CheggSolutions - Thegdp

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## AC Circuit Analysis

**Given:**

- a (Resistance) = 10 Ω
- b (Inductance) = 0.1 H
- c (Capacitance) = 0.008 F
- d (Inductance) = 0.2 H
- e (Resistance) = 4 Ω
- $v_s(t) = 50 \cos(25t)$ V

**a) Find the magnitude of $v_0(t)$**

**b) Find the phase angle of $v_0(t)$**

**Step-by-step Solution:**

**Step 1: Convert $v_s(t)$ to its phasor form**

Given: $v_s(t) = 50 \cos(25t)$

Phasor form is: $V_s = 50 \angle 0°$

**Step 2: Find impedances of each component at ω = 25 rad/s**

**Resistor (a and e):**
$Z_R = R$
$Z_a = 10\ \Omega$
$Z_e = 4\ \Omega$

**Inductor (b and d):**
$Z_L = j\omega L$
$Z_b = j \times 25 \times 0.1 = j2.5\ \Omega$
$Z_d = j \times 25 \times 0.2 = j5\ \Omega$

**Capacitor (c):**
$Z_C = 1/j\omega C$
$Z_c = 1/(j \times 25 \times 0.008) = -j5\ \Omega$

**Step 3: Calculate the total impedance of the series and parallel combinations**

- **Series combination across path 1:**
- $Z_{path1} = Z_b + Z_c + Z_d = j2.5 - j5 + j5 = j2.5\ \Omega$

- **Series combination across path 2:**
- $Z_{path2} = Z_a + Z_e = 10 + 4 = 14\ \Omega$

- **Parallel combination of $Z_{path1}$ and R:**
- $1/Z_{total} = 1/Z_{path1} + 1/Z_{path2}$
- $1/Z_{total} = 1/j2.5 + 1/14$
- $Z_{total} = (1/(j2.5) + 1/14)^{-1}$
- $Z_{total} = ((14/(j2.5 \times 14)) + (j2.5/(j2.5 \times 14)))^{-1}$
- $Z_{total} = ((14 + j2.5)/35)^{-1}$
- $Z_{total} = (35/(14 + j2.5))$
- $Z_{total} = (35(14 - j2.5)/((14 + j2.5)(14 - j2.5)))$
- $Z_{total} = (35(14 - j2.5))/(196 + 6.25)$
- $Z_{total} = (490 - j87.5)/202.25$
- $Z_{total} = 2.42 - j0.43\ \Omega$

**Step 4: Calculate current I using Ohm's Law**

- $V_s = I \times Z_{total}$
- $50 \angle 0° = I\,(2.42 - j0.43)$
- $I = 50 \angle 0°/(2.42 - j0.43)$
- $I = 50 \times (2.42 + j0.43)/((2.42 - j0.43)(2.42 + j0.43))$
- $I = 50(2.42 + j0.43)/(2.9869 + 0.1849)$
- $I = 50(2.42 + j0.43)/3.1718$
- $I = 121 + j21.5/3.1718$
- $I = 38.15 + j6.78$
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- $|I| \approx 38.76$ A, $\angle I \approx 10.4°$

Step 5: Calculate V_0

- $V_0 = I \times Z_c$
- $V_0 = (38.15 + j6.78) \times (-j5)$
- $V_0 = -j(38.15 \times 5 + j6.78 \times 5)$
- $V_0 = -j(190.75 - j33.9)$
- $V_0 = -j190.75 - 33.9$
- $V_0 = -33.9 - j190.75$

Step 6: Find magnitude and phase angle of V_0

- Magnitude: $|V_0| = \sqrt{((-33.9)^2 + (-190.75)^2)}$
- $|V_0| \approx \sqrt{(1150.41 + 36391)} \approx \sqrt{37541} \approx 194$ V
- Phase angle: $\theta_{V_0} = \tan^{-1}(-190.75 / -33.9)$
- $\theta_{V_0} \approx \tan^{-1}(5.63) \approx -79.94°$

Final Solution:

- (a) The magnitude of $v_0(t) \approx 194$ V
- (b) The phase angle of $v_0(t) \approx -79.94°$

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