Steps in Applying the Laplace transform

- **Transform the circuit from the time domain to the Laplace (*s*) domain, including initial conditions.**

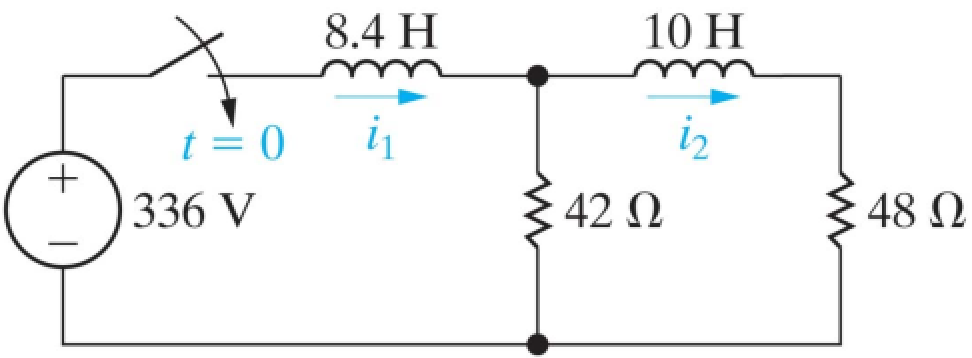
--*The elegance of using the Laplace transform in circuit analysis lies* in (1) transforming the differential equation into an *algebraic* equation; and (2) automatic inclusion of initial conditions in the transformation process, thus providing a complete (**transient and steady-state**) solution.

- **Solve the circuit using nodal analysis, mesh analysis, source transformation, superposition, or any other analysis technique with which we are familiar.**

- Take the inverse transform of the solution and thus obtain the solution in the time domain.

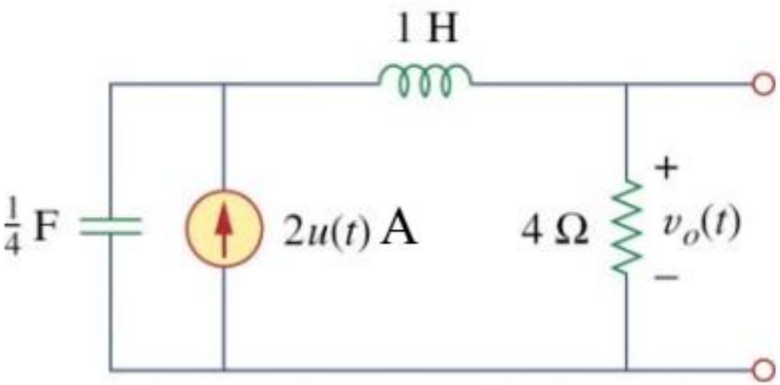
Example 1

Assuming no initial energy storage, find $i_1(t)$ and $i_2(t)$ for $t > 0$.



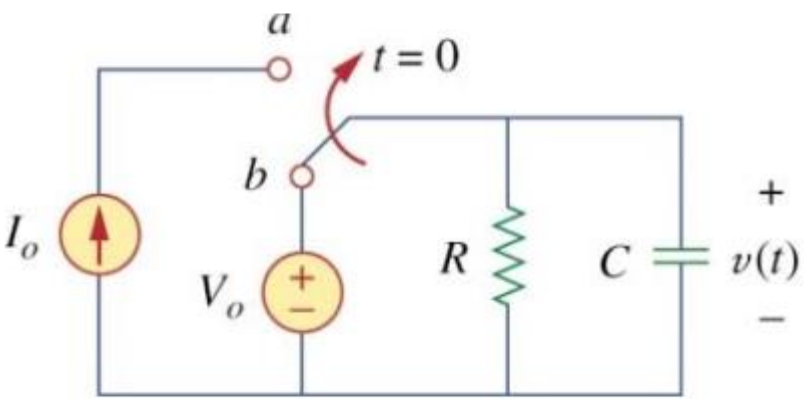
Example 2

Determine $v_0(t)$ *for* $t>0$ *assuming zero initial conditions:*



Example 3

- The switch has been in position *b* for a long time. It is moved to position *a* at $t = 0$. Determine $v(t)$ for $t > 0$.

