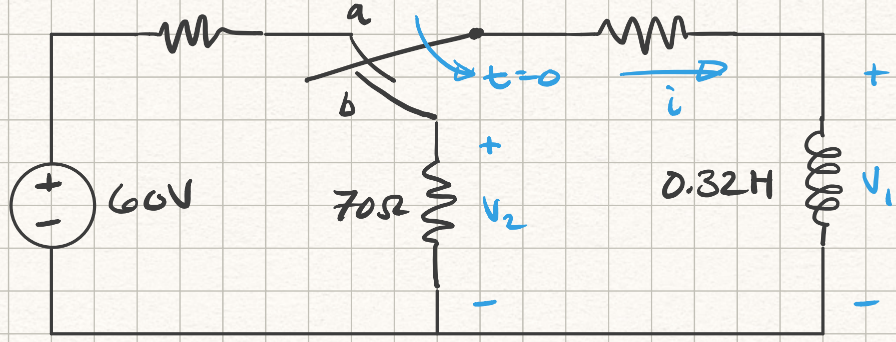
ENGR 221 HW#8, Due 6/5/20, Sean Lai

CH 7: 3, 52, 75

7.3:

Given:



at $t=0$ switch $a \to b$.

Find:
a) initial current in inductor i_0
b) time constant τ for $t > 0$
c) i, v_1, v_2, for $t \geq 0$
d) what % of initial energy in inductor is dissapated in 90Ω resistor at $t = 1ms$

Solution:

a) ind acts as s.c. in s.s.

$\rightarrow \quad i_0 = \frac{V}{R_{eq}}$

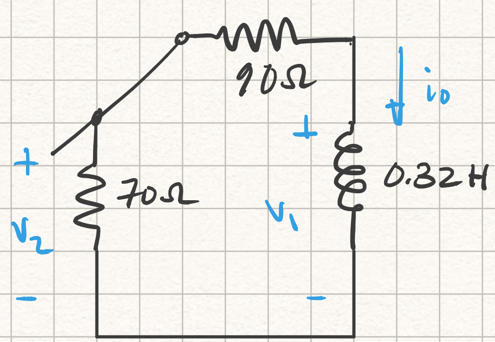
$i_0 = \frac{60V}{120\Omega} \quad \therefore \quad \boxed{i_0 = 0.5A}$

b) $R_{thb} = 160\Omega$

$\tau = \frac{L}{R_{th}}$

$\tau = \frac{0.32H}{160\Omega} \quad \therefore \quad \boxed{\tau = 2ms}$

c) general eq: $X(t) = X_{ss} + (X_0 - X_{ss})e^{-t/\tau}$



$i_{ss} = 0$ as power will all dissapate

$\therefore \quad i(t) = i_0 e^{-t/\tau}$

$\boxed{i(t) = 0.5e^{-t/2m} \text{ A}}$

CONTINUED →

7.3 continued:

