Chapter 7

Capacitor and Inductor

Find the current for a capacitor $C = 1$ mF when the voltage across the capacitor is represented by the signal shown in Figure 7.2-6.

solution

The voltage (with units of volts) is given by

$$v(t) = \begin{cases} 0 & t \le 0 \\ 10t & 0 \le t \le 1 \\ 20 - 10t & 1 \le t \le 2 \\ 0 & t \ge 2 \end{cases}$$

Then, because $i = C\,dv/dt$, where $C = 10^{-3}$ F, we obtain

$$i(t) = \begin{cases} 0 & t < 0 \\ 10^{-2} & 0 < t < 1 \\ -10^{-2} & 1 < t < 2 \\ 0 & t > 2 \end{cases}$$

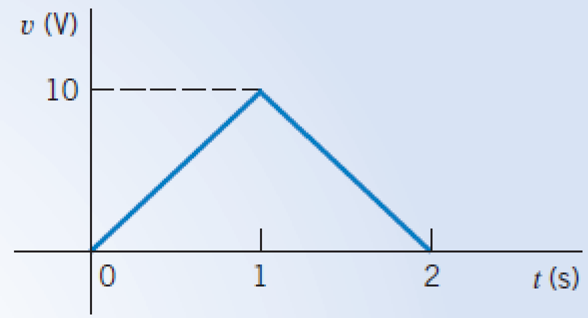


FIGURE 7.2-6 Waveform of the voltage across a capacitor for Example 7.2-1. The units are volts and seconds.

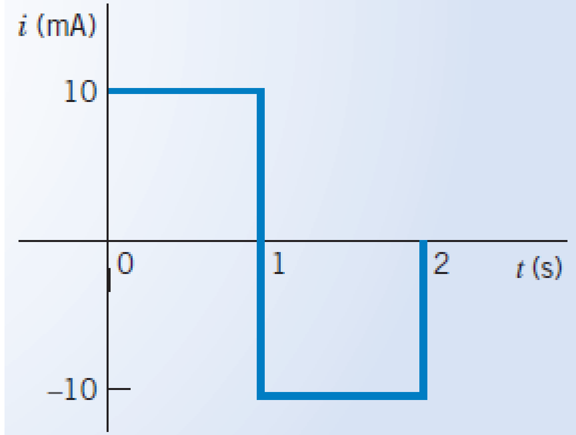


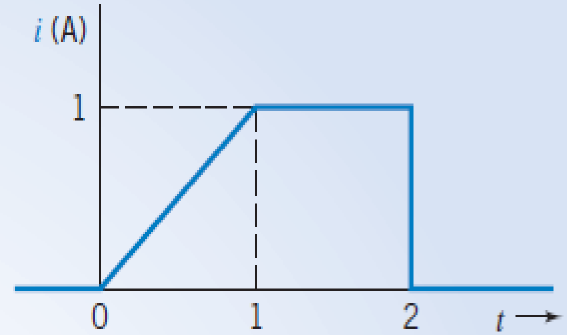
FIGURE 7.2-7 Current for Example 7.2-1.

Find the voltage $v(t)$ for a capacitor $C = 1/2$ F when the current is as shown in Figure 7.2-8 and $v(t) = 0$ for $t \leq 0$.

Solution

First, we write the equation for $i(t)$ as

$$i(t) = \begin{cases} 0 & t \leq 0 \\ t & 0 \leq t \leq 1 \\ 1 & 1 \leq t \leq 2 \\ 0 & 2 < t \end{cases}$$

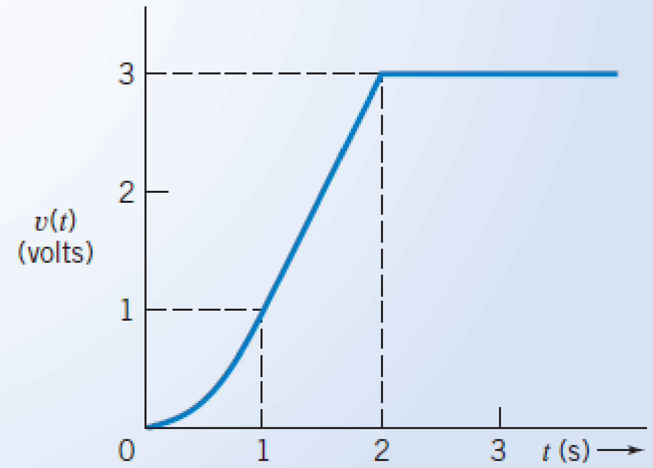


Then, because $v(0) = 0$

$$v(t) = \frac{1}{C}\int_0^t i(\tau)d\tau + v(0) = \frac{1}{C}\int_0^t i(\tau)d\tau$$

and $C = 1/2$, we have

$$v(t) = \begin{cases} 0 & t \leq 0 \\ 2\int_0^t \tau d\tau & 0 \leq t \leq 1 \\ 2\int_1^t (1)d\tau + v(1) & 1 \leq t \leq 2 \\ v(2) & 2 \leq t \end{cases}$$



with units of volts. Therefore, for $0 < t \leq 1$, we have

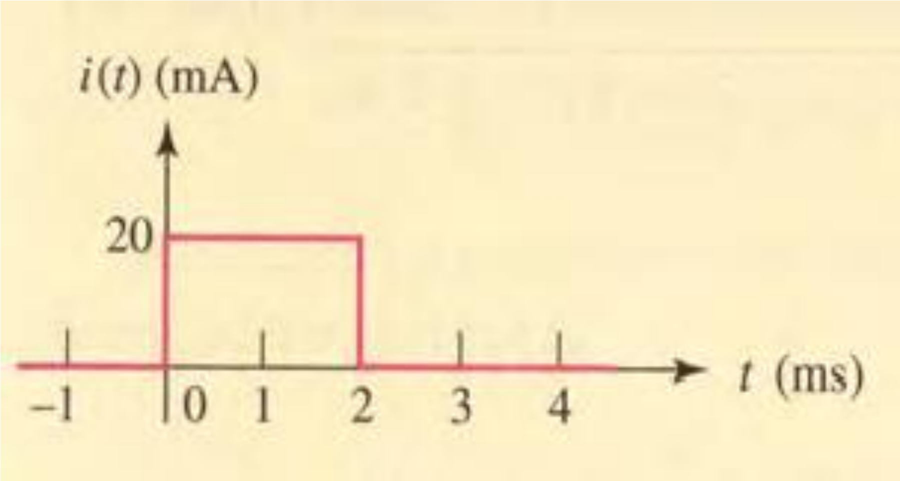
$$v(t) = t^2$$

For the period $1 \leq t \leq 2$, we note that $v(1) = 1$ and, therefore, we have

$$v(t) = 2(t - 1) + 1 = (2t - 1) \text{ V}$$

V(2)=2.2-1=3

Find the voltage associated with the current shown for C=5μF



$$v(t) = 0 \qquad t \leq 0$$

If we now consider the time interval represented by the rectangular pulse, we obtain

$$v(t) = \frac{1}{5 \times 10^{-6}} \int_0^t 20 \times 10^{-3} \, dt' + v(0)$$

Since $v(0) = 0$,

$$v(t) = 4000t \qquad 0 \leq t \leq 2 \text{ ms}$$

For the semi-infinite interval following the pulse, the integral of $i(t)$ is once again zero, so that

$$v(t) = 8 \qquad t \geq 2 \text{ ms}$$