

Electrical Circuit (2)

AC Superposition (week3 class3)

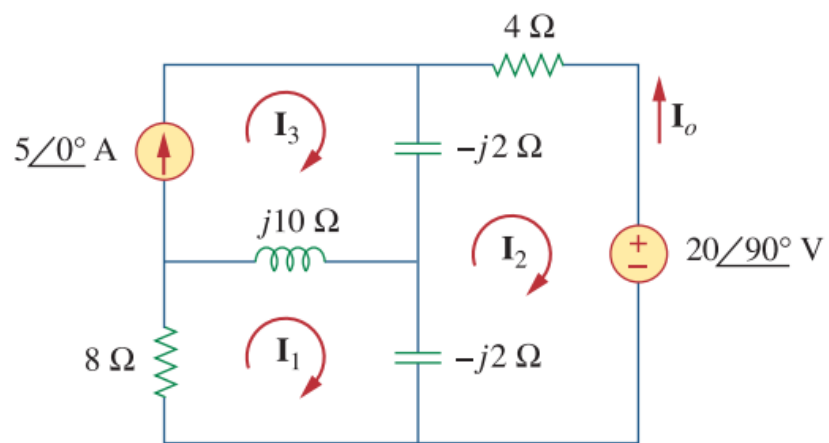
Dr. Akram Al-Mahrouk

Philadelphia University

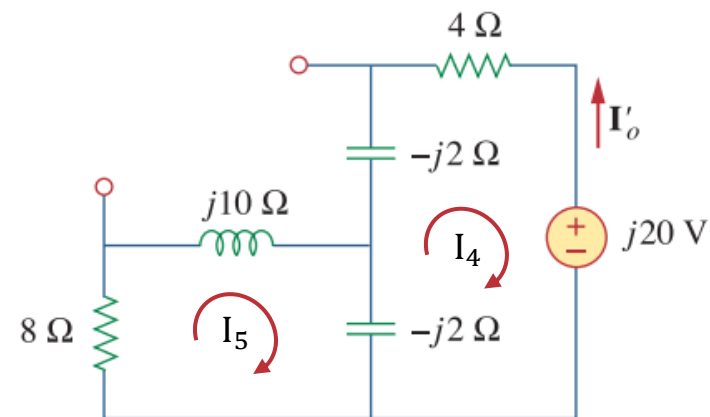
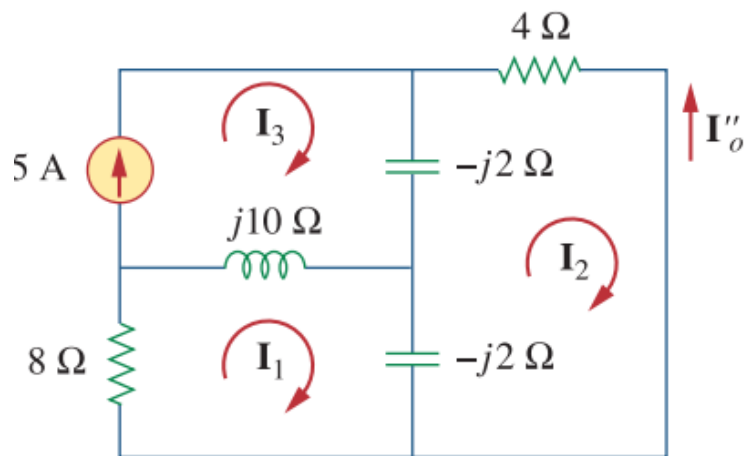
Chapter 10 Sinusoidal Steady-State Analysis 413

- 10.1 Introduction 414
- 10.2 Nodal Analysis 414
- 10.3 Mesh Analysis 417
- 10.4 Superposition Theorem 421
- 10.5 Source Transformation 424
- 10.6 Thevenin and Norton
Equivalent Circuits 426
- 10.7 Op Amp AC Circuits 431
- 10.8 AC Analysis Using *PSpice* 433
- 10.9 †Applications 437
 - 10.9.1 Capacitance Multiplier
 - 10.9.2 Oscillators
- 10.10 Summary 441
 - Review Questions 441
 - Problems 443