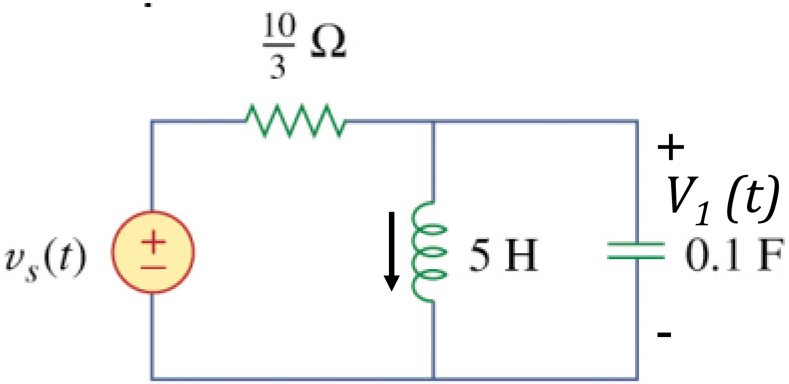


Example 4

- Find (1) the voltage across the capacitor

  (2) current through the inductor

  assuming that $v_s(t) = 10u(t)$ V, and assume that at $t = 0$, *-1 A* flows through the inductor and +5 V is across the capacitor.



Example 4

- Find (1) the voltage across the capacitor

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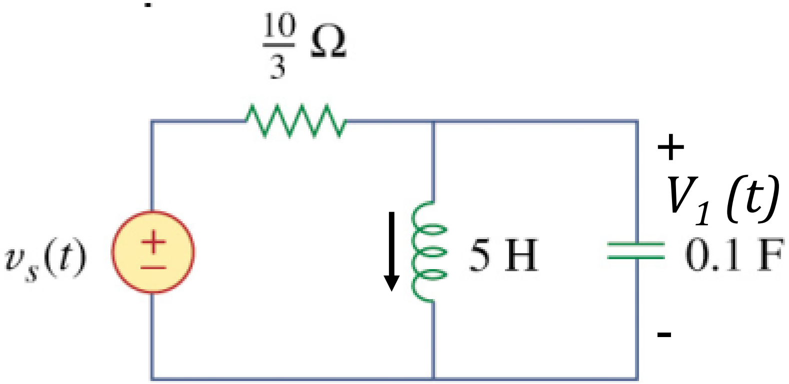
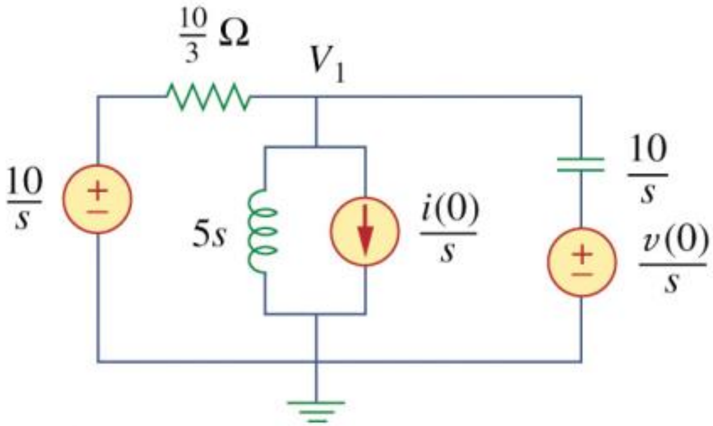
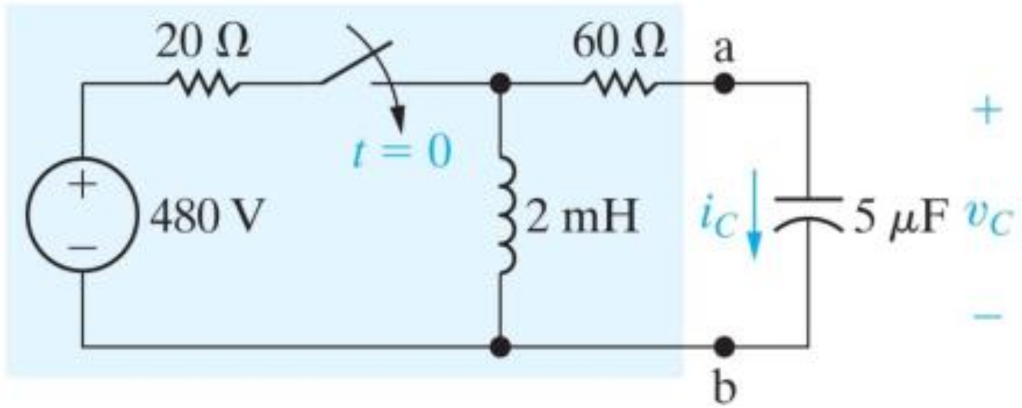