v_1: $-i_0(90) - v_1 - i_0(70) = 0$ initially

$$v_{1_0} = -i_0(90+70)$$
$$v_{1_0} = -0.5(160)$$
$$v_{1_0} = -80\,V$$

$v_{ss} = 0$

$$\rightarrow \boxed{v_1(t) = -80\,e^{-t/2m}\ V}$$

v_2: $v_2 = -i(t)(70\Omega)$

$$\rightarrow \boxed{v_2(t) = -35\,e^{-t/2m}\ V}$$

d) $w_0 = \frac{1}{2} L i_0^2$

$w_0 = 0.04\,J$

$w_{90}(t) = \int_0^t P\,dt$, $P = i^2 R$, $t_1 = 1\,ms$

$$w_{90}(t) = \int_0^t (0.5e^{-t/2m})^2 \cdot 90\ dt$$

$$w_{90\,1m} = 22.5\int_0^{1m} e^{-t/1m}\ dt$$

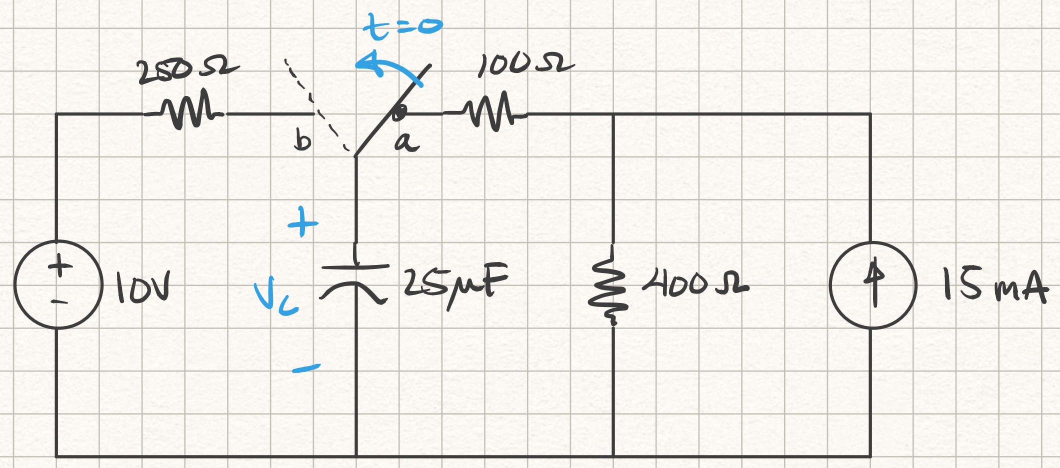
$$w_{90\,1m} = 22.5 \cdot -1m\left[e^{-t/1m}\right]\Big|_0^{1m}$$
$$= -22.5m\left[e^{-1} - 1\right]$$

$$w_{90,1m} = 0.01422\,J$$

$$\%\ diff = \frac{0.01422}{0.04} \rightarrow \boxed{\%\ loss = 35.6\%}$$

7.52:

Given:



Find:

a) V_{co}, V_{css}, τ for $t \geq 0$, and $V_c(t)$

b) assume pos. b for a long time and swiched to a at t=0. find V_{co}, V_{css}, τ, $v(t)$

Solution:

a) $R_{tha} = 500\Omega$, $i_{ca} = 0$

since $i_{ca} = 0$, $V_{400} = 15m \cdot 400$

$V_{400} = 6V$

$\rightarrow V_{ca} - 0(100) - 6V = 0$

$V_{ca} = 6V \rightarrow \boxed{V_{co} = 6V}$

at ss after switch to b, $i_c = 0$

$\rightarrow 10V - V_{css} = 0$

$\rightarrow \boxed{V_{css} = 10V}$

$R_{thb} = 250\Omega$

$\tau = R_{th} \cdot C \rightarrow \tau = 250 \cdot 25\mu$

$\boxed{\tau = 6.25\ ms}$

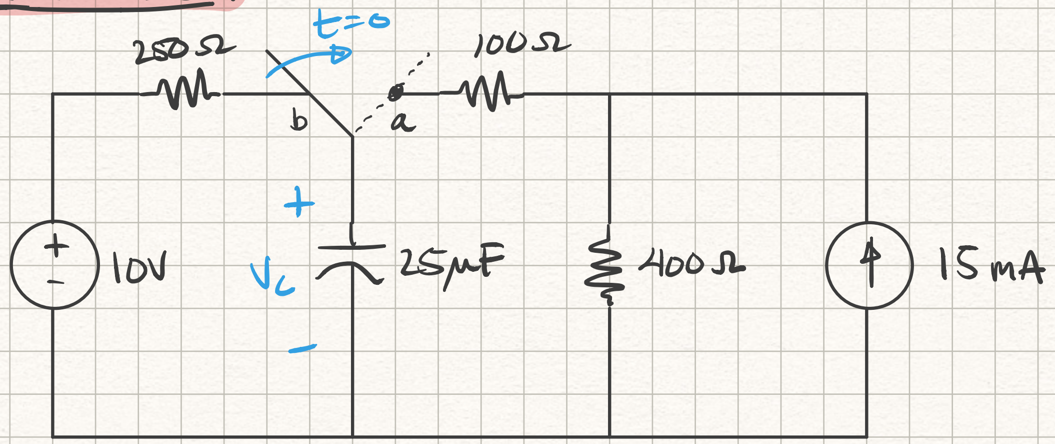
$V_c(t) = 10 + (6-10)e^{-t/6.25m}$

$\boxed{V_c(t) = 10 - 4e^{-160t}\ V}$

CONTINUED →

7.52 Continued:

b)



