Chapter 7, Solution 67.

If $v(0) = 5$ V, find $v_o(t)$ for $t > 0$ in the op amp circuit in Fig. 7.132. Let $R = 10$ kΩ and $C = 1$ μF.

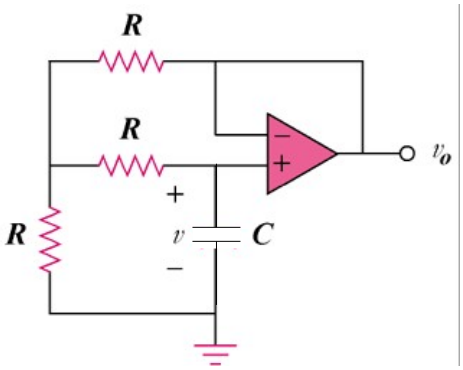
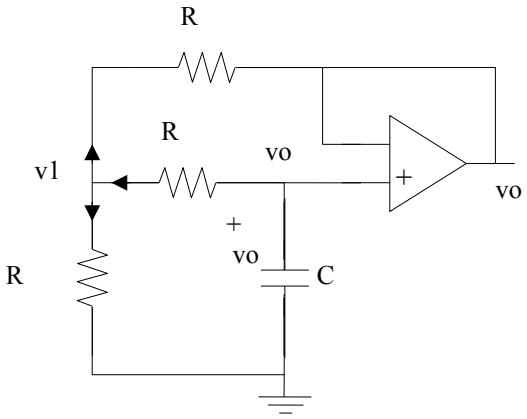


Figure 7.132
For Prob. 7.67.

Solution

The op amp is a voltage follower so that $\boxed{v_o = v}$ as shown below.



At node 1,

$$\boxed{\frac{v_o - v_1}{R} = \frac{v_1 - 0}{R} + \frac{v_1 - v_o}{R} \longrightarrow v_1 = \frac{2}{3}v_o}$$

At the noninverting terminal,

$$\boxed{C\frac{dv_o}{dt} + \frac{v_o - v_1}{R} = 0}$$

$$-RC\frac{dv_o}{dt} = v_o - v_1 = v_o - \frac{2}{3}v_o = \frac{1}{3}v_o$$

$$\frac{dv_o}{dt} = -\frac{v_o}{3RC}$$

$$v_o(t) = V_T\, e^{-t/3RC}$$

$$V_T = v_o(0) = 5\ V, \qquad \tau = 3RC = (3)(10\times10^{3})(1\times10^{-6}) = \frac{3}{100}$$

$$v_o(t) = 5e^{-100t/3}u(t)\ V$$