - j)\,j = 2 + j$, find z.

Answer: $1 - j$

2. If $\tan\alpha = 3/4$, find $\cos^2\alpha + 2\sin 2\alpha$.

Answer: 64/25

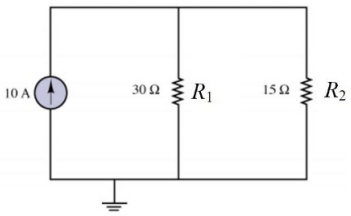
3. If $y = x^6 \sin(1/x)$, find the derivative of y.

Answer: $6x^5 \sin(1/x) - x^4 \cos(1/x)$

4. Evaluate $\int xe^{x^2} dx$

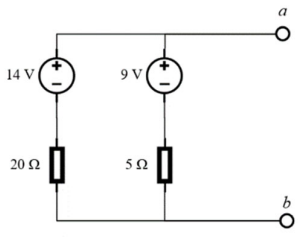
Answer: $\frac{1}{2}e^{x^2} + c$

5. Find the power consumed by resistors R_1 and R_2.



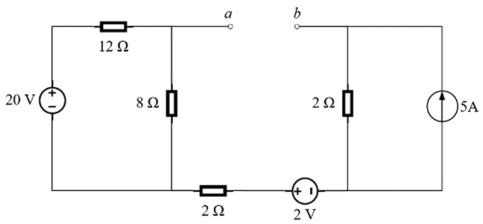
Answer: P_1:P_2 = 1:2; P_1 = 333 W

6. Find the Norton equivalent with respect to terminals *a*-*b* in the following circuit.



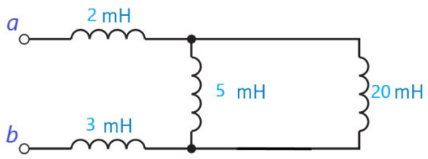
Answer: R_N = 4 Ω, I_N=2.5 A

7. Find the Thevenin equivalent with respect to terminals *a*-*b* in the following circuit.



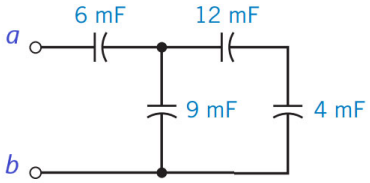
Answer: R_{th} = 8.8 Ω, U_{ab} = 0 V

8. For the four inductors connected in the following circuit, find the equivalent inductance L_{ab}.



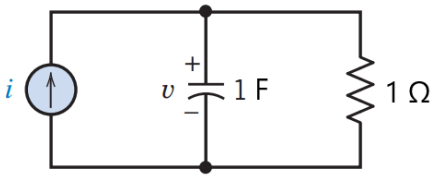
Answer: 9 mH

9. For the four capacitors connected as shown on the following circuit, find the equivalent capacitance C_{ab}.



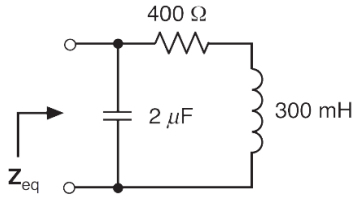
Answer: 4 mF

10. Find i for the following circuit if $v = 5(1 - 2e^{-2t})$ V.
[Hint: You may use the KCL to solve the problem.]



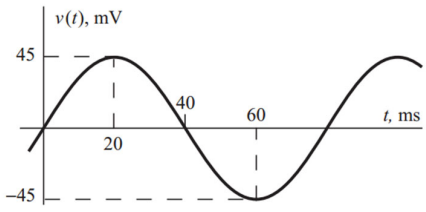
Answer: $5 + 10e^{-2t}$ A

11. Determine the equivalent impedance Z_{eq} of the following circuit at the frequency $\omega = 1000$ rad/s.



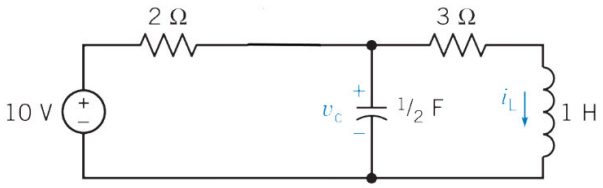
Answer: $599\angle -26.5°\ \Omega$

12. Express the voltage in the following figure in the general form $v(t) = Acos(\omega t + \phi)\ V$ where $A \geq 0$ and $-180° < \varphi \leq 180°$.



Answer: $v(t) = 0.045cos(25\pi t - 90°)$ V

13. Under steady-state dc conditions, find i_L and v_c of the following circuit.

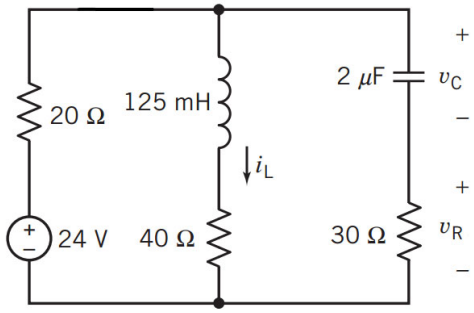


Answer: $i_L = 2$ A, $v_c = 6$ V

14. Determine the capacitance of a capacitor when the voltage across it is $v(t) = 12\cos(500t - 45°)$ **V** and the current is $i(t) = 3\cos(500t + 45°)$ **mA**.

