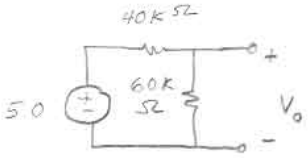
7.69

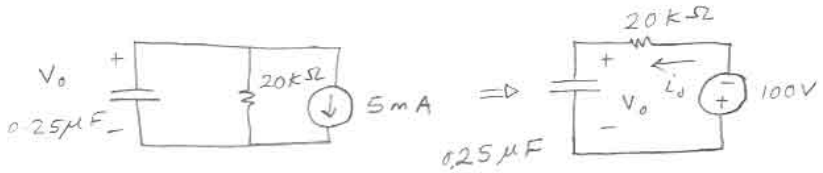
HW #10

$t < 0$



$$V_o = \frac{60}{60+40} \times 50 = 30\,V, \quad t < 0$$

$t > 0$



$$-V_o + 20000(-i_o) - 100 = 0, \quad i_o = 0.25\times10^{-6}\frac{dV_o}{dt}$$

$$\therefore \; -V_o - 20000(0.25\times10^{-6})\frac{dV_o}{dt} - 100 = 0$$

$$\frac{dV_o}{dt} + 200\,V_o = -20000$$

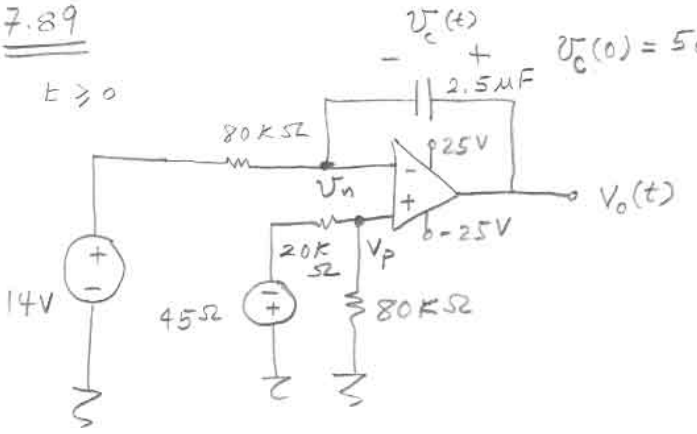
$$V_o(t) = -\frac{20000}{200} + A\,e^{-200t} = -100 + Ae^{-200t}$$

$$V_o(0) = 30 = -100 + A \Rightarrow A = 130$$

$$\therefore \; V_o(t) = -100 + 30\,e^{-200t}, \quad t \geq 0.$$

7.89

$t \geq 0$



$$V_p = -\frac{80}{100} \times 45 = -36\,V = V_n$$

$$\frac{v_n - 14}{80K} + 2.5\times10^{-6}\frac{d}{dt}\underbrace{(v_n - v_o)}_{-v_c} = 0$$

$$\therefore \frac{v_n - 14}{80K} - 2.5\times10^{-6}\frac{dv_c}{dt} = 0$$

$$\frac{dv_c}{dt} = \frac{v_n - 14}{80K(2.5\times10^{-6})} = \frac{-36-14}{80K(2.5\times10^{-6})}$$

$$= -250$$

$$\therefore v_c(t) = -250t + A$$

$$v_c(0) = 56 = 0 + A \Rightarrow A = 56$$

$$\therefore v_c(t) = -250t + 56, \quad t \geq 0.$$

$$v_o = v_n + v_c = 20 - 250t, \quad v_o(t) = 0 \Rightarrow$$

$$20 - 250t = 0 \Rightarrow t = \frac{20}{250} = 80\,ms$$

9.3

a) 40V

b) $f = 50\,Hz$

c) $\omega = 2\pi f = 314.16\ rad/s$

d) $\theta\,(radians) = \frac{2\pi}{360^\circ} \times 60^\circ = 1.05\ rad.$

e) $\theta = 60^\circ.$

f) $T = \frac{1}{f} = 20\,ms.$

g) $v = -40$ for $100\pi t + \frac{\pi}{3} = \pi \Rightarrow t = 6.67\,ms$

h) $v = 40\cos\left[100\pi\left(t - \frac{10^{-2}}{3}\right) + \pi/3\right]$

$= 40\cos 100\pi t\ [V].$

i) $100\pi(t - t_0) + \frac{\pi}{3} = 100\pi t - \frac{\pi}{2} \Rightarrow$

$100\pi t_0 = \frac{5\pi}{6} \Rightarrow t_0 = 8.33\ ms.$

j) $100\pi(t + t_0) + \frac{\pi}{3} = 100\pi t + 2\pi$

$\Rightarrow 100\pi t_0 = \frac{5\pi}{3} \Rightarrow t_0 = 16.67\,ms$

to the left.

9.5

a) $v(t) = 80\cos(\omega t + \theta)$, ω & θ are unknowns.

$$\frac{dv(t)}{dt} = -80\omega \sin(\omega t + \theta).$$

When $v = 0 = 80\cos(\omega t_0 + \theta) \Rightarrow \omega t_0 + \theta = -\frac{\pi}{2}$,

because at the same instant t_0 ,

$$\frac{dv}{dt} > 0 .$$

$$\therefore \quad 80000 = -80\omega \sin\left(-\pi/2\right) = 80\omega$$

$$\therefore \omega = 1000 \text{ rad/s}.$$

b) $v(t) = 80\cos(10^3 t + \theta)$

$$0 = 80\cos\left[10^3\left(-\frac{2\pi}{3} \times 10^{-3}\right) + \theta\right]$$

$$\Rightarrow \quad \left(-\frac{2\pi}{3}\right) + \theta = -\frac{\pi}{2}$$

$$\theta = -\frac{\pi}{2} + \frac{2\pi}{3} = \frac{\pi}{6} = 30^\circ$$

$$\therefore v(t) = 80\cos\left(10^3 t + 30^\circ\right) \quad V$$

9.8 $V_m = \sqrt{2}\, V_{rms} = \sqrt{2}(120) = 169.7\ V$

9.11

a) $\bar{Y} = 50\angle 60^\circ + 100\angle -30^\circ$

$= 50(\cos 60^\circ + j\sin 60^\circ) + 100(\cos 30^\circ - j\sin 30^\circ)$

$= 50(0.5 + j\,0.866) + 100(0.866 - j0.5)$

$= (25 + j43.30) + (86.6 - j50)$

$= 111.6 - j6.7 = \sqrt{111.6^2 + (6.7)^2}\ \angle \tan^{-1}\left(\frac{-6.7}{111.6}\right)$

$= 111.8\angle -3.44^\circ$

$\therefore y(t) = 111.8\cos(500t - 3.44^\circ)$.

b) $y(t) = 102.99\cos(377t + 40.29^\circ)$

c) $y(t) = 161.59\cos(100t - 29.96^\circ)$

d) $y(t) = 0$.