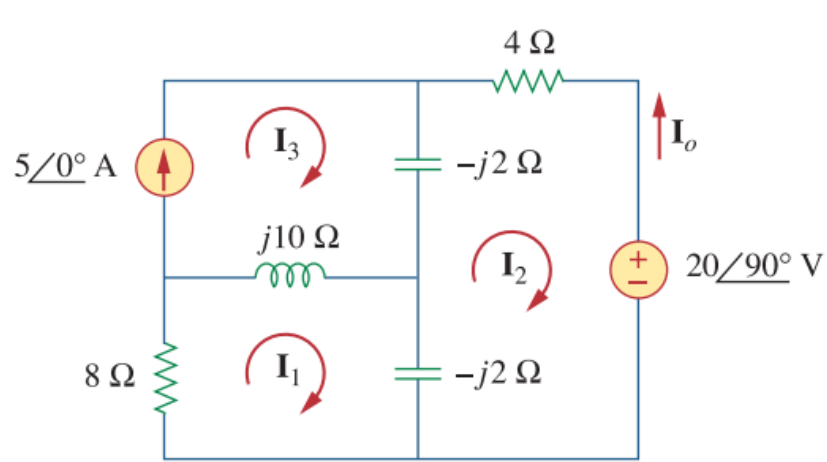
10.4 Superposition Theorem



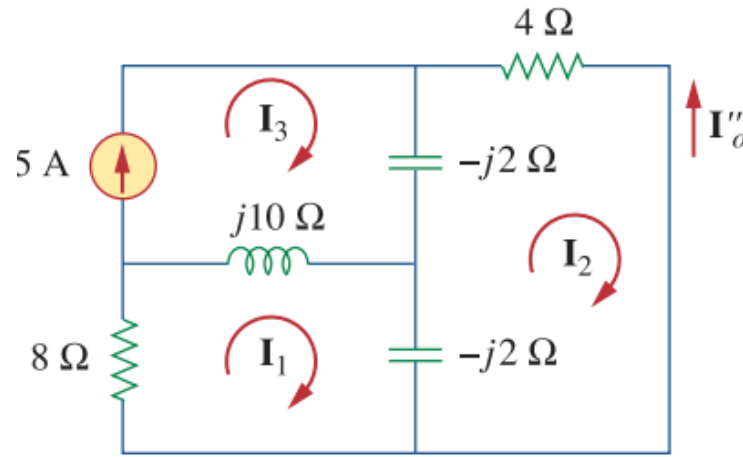
$$\mathbf{I}_o = -5 + j3.529 = 6.12\angle 144.78^\circ \text{ A}$$



10.4 Superposition Theorem



$$\mathbf{I}_o = -5 + j3.529 = 6.12 \angle 144.78^\circ \text{ A}$$



$$8I_1 + j10I_1 - j10I_3 + (-2jI_1 + 2jI_2) = 0$$

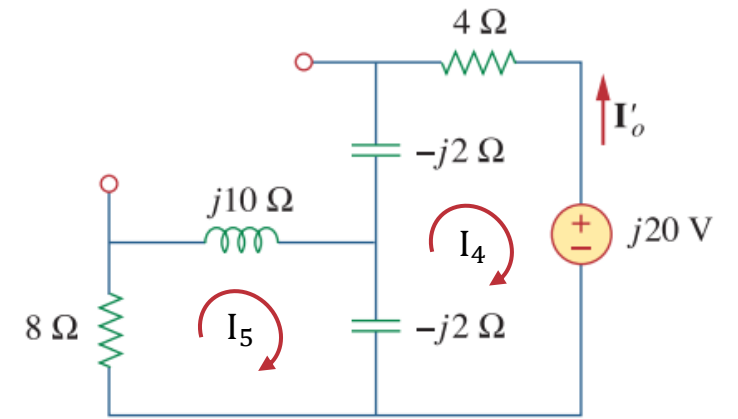
$$-2jI_2 + j2I_1 + (-2jI_2) + 2jI_3 + 4I_2 = 0$$