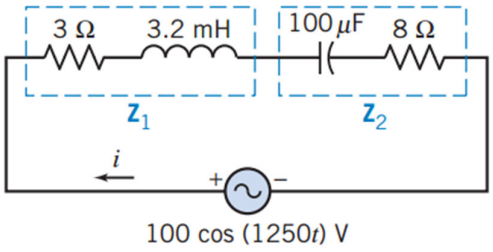
Answer: $C = 0.5$ uF

15. Under the dc condition, find i_L, v_C, and v_R in the following circuit.



Answer: $i_L = 0.4$ A, $v_C = 16$ V, *and* $v_R = 0$ V

16. In the following circuit, the impedances are given by $Z_1 = 5\angle 51.3°\ \Omega$ and $Z_2 = 8\sqrt{2}\angle -45°\ \Omega$. Find the current $i(t)$.



Answer: $i(t) = 8.55\cos(1250t + 20°)$ A

Part II: Written Questions (2 questions, 25 minutes per question, extra 6-minute upload time per question)

Question 1 (25 points)

(A) Fig. Q1(a) shows an ac circuit. The input voltage source is given by $v_{s1}(t) = 12\cos(1000t + 15°)$ V.

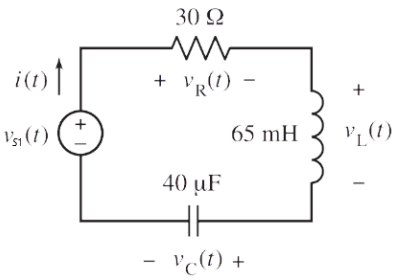


Fig. Q1(a)

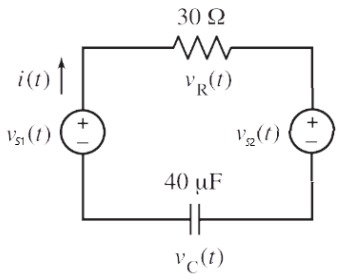


Fig. Q1(b)

Determine

(a) the impedances of the capacitor Z_C, Z_L, and Z_R; (3 points)
(b) the voltages V_R, V_L, and V_C; (6 points)
(c) the current $i(t)$ and its rms value; and (4 points)
(d) the new current $i(t)$ and its rms value if the inductor in Fig. Q1(a) is replaced by a second voltage source $v_{s2}(t) = 5\cos(1000t)$ V, as shown in Fig. Q1(b). (6 points)

(B) If a current is given by $i(t) = A + Bcos(\omega t)$, where A and B are constants, drive the formula of the rms value of $i(t)$. (6 points)

Answer:

(A)

(a) $\boldsymbol{\omega = 1000}$ **rad/s**

$\boldsymbol{Z_C = -j25\ \Omega}$

$\boldsymbol{Z_L = j65\ \Omega}$

$\boldsymbol{Z_R = 30\ \Omega}$

(b) $\boldsymbol{V_s = 12\angle 15°}$ **V**

$\boldsymbol{V_R = 7.2\angle -38.13°}$ **V**

$\boldsymbol{V_L = 15.6\angle 51.87°}$ **V**

$\boldsymbol{V_c = 6\angle -128.13°}$ **V**

(c) $\boldsymbol{i(t) = 0.24cos\,(1000t - 38.13°)}$ **A**

$$I_{RMS} \approx \frac{0.24}{\sqrt{2}} = 0.17 \text{ A}$$

(d) For V_{s1} Source:

$$I_1 = 0.31\angle 54.8°$$

For V_{s2} Source:

$$I_1 = 0.13\angle 39.8°$$

$$i(t) = 0.31\cos(1000t + 54.8°) - 0.13\cos(1000t + 39.8°)$$

$$i(t) = 0.31\cos(1000t + 54.8°) + 0.13\cos(1000t - 140°)$$

$$i(t) = 0.19\cos(1000t + 65°)$$

$$I_{RMS} = \sqrt{0.19^2/2} = 0.13 \text{ A}$$

Power cannot be calculated by superposition.

∴A traditional *wrong* answer is $I_{RMS} = \sqrt{\frac{0.31^2}{2} + \frac{0.13^2}{2}} = 0.24$ A

(B)

$$P = I_{RMS}^2 R \rightarrow I_{RMS} = \sqrt{A^2 + \frac{B^2}{2}}$$

Question 2

(A) Fig. Q2(a) shows a dc circuit. The input voltage source is 9 V.

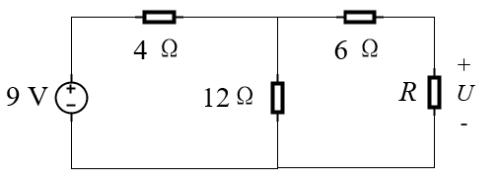


Fig. Q2(a)

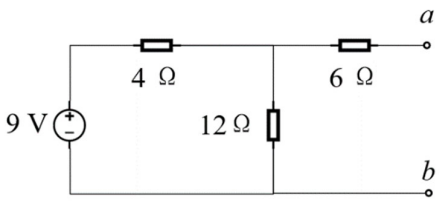


Fig. Q2(b)

Find

(a) the voltage U and power of R if $R = 20\ \Omega$; and (5 points)

(b) the resistance R by using mesh analysis if $U = 4.5$ V. (10 points)

(B) If the resistor R is removed as shown in Fig. Q2(b), find the Thevenin equivalent circuit at terminals a-b. (10 points)

Answer:

(A):

(a) $U = 4.66$ V

$P = 1.08$ W

(b) $R = 18\ \Omega$

(B) $V_{th} = 6.75$ V

$R_{th} = 9\ \Omega$