Solution Set 6 (Fall 2011)

6.1

C=10μf

i(t)= 10 $Cos10^3 t$ (mA) = (10m). $Cos10^3 t$ (A)

i(t<0)=0 , v(t<0)=0

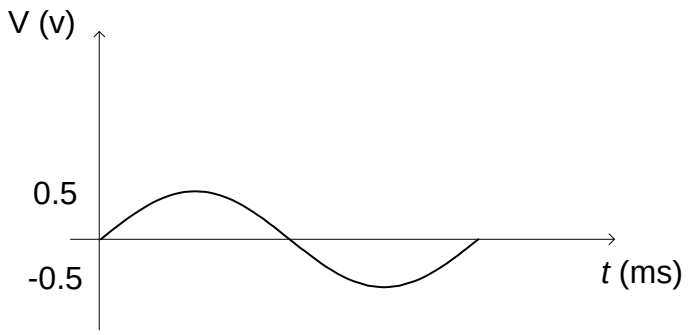
(a) Find the expression for the voltage across the capacitors.

$$V = \frac{1}{c}\int_0^t i dt = \frac{1}{10\mu}\int_0^t (10m)\cos 10^3 t dt$$

$$= \frac{10m}{10\mu}.\frac{1}{10^3} \text{ Sin}10^3 t$$

$$= \text{Sin}10^3 t \text{ (v)}$$

(b) sketch the voltage across the capacitor:



(c)Find the expression for power.

P = i.v = (5m). $Cos10^3 t$ * 0.5 $Sin10^3 t$

=1.25 $Sin(2*10^3)t$ (mW)

6.2

$i = 2\text{ mA} \cdot \frac{dv}{dt} = \frac{5v}{10v}$

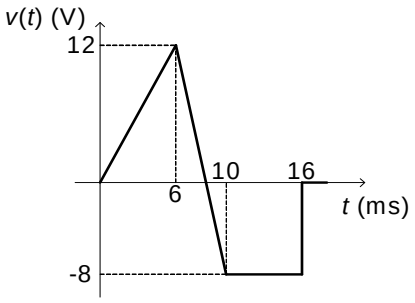
Find c:

$$i = c\,\frac{dv}{dt}$$

$$2\text{ m} = c \cdot \frac{5}{10}$$

$$C = 4\text{ mF}$$

6.3



$C = 2\ \mu F$

$$i = c\,\frac{dv}{dt}$$

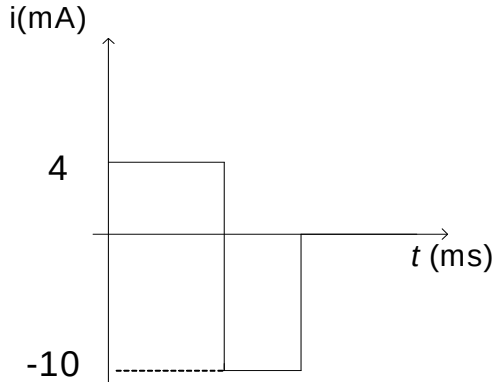
$0 < t < 6\text{ ms}$, $\frac{dv}{dt} = \frac{12}{6m} = 2\text{ k}$

$$i = c\,\frac{dv}{dt} = (2\mu) \cdot (2\text{k}) = 4\text{ mA}$$

$6\text{ms} < t < 10\text{ ms}$, $\frac{dv}{dt} = \frac{-