$$I_3 = 5$$

$$(8 + j10 - 2j)I_1 + 2jI_2 = j10(5)$$

$$j2I_1 + (-2j - 2j + 4)I_2 = -j2(5)$$

$$I_1 = 2.647 + j2.941 \quad I_2 = 2.647 - j1.176$$



$$8I_5 + j10I_5 + (-2jI_5 + 2jI_4) = 0$$

$$-2jI_4 + j2I_5 + (-2jI_4) + 4I_4 + j20 = 0$$

$$2jI_4 + (8 + j10 - 2j)I_5 = 0$$

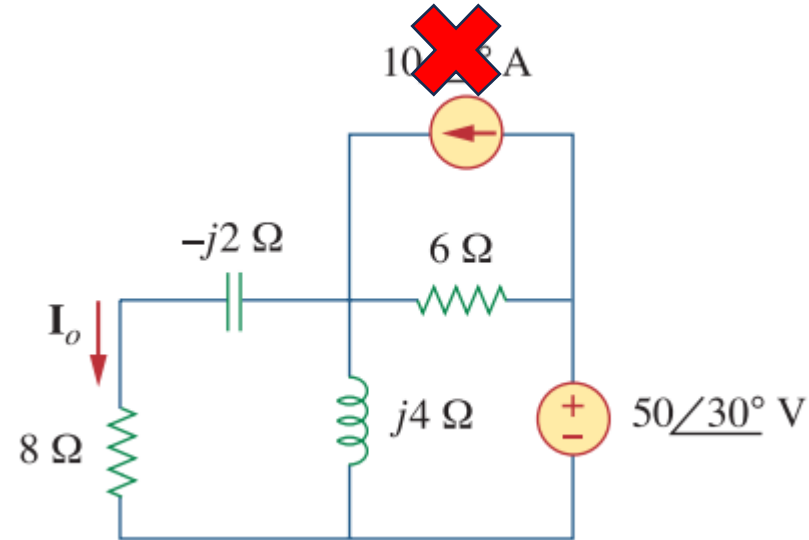
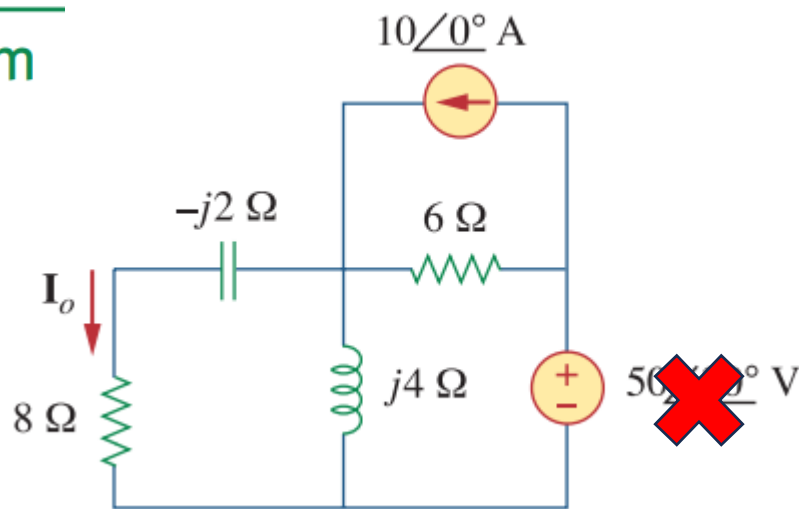
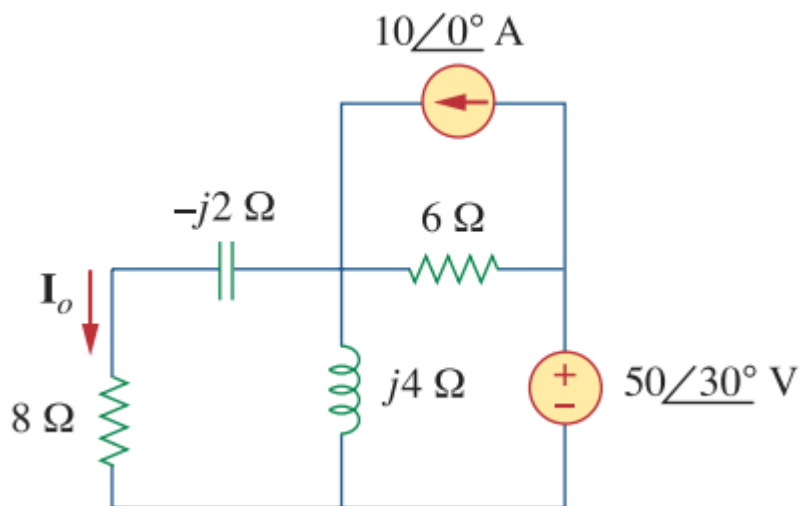
$$(-2j - 2j + 4)I_4 + j2I_5 = -j20$$