$V_{ocb} = 10V$, $V_{cssb} = 6V$ ← solved in part a)

$R_{tha} = 500\Omega$

$\tau = 500 \cdot 25\mu$

$\tau = 12.5ms$

→

$V_{cob} = 10V$

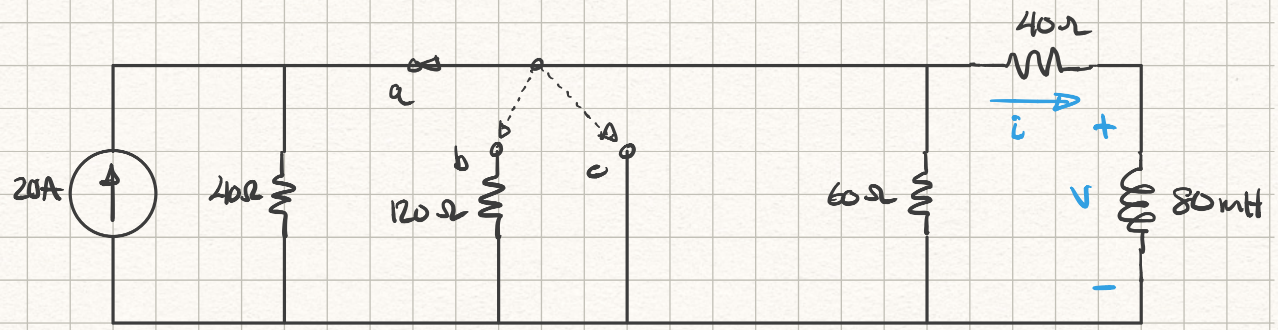
$V_{cssb} = 6V$

$\tau_b = 12.5ms$

$V_{cb}(t) = 6 + 4e^{-80t}\ V$

7.75:

Given:



$t < 0 \rightarrow a$

$0 \le t < 1ms \rightarrow b$

$t \ge 1ms \rightarrow c$

Find:

a) $i(0^+)$

b) $i(200\mu s)$

c) $i(6ms)$

d) $v(1^- ms)$

e) $v(1^+ ms)$

Solution:

a) At s.s, $i = i_s \cdot \frac{60 \| 40}{40 + 60\|40}$

$$\boxed{i(0^+) = 7.5A}$$

b) $i_{b_{ss}} = 0$

$R_{thb} = 40 + 120 \| 60 = 80\Omega$

$\tau_b = \frac{L}{R_{thb}} = 1ms$

$\rightarrow i_b(t) = 7.5e^{-1000t}$

$$\boxed{i_b(200\mu) = 6.14\ A}$$

c) $i_{c_{ss}} = 0$, $i_0 = i_b(1m) = 2.76A$

$R_{thc} = 40\Omega$

$\tau_c = 2ms \rightarrow i_c(t) = 2.76e^{-500t_c}$

$$\boxed{i_c(6m) = 226.5mA}$$

note at $t = 6ms$, $t_c = 5ms$

CONTINUED →

d) $v = L\frac{di}{dt}$

$$v(1m^-) = L \left.\frac{di_b(t)}{dt}\right|_{t=1m}$$

$$v(1m^-) = 80m \cdot -7500e^{-1000(1m)}$$

$$\boxed{v(1^-m) = -220.73V}$$

e) $v(1^+m) = L \left.\frac{di_c(t)}{dt}\right|_{t_0 = 0m}$

$$v(1^+m) = 80m \cdot -1380e^0$$

$$\boxed{v(1^+m) = 110.4V}$$