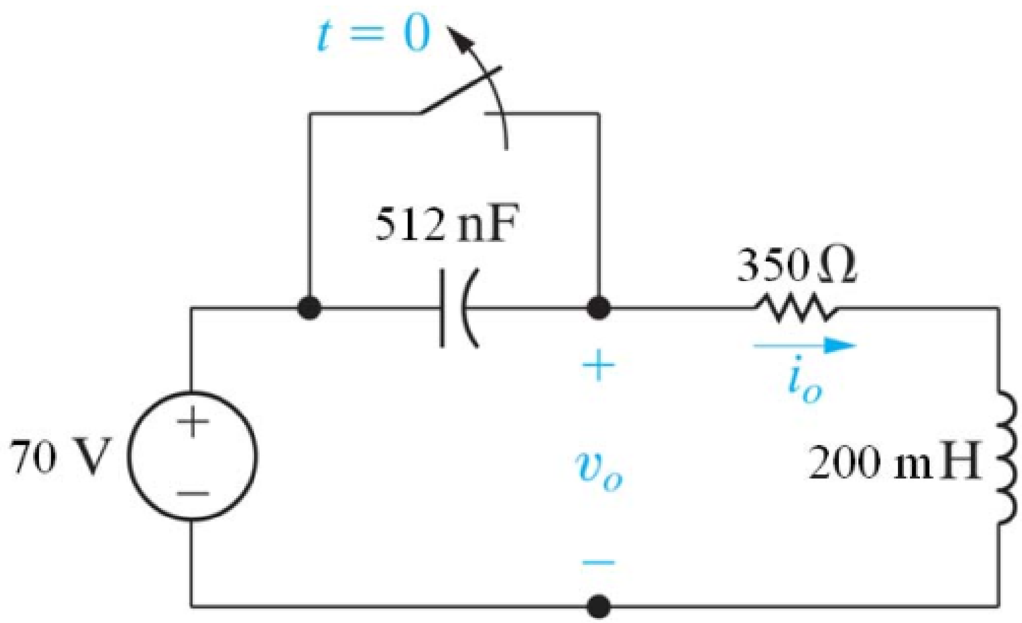
Example 5

- Use Thevenin's equivalent circuit w.r.t. terminals *a*-*b* to find current $i_C(t)$ for t>0.



Example 6

- Find $v_o(t)$ *for* $t>0$



$$V_0(s) = \frac{70s - 268{,}125}{s^2 + 1750s + 9{,}765{,}625} = \frac{K_1}{(s + 875 - j3000)} + \frac{K_2}{(s + 875 + j3000)}$$

$$K_1 = \left.\frac{70s - 268{,}125}{(s + 875 + j3000)}\right|_{s=-875+j3000} = \frac{70(-875 + j3000) - 268{,}125}{[(-875 + j3000) + 875 + j3000]} = 65.1\angle 57.48^\circ$$

$$K_2 = \left.\frac{70s - 268{,}125}{(s + 875 - j3000)}\right|_{s=-875-j3000} = \frac{70(-875 - j3000) - 268{,}125}{[(-875 - j3000) + 875 + -j3000]} = 65.1\angle -57.48^\circ$$

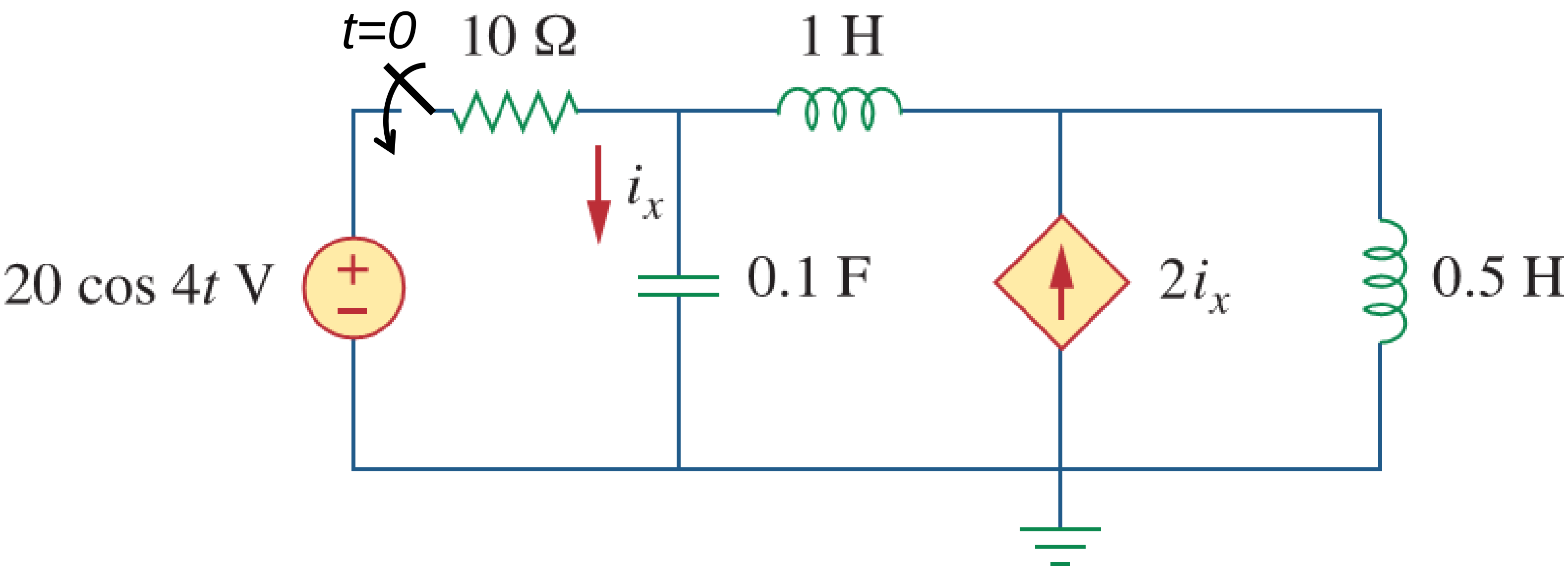
$$V_0(s) = \frac{65.1\angle 57.48^\circ}{(s + 875 - j3000)} + \frac{65.1\angle -57.48^\circ}{(s + 875 + j3000)}$$

