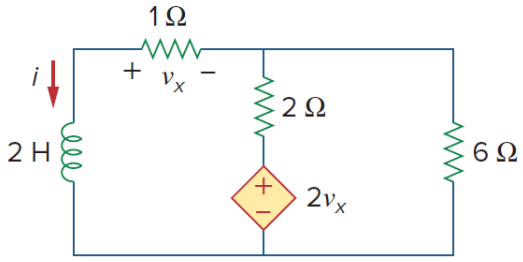
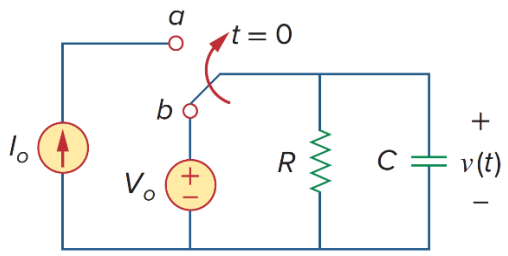
Solutions of Assignment 12

1. Find $i(t)$ and $v_x(t)$ in the circuit below. Assume $I_0 = i(0^-) = 12\ A$.



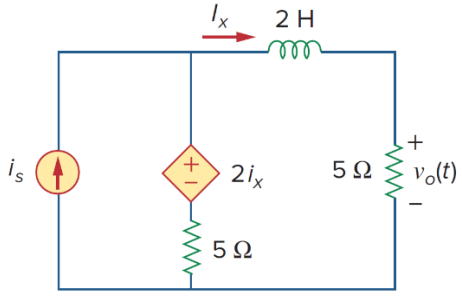
Answer: $\boldsymbol{i(t) = 12e^{-2t}\ A, v_x(t) = -12e^{-2t}\ V\ for\ t > 0}$.

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



Answer: $\boldsymbol{v(t) = (V_0 - I_0R)e^{-\frac{t}{\tau}} + I_0R, t > 0, where\ \tau = RC}$.

3. Assume there is no initial energy stored in the circuit below at $t = 0$ and that $i_s = 10\ u(t)\ A$.



a. Use Thevenin's theorem to find $V_o(s)$.

(Hints: Remove 5 Ω resistor and find $V_{Th} = V_{oc}$. Short 5 Ω resistor to find I_{sc} by using the node-voltage method, then $Z_{Th} = \frac{V_{Th}}{I_{sc}}$.

b. Find the transfer function of $H(s) = \frac{V_o(s)}{I_s(s)}$

c. Applying the initial- and final- value theorems to find $v_0(0^+)\ and\ v_o(\infty)$.

d. Determine $v_o(t)$.

e. If $i_s = 20\cos(4t + 30^0)\, u(t)$ A, determine the steady-state response $v_{oss}(t)$.

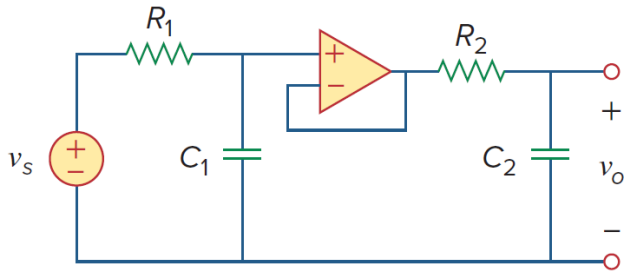
Answer: $\boldsymbol{v_o(t) = 31.25(1 - e^{-4t})u(t)}$ **V;** $\boldsymbol{v_{oss}(t) = 31.25\sqrt{2}\cos(4t - 15^0)\, V}$

4. In the op-amp circuit below, $v_s(t) = 10u(t)$. Assume that $R_1 = R_2 = 10\ k\Omega$, $C_1 = 20\ \mu F, and\ C_2 = 100\ \mu F$. The op-amp in the circuit is ideal. The initial anergy stored in the circuit is zero.

   a. Find the transfer function $H(s) = \frac{V_o(s)}{V_s(s)}$.

   b. Determine the type of the circuit response based on the transfer function.

   c. Determine $v_o(t)\ for\ t > 0$.



Answer: $\boldsymbol{v_o(t) = \left(10 - 12.5e^{-t} + 2.5e^{-5t}\right)u(t)\, V}$