Lecture 32
1st Order Transients – 3 of 5

extensions and examples

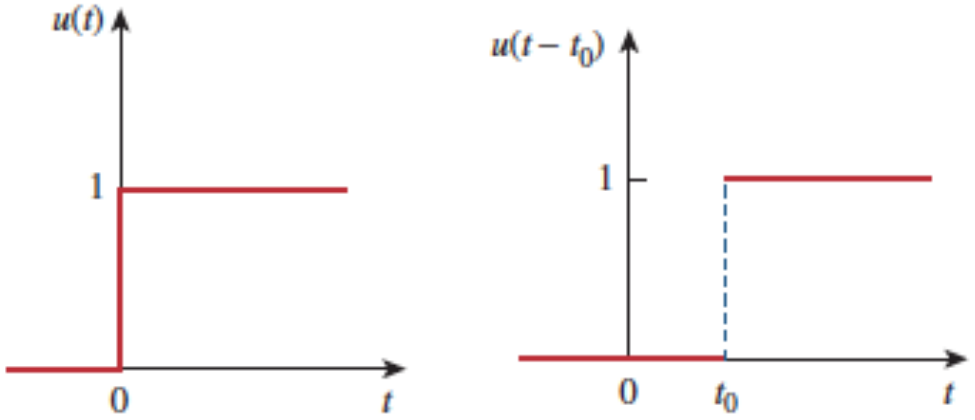
Other Stuff

- Time invariance; for switch at $t = t_0$

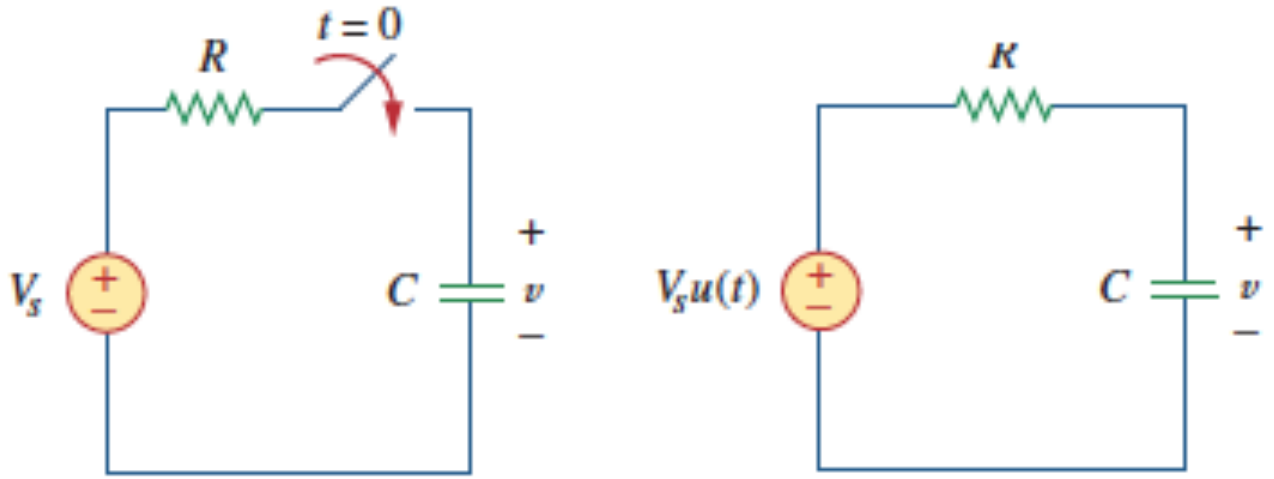
$$x(t) = x(\infty) + (x(t_0) - x_\infty)e^{-(t-t_0)/\tau} + x_\infty$$