$$I_4 = 2.352 - j2.352 \quad I_5 = -0.588$$

$$I_o = -(I_2 + I_4)$$

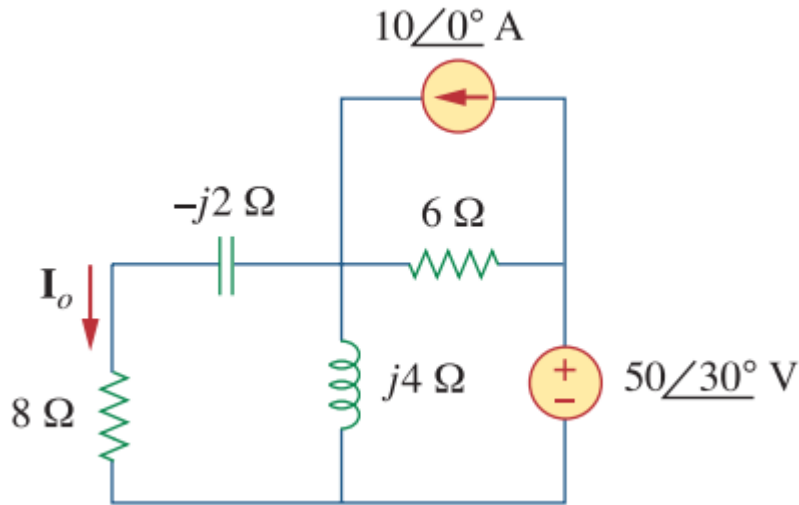
$$I_o = -(2.647 - j1.176 + 2.352 - j2.352) = -5 + j3.529 \text{ A}$$

10.4 Superposition Theorem

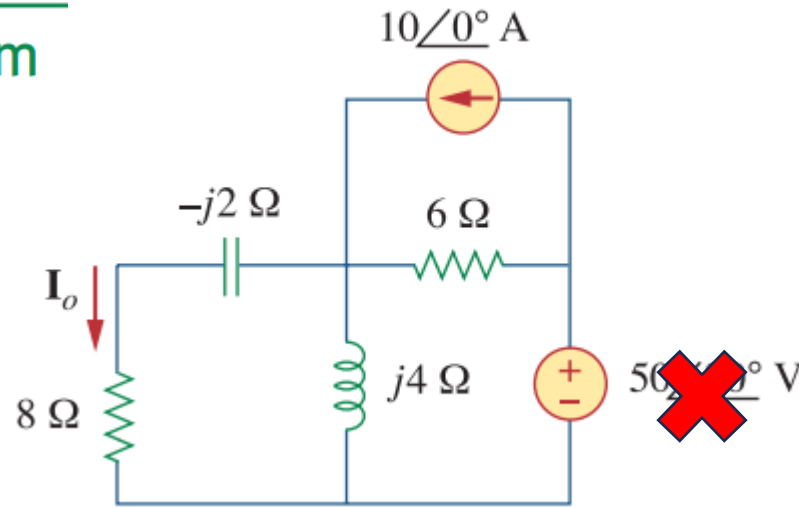


Answer: $5.97\angle 65.45^\circ \text{ A}$.