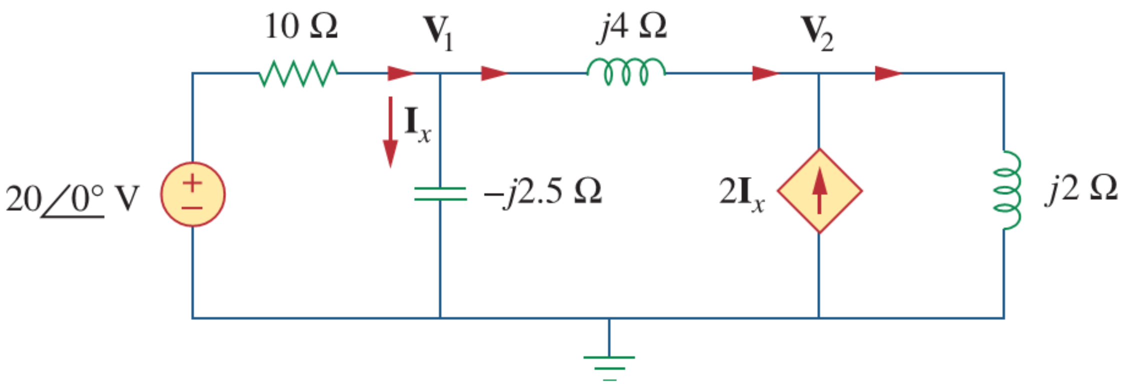
$$v_0(t) = 2(65.1)e^{-875t}\cos(3000t + 57.48^\circ) = 130.2e^{-875t}\cos(3000t + 57.48^\circ)u(t)\ \mathrm{V}$$

Example 7

- Example---Find i_x(s.s.) assuming no initial energy stored

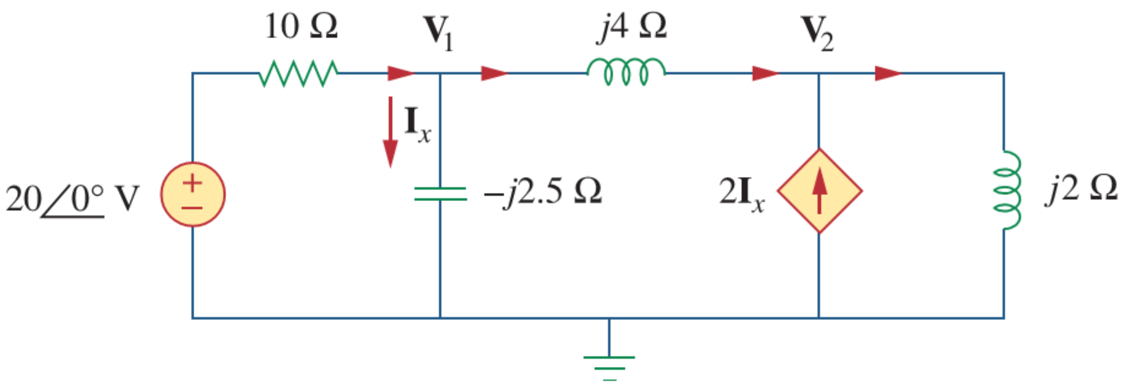
Using phasor method and Laplace transform method





$$\frac{20-\mathbf{V}_1}{10} = \frac{\mathbf{V}_1}{-j2.5} + \frac{\mathbf{V}_1-\mathbf{V}_2}{j4}$$

$$2\mathbf{I}_x + \frac{\mathbf{V}_1-\mathbf{V}_2}{j4} = \frac{\mathbf{V}_2}{j2}$$



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$$i_x = 7.59\cos(4t + 108.4^\circ)\ \text{A}$$