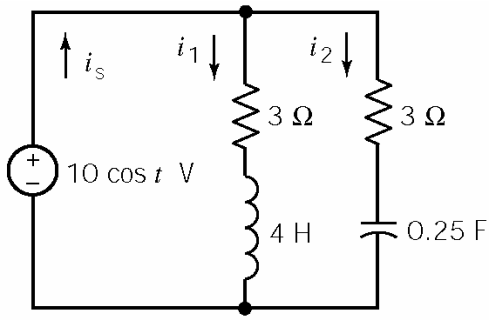
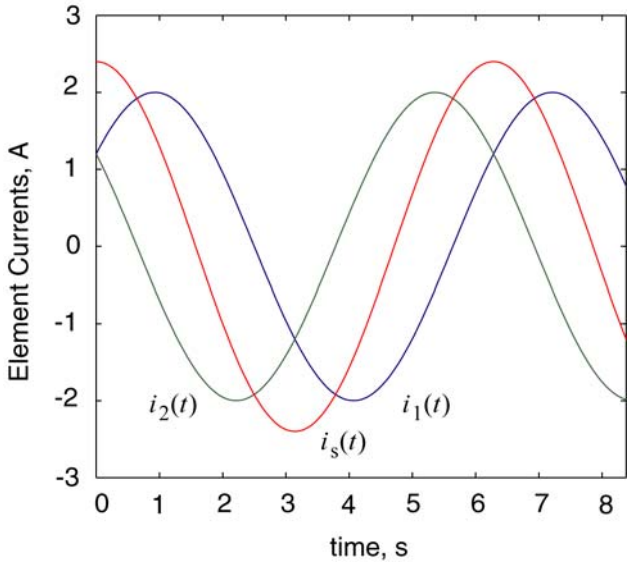
Two Experiments

Experiment 1: Here is a circuit together with plots showing the element currents as functions of time:





We can represent the element currents analytically as

$$i_1(t) = 2\cos(t - 53.13°) \text{ A}, \quad i_2(t) = 2\cos(t + 53.13°) \text{ A} \quad \text{and} \quad i_s(t) = 2.4\cos t \text{ A}.$$

Apply KCL to get

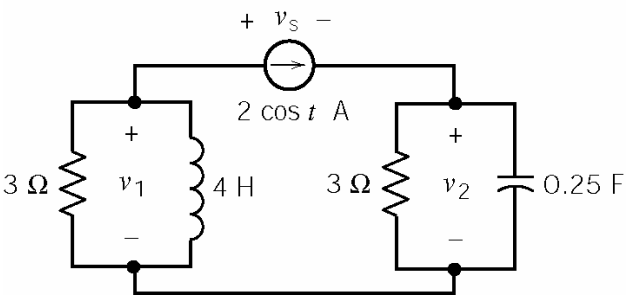
$$i_s(t) = i_1(t) + i_2(t) \quad \Rightarrow \quad 2.4\cos t = 2\cos(t - 53.13°) + 2\cos(t + 53.13°)$$

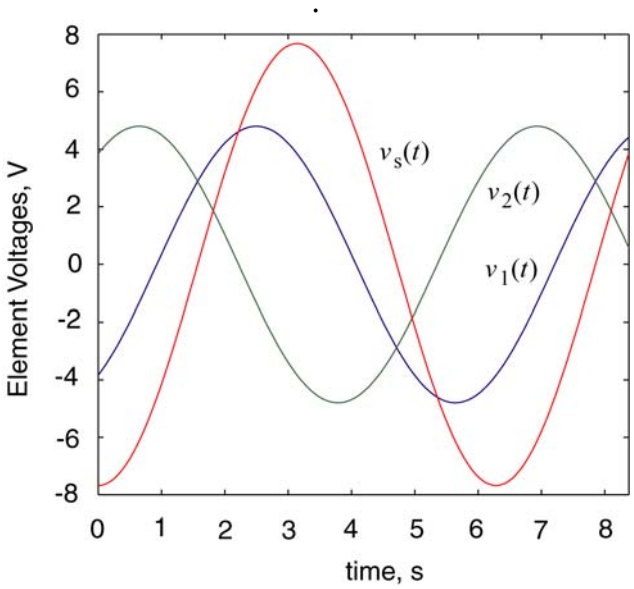
We can verify this equation using (a) trigonometry, (b) Euler's identity or (c) phasors. The following table verifies that the equation is satisfied at several particular instants of time.

t, s	$i_1(t)$, A	$i_2(t)$, A	$i_s(t)$, A	$i_1(t) + i_2(t) - i_s(t)$
0	1.2	1.2	2.4	0
1	1.995	–0.698	1.297	0
2	0.955	–1.954	–0.999	0
3	–0.962	–1.414	–2.376	0
4	–1.995	0.427	–1.569	0
5	–1.194	1.875	0.681	0

(Notice that the value of each element current is sometimes positive and sometimes negative. Clearly, it is futile to try to choose the reference directions of the currents to make their values be positive.)

Experiment 2: Here is a circuit together with plots showing the element voltages as functions of time:





We can represent the element currents analytically as

$v_1(t) = 4.8\cos(t - 143.13°)$ V, $v_2(t) = 4.8\cos(t - 36.87°)$ V and $v_s(t) = -7.68\cos t$ V

Apply KVL to get

$$v_s(t) = v_1(t) - v_2(t) \quad \Rightarrow \quad -7.68\cos t = 4.8\cos(t - 143.13°) - 4.8\cos(t - 36.87°)$$

We can verify this equation using (a) trigonometry, (b) Euler's identity or (c) phasors. The following table verifies that the equation is satisfied at several particular instants of time.

t, s	$v_1(t)$, V	$v_2(t)$, V	$v_s(t)$, V	$v_1(t) - \left(v_2(t) + v_s(t)\right)$
0	–3.84	3.84	–7.68	0
1	0.349	4.498	–4.15	0
2	4.217	1.021	3.196	0
3	4.208	–3.395	7.603	0
4	0.33	–4.69	5.02	0
5	–3.851	–1.672	–2.179	0

(Notice that the value of each element voltage is sometimes positive and sometimes negative. Clearly, it is futile to try to choose the reference directions of the voltages to make their values be positive.)