10.4 Superposition Theorem



Answer: $5.97 \angle 65.45^\circ$ A.



$$8I_1 - j2I_1 + j4I_1 - j4I_2 = 0$$

$$j4I_2 - j4I_1 + 6I_2 - 6I_3 = 0$$

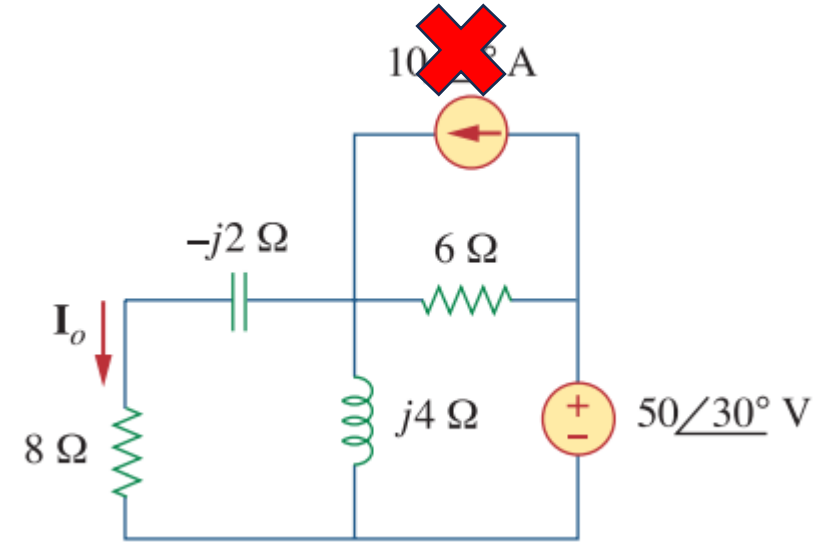
$$I_3 = -10$$

$$(8 - j2 + j4)I_1 - j4I_2 = 0$$

$$-j4I_1 + (6 + j4)I_2 = 6(-10)$$

$$I_1 = -2.082 - j2.649$$

$$I_2 = -6.34 + j2.839$$



$$8I_4 - j2I_4 + (j4I_4 - j4I_5) = 0$$

$$j4I_5 - j4I_4 + 6I_5 + 50\angle 30 = 0$$

$$(8 - j2 + j4)I_4 - j4I_5 = 0$$

$$-j4I_4 + (6 + j4)I_5 = -50\angle 30$$

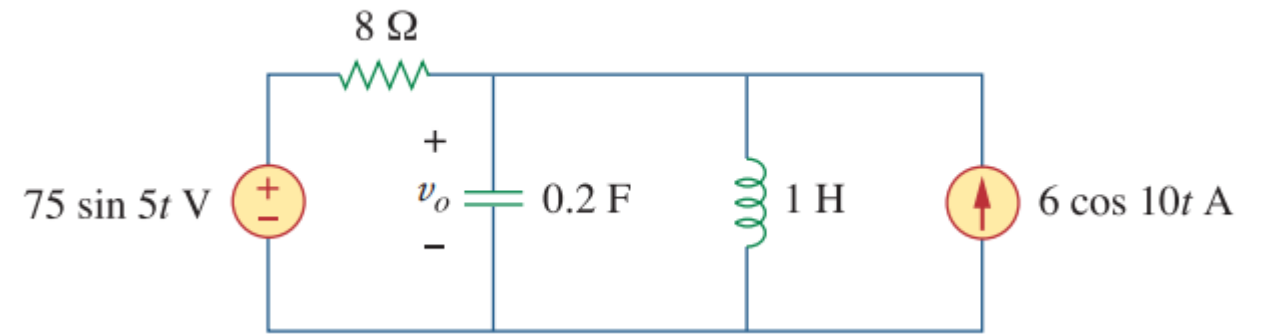
$$I_4 = -0.398 - j2.779$$

$$I_5 = -5.758 - j0.592$$

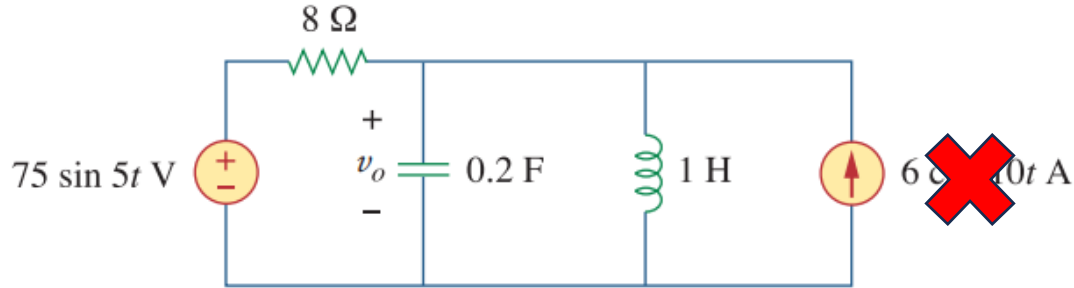
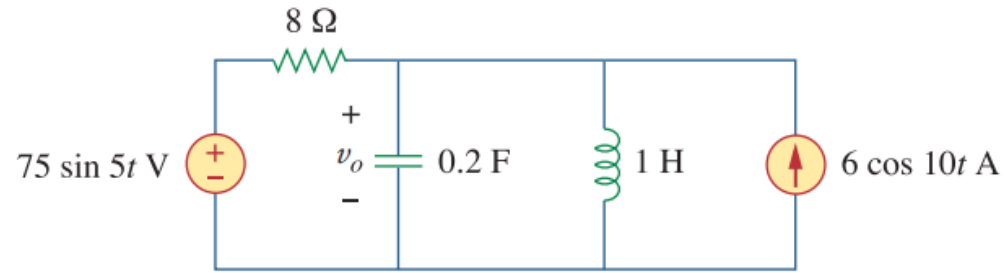
$$I_o = -(I_1 + I_4)$$

$$I_o = -(-2.082 - j2.649 - 0.398 - j2.779) = 2.48 + j5.428 \text{ A}$$

10.4 Superposition Theorem



10.4 Superposition Theorem

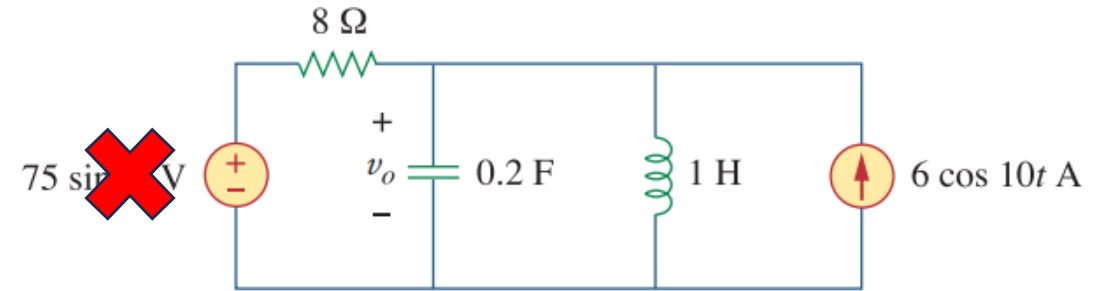


$$X_L = j5 \quad X_C = -\frac{1}{j5(0.2)} = -j$$

$$Z_0 = \frac{j5 * -j}{4j} = -j1.25$$

$$V_0 = 75 \frac{-j1.25}{8 - j1.25}$$

$$V_0 = 1.787 - j11.44 = 11.577 \angle -81.12^\circ$$



$$X_L = j10 \quad X_C = -\frac{1}{j10(0.2)} = -0.5j$$

$$Z_0 = \frac{j10 * -0.5j}{9.5j} = -j0.526$$

$$I_0 = 6 \frac{8}{8 - j0.526} = 5.97 + j0.3928 \text{ A}$$

$$V_0 = (5.97 + j0.3928) * -j0.526$$

$$V_0 = 0.2066 - j3.14 = 3.15 \angle -86.24^\circ$$

Answer: $11.577 \sin(5t - 81.12^\circ) + 3.154 \cos(10t - 86.24^\circ) \text{ V}.$

