Boise State University
Electrical Engineering Department

EE 210: Circuits I

Solution 1

$$i = C\frac{dv}{dt} = 5\left(2e^{-3t} - 6te^{-3t}\right) = \underline{10(1 - 3t)e^{-3t}\ \text{A}}$$

$$p = vi = 10(1\text{-}3t)e^{-3t} \cdot 2t\,e^{-3t} = \underline{20t(1 - 3t)e^{-6t}\ \text{W}}$$

Solution 2

$$v = \begin{cases} 5000t, & 0 < t < 2\text{ms} \\ 20 - 5000t, & 2 < t < 6\text{ms} \\ -40 + 5000t, & 6 < t < 8\text{ms} \end{cases}$$

$$i = C\frac{dv}{dt} = \frac{4x10^{-6}}{10^{-3}}\begin{cases} 5, & 0 < t < 2ms \\ -5, & 2 < t < 6ms \\ 5, & 6 < t < 8ms \end{cases} = \underline{\begin{cases} 20\text{ mA}, & 0 < t < 2ms \\ -20\text{ mA}, & 2 < t < 6ms \\ 20\text{ mA}, & 6 < t < 8ms \end{cases}}$$

Solution 3

$$v = \frac{1}{C}\int idt + v(t_o) = \frac{1}{50x10^{-3}}\int_o^t 4tx10^{-3}\,dt + 10$$

$$= \frac{2t^2}{50} + 10 = \underline{\mathbf{0.04t^2 + 10\ V}}$$

Solution 4

$$v = \frac{1}{C}\int_0^t i dt + v(0) = 10 + \frac{1}{4x10^{-3}}\int_0^t i(t)dt$$

For 0<t <2, i(t)=15mA, V(t)= 10+ $v = 10 + \frac{10^3}{4x10^{-3}}\int_0^t 15dt = 10 + 3.76t$

v(2) = 10+7.5 =17.5

For 2 < t <4, i(t) = –10 mA

$$v(t) = \frac{1}{4x10^{-3}}\int_2^t i(t)dt + v(2) = -\frac{10x10^{-3}}{4x10^{-3}}\int_2^t dt + 17.5 = 22.5 + 2.5t$$

v(4)=22.5-2.5x4 =12.5

For 4<t<6, i(t) = 0, $v(t) = \frac{1}{4x10^{-3}}\int_2^t 0dt + v(4) = 12.5$

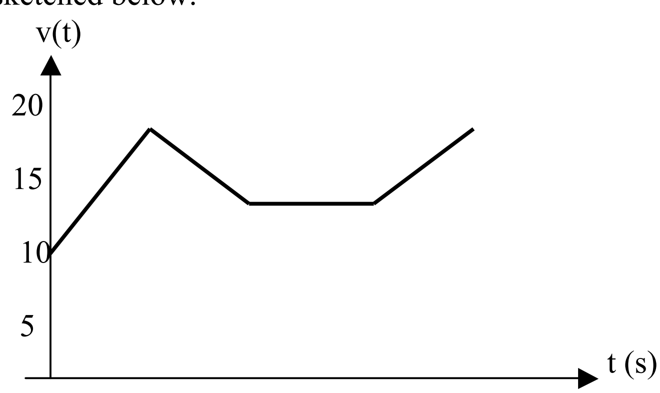
For 6<t<8, i(t) = 10 mA

$$v(t) = \frac{10x10^3}{4x10^{-3}}\int_4^t dt + v(6) = 2.5(t-6) + 12.5 = 2.5t - 2.5$$

Hence,

$$v(t) = \begin{cases} 10 + 3.75t\,V, & 0 < t < 2s \\ 22.5 - 2.5t\,V, & 2 < t < 4s \\ 12.5\,V, & 4 < t < 6s \\ 2.5t - 2.5\,V, & 6 < t < 8s \end{cases}$$

which is sketched below.



Solution 5

(a) 4F in series with 12F = 4 x 12/(16) = 3F

3F in parallel with 6F and 3F = 3+6+3 = 12F

4F in series with 12F = 3F

i.e. C_{eq} = **3F**

(b) C_{eq} = 5 + [6x(4 + 2)/(6+4+2)] = 5 + (36/12) = 5 + 3 = **8F**

(c) 3F in series with 6F = (3 x 6)/9 = 2F

$$\frac{1}{C_{eq}} = \frac{1}{2} + \frac{1}{6} + \frac{1}{3} = 1$$

C_{eq} = **1F**

Solution 6

(a) For the capacitors in series,

$$Q_1 = Q_2 \longrightarrow C_1 v_1 = C_2 v_2 \longrightarrow \frac{v_1}{v_2} = \frac{C_2}{C_1}$$

$$v_s = v_1 + v_2 = \frac{C_2}{C_1} v_2 + v_2 = \frac{C_1 + C_2}{C_1} v_2 \longrightarrow \underline{v_2 = \frac{C_1}{C_1 + C_2} v_s}$$

Similarly, $\underline{v_1 = \frac{C_2}{C_1 + C_2} v_s}$

(b) For capacitors in parallel

$$v_1 = v_2 = \frac{Q_1}{C_1} = \frac{Q_2}{C_2}$$

$$Q_s = Q_1 + Q_2 = \frac{C_1}{C_2} Q_2 + Q_2 = \frac{C_1 + C_2}{C_2} Q_2$$

or

$$Q_2 = \frac{C_2}{C_1 + C_2}$$

$$Q_1 = \frac{C_1}{C_1 + C_2} Q_s$$

$$i = \frac{dQ}{dt} \longrightarrow \underline{i_1 = \frac{C_1}{C_1 + C_2} i_s}, \quad \underline{i_2 = \frac{C_2}{C_1 + C_2} i_s}$$