- Unit step function

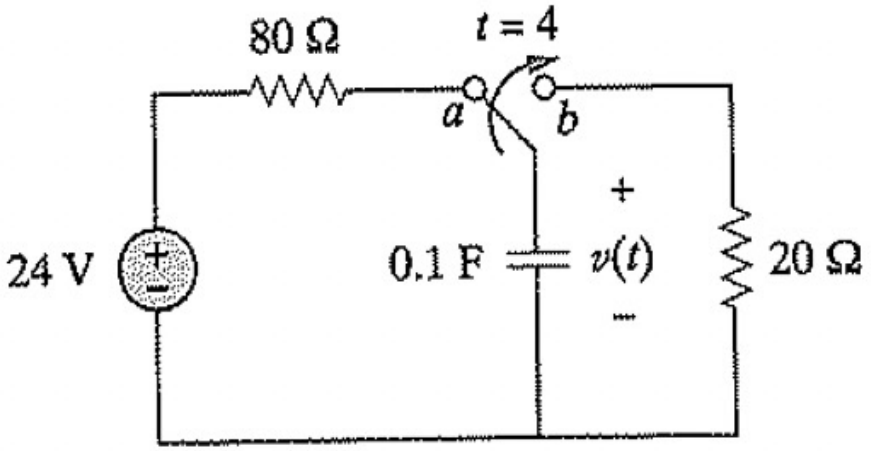
$$u(t) = \begin{cases} 0, & t < 0 \\ 1, & t > 0 \end{cases}$$

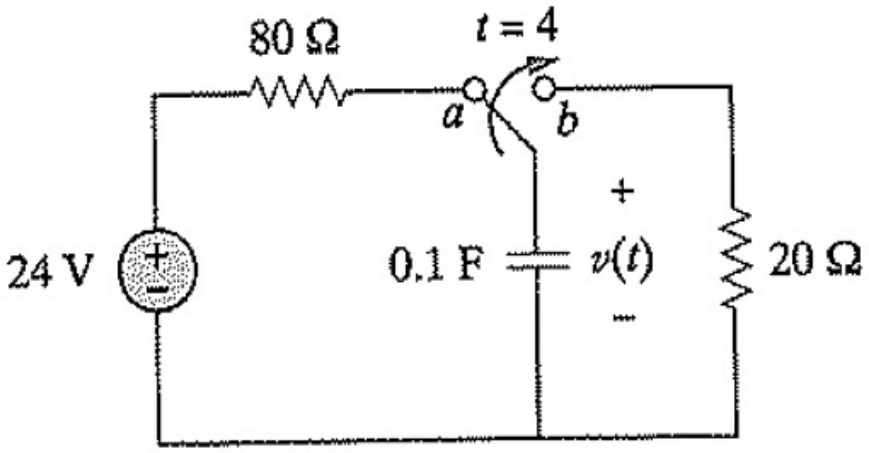


might replace the switch



Example: note the 4 seconds





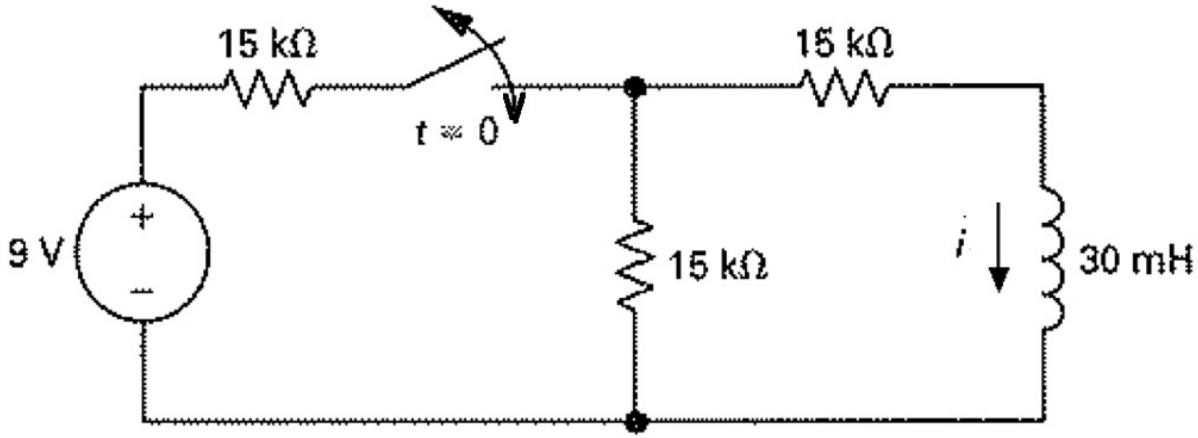
a→b:

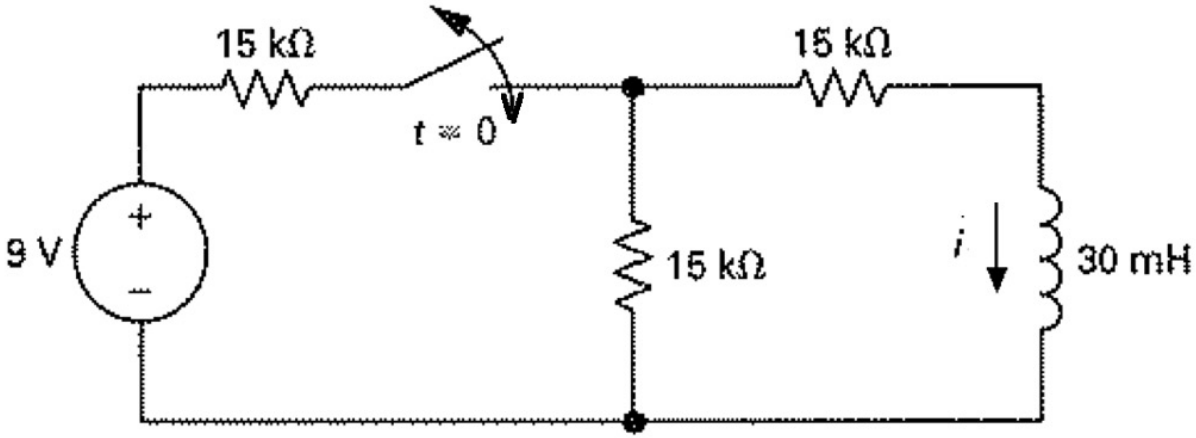
$$v(4) = 24\ V$$
$$v_\infty = 0\ V$$
$$R_{Th} = 20\ \Omega$$

b→a:

$$v(4) = 0\ V$$
$$v_\infty = 24\ V$$
$$R_{Th} = 80\ \Omega$$

Example: switch opens





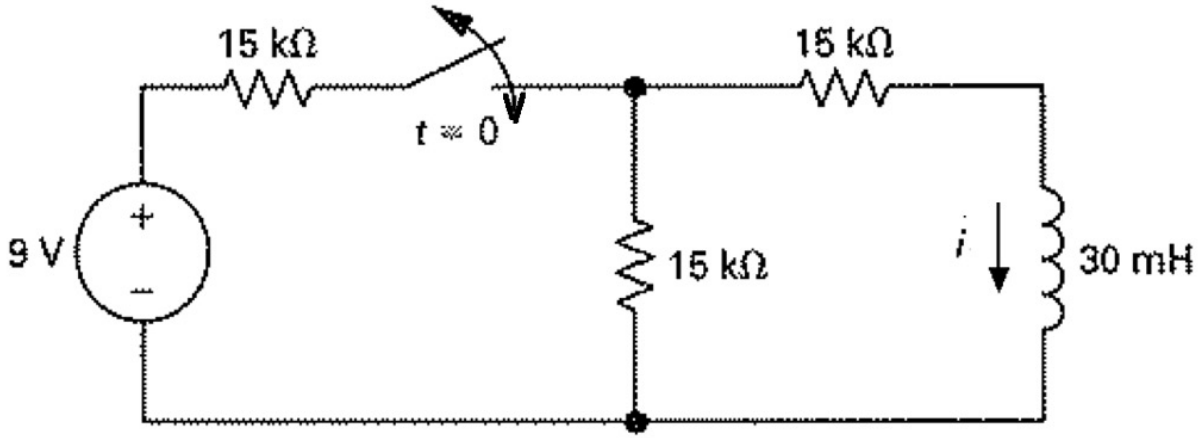
Opening at zero:

$i_0 = 0.2\ mA$

$i_\infty = 0\ mA$

$R_{Th} = 30\ k\Omega$

Example: switch closes



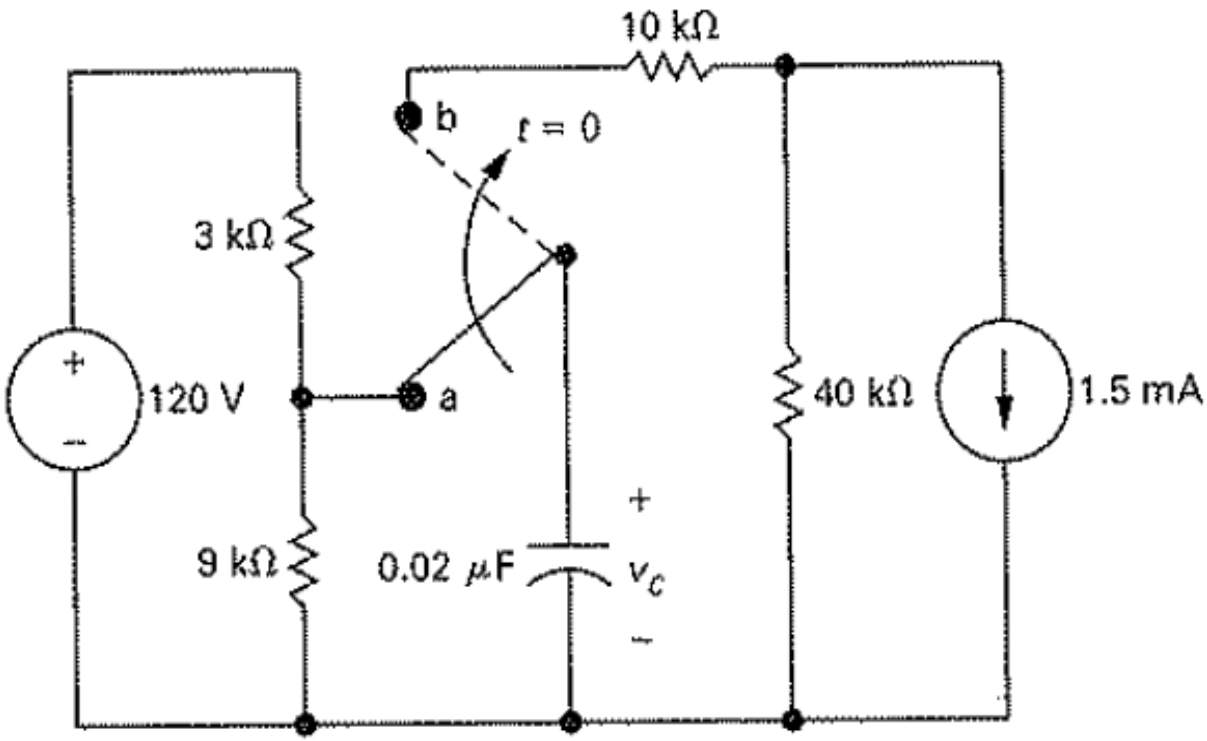
Closing at zero:

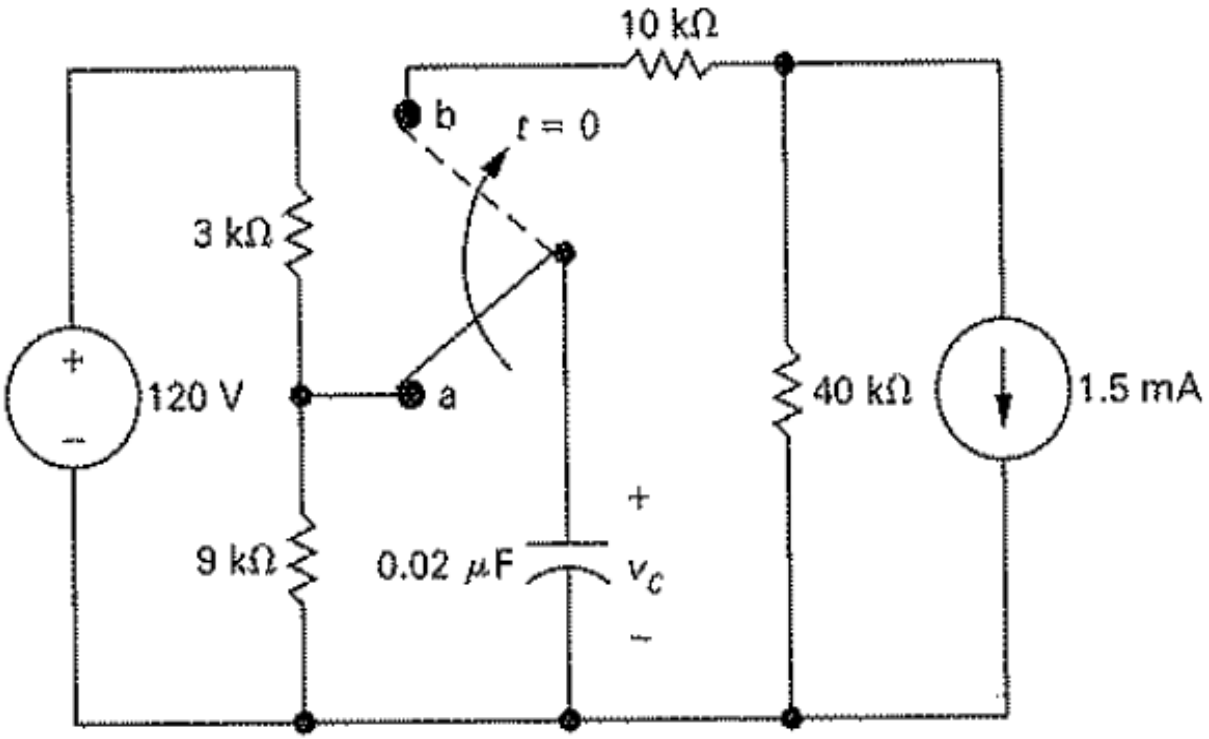
$i_0 = 0\ mA$

$i = 0.2\ mA$

$R_{Th} = 22.5\ k\Omega$

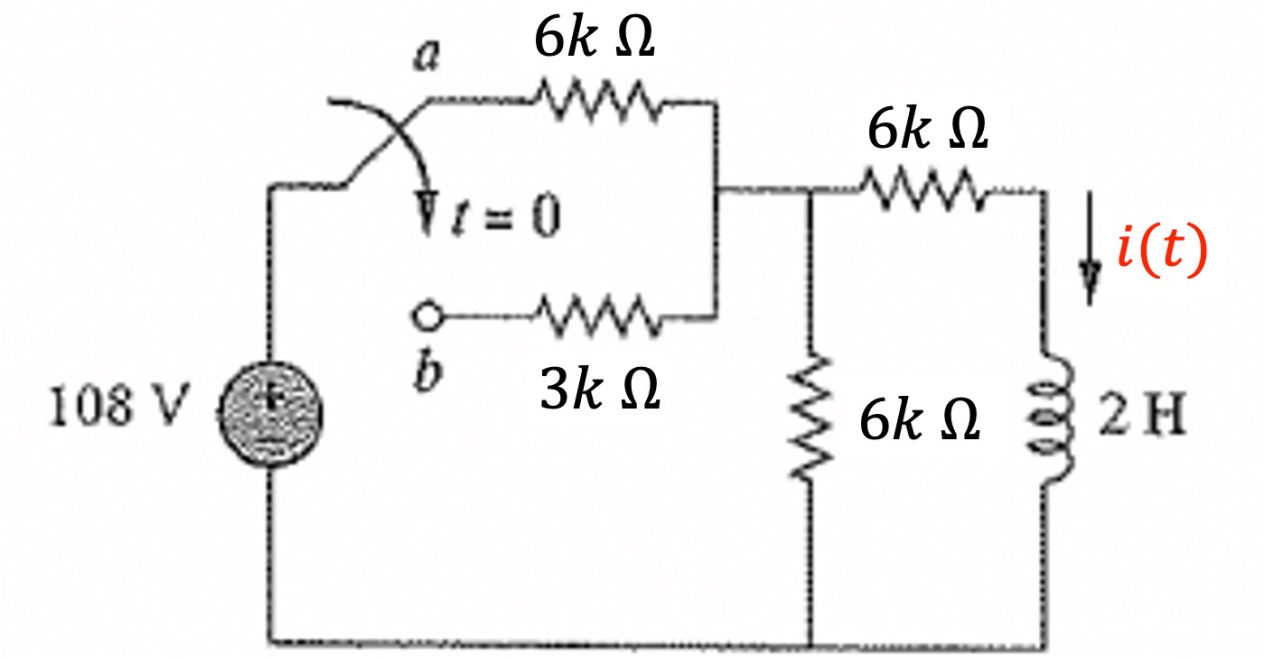
Example: switch moves from a to b

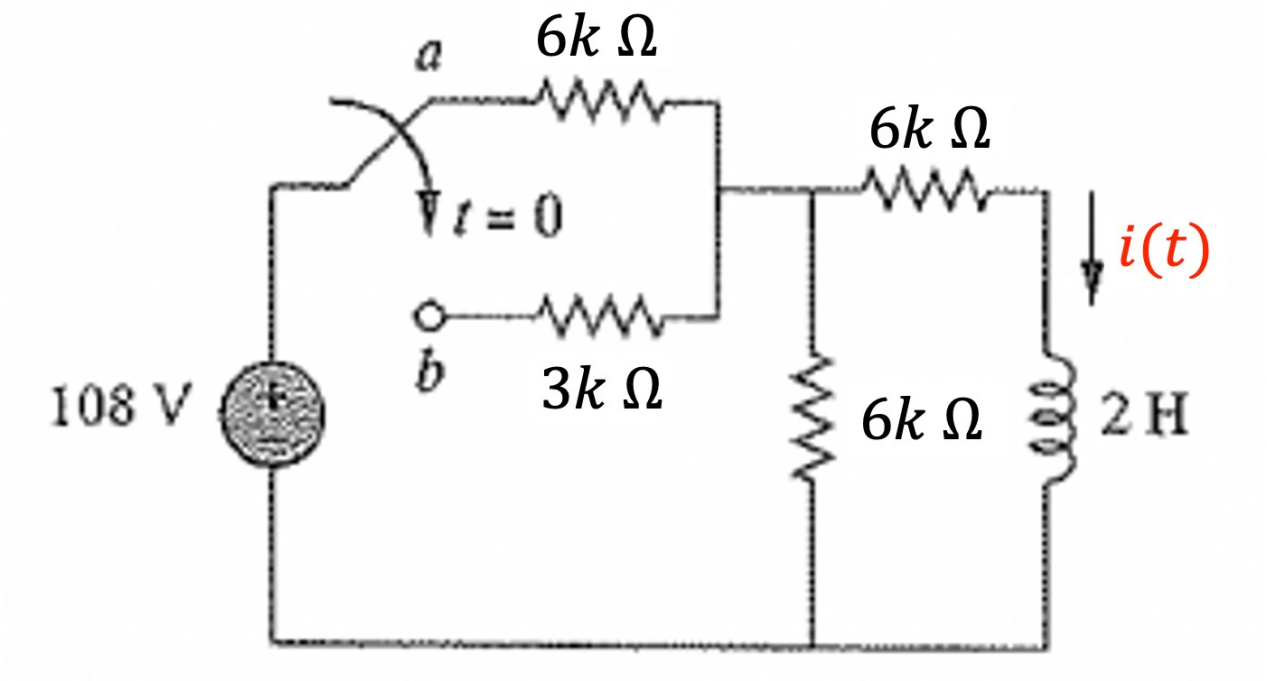




$$v_0 = 90\ V$$
$$v_\infty = -60\ V$$
$$R_{Th} = 50\ k\Omega$$

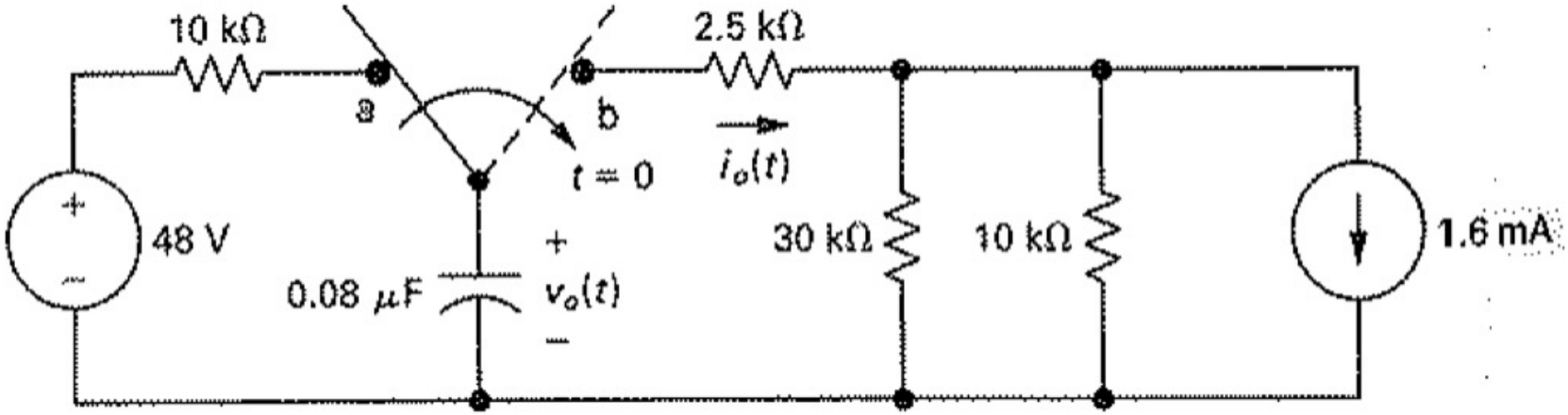
Practice problem: find $i(t)$

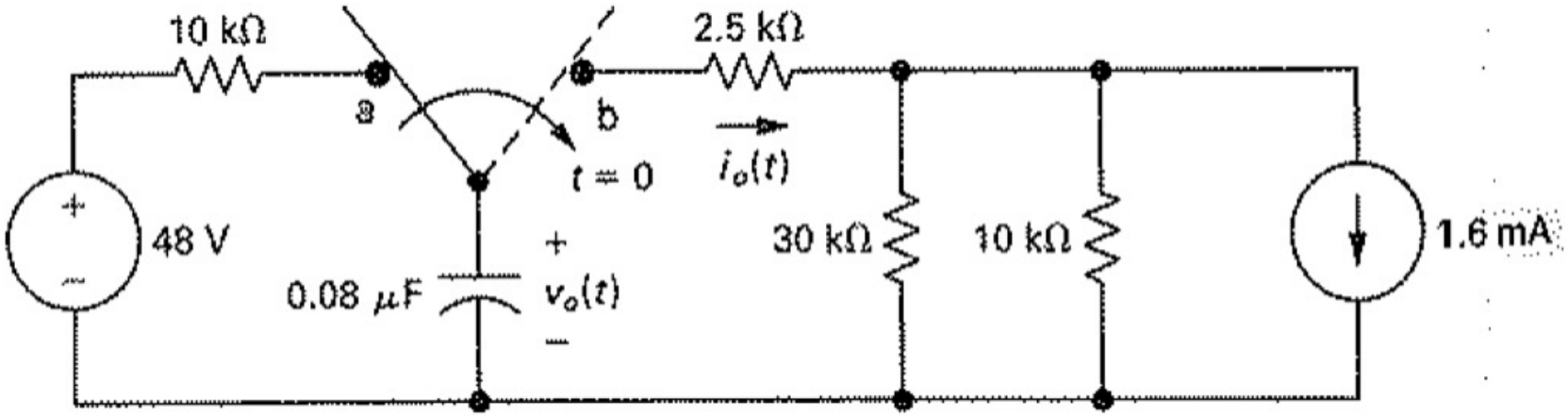




$$i(t) = -3\, e^{-4000t} + 9\ mA$$

Practice problem:

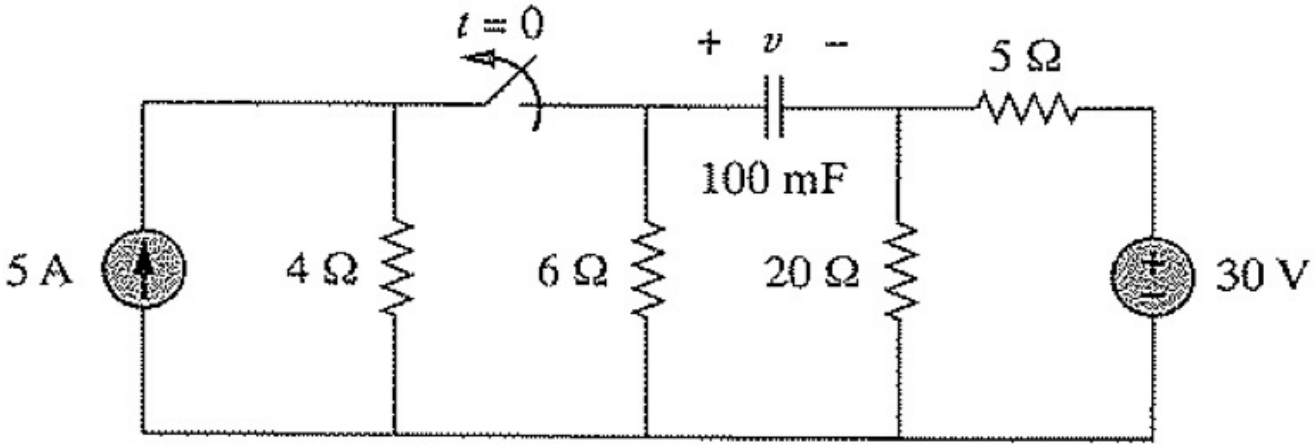




$$v(t) = 60\, e^{-125t} - 12\ V$$

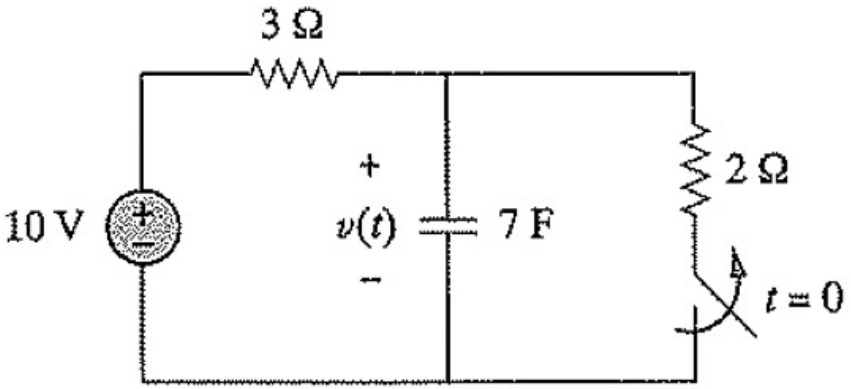
$$v(t) = 12\,e^{-t} - 24\,V$$

Practice problem:



$$v(t) = -6e^{-t/21} + 10\ V$$

Practice problem:



$v(0) = 28\ V$

$v_\infty = 14.0\ V$

$R = 54.8\ \Omega$

Practice problem: