Week 1 Homework

Bryan SebaRaj

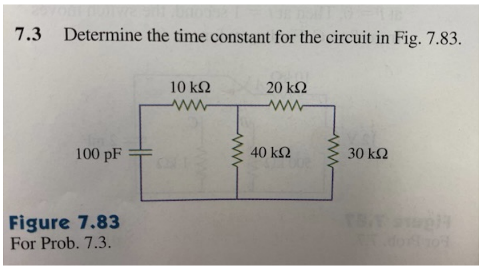
Professor Hong Tang

EENG 203 - Circuits and System Design

January 21, 2025

Homework for January 14, 2025

7.3



The circuit above is an RC circuit, comprised of a non-polarized capacitor and resistors. Therefore,

$$\tau = RC$$

$$R = 10k\Omega + (40k\Omega||(20k\Omega + 30k\Omega))$$

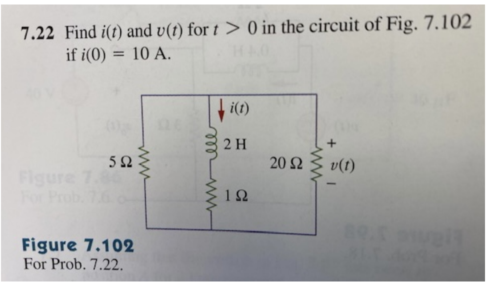
$$R = 10k\Omega + (40k\Omega||50k\Omega) = 10k\Omega + \frac{40k\Omega \cdot 50k\Omega}{40k\Omega + 50k\Omega}$$

$$R = 32.22\ k\Omega$$

Substituting the values of R and $C = 100pF$ into the equation for τ,

$$\tau = 32.22k\Omega \cdot 100pF = 3.222\ \mu s$$

7.22



In an RL circuit, $i(t) = i(0)e^{-\frac{t}{\tau}}$, where $\tau = \frac{L}{R}$. Calculating R,

$$R = (5\Omega||20\Omega) + 1\Omega = \frac{5\Omega \cdot 20\Omega}{5\Omega + 20\Omega} + 1\Omega = 5\ \Omega$$

Since $C = 2$, $\tau = \frac{L}{R} = \frac{2}{5}$. Substituting τ and the given $i(0) = 10\ A$,

$$i(t) = 10e^{-2.5t}\ A$$

Using current division, $i_0 = \frac{5}{5+20}(-i) = -\frac{i}{5} = -\frac{10e^{-2.5t}A}{5} = 2e^{-2.5t}\ A$

Homework for January 14, 2025

5.30

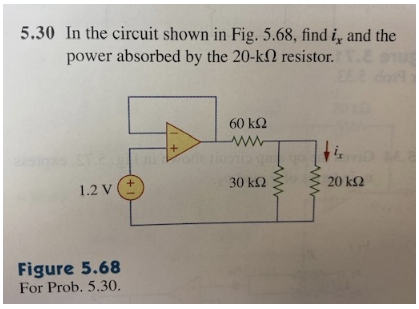

5.30 In the circuit shown in Fig. 5.68, find i_x and the power absorbed by the 20-kΩ resistor.

Figure 5.68
For Prob. 5.30.

The voltage output, $v_0 = v_i = 1.2V$
The two parallel resistors, $R_1 = 20k\Omega$ and $R_2k\Omega$, can be combined to form a single resistor,

$$R_{eq} = (20k\Omega||30k\Omega = \frac{20k\Omega \cdot 20k\Omega}{20k\Omega + 30k\Omega} = 12\ k\Omega$$

By voltage division,

$$v_x = \frac{R_eq}{R_eq + 60k\Omega} v_i = \frac{12k\Omega}{12k\Omega + 60k\Omega} 1.2V = 0.2\ V$$

$$i_x = \frac{v_x}{R} = \frac{0.2V}{20k\Omega} = 10\ \mu A$$

$$p = \frac{v_x^2}{R} = \frac{(0.2V)^2}{20k\Omega} = 2\ \mu W$$

7.71

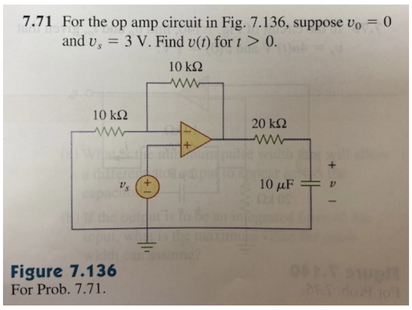

7.71 For the op amp circuit in Fig. 7.136, suppose $v_0 = 0$ and $v_s = 3$ V. Find $v(t)$ for $t > 0$.

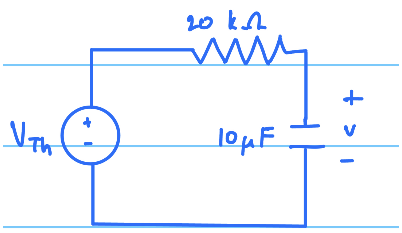
Figure 7.136
For Prob. 7.71.

Assuming that the op amp is noninverting, its gain can be calculated as

$$A_v = 1 + \frac{R_2}{R_1} = 1 + \frac{10k\Omega}{10k\Omega} = 2$$

Therefore, the Thevenin equivalent circuit (see below), has a voltage source

$$V_{th} = A^v v_s = 2 \cdot 3V = 6\ V$$



$$v(t) = v_{Th} + [v(0) - v_{Th}]e^{-\frac{t}{\tau}}$$

$$v(t) = 6 + [0 + 6]e^{-\frac{t}{\tau}} = 6(1 - e^{-\frac{t}{\tau}})\ V,\ \forall t > 0$$

In an RC circuit,

$$\tau = RC = 30k\Omega \cdot \frac{1000\Omega}{1k\Omega} \cdot 10\mu F \cdot \frac{1F}{10^{-6}\mu F} = 0.2\ s$$

Therefore, $v(t) = 6(1 - e^{-5t})\ V,\ \forall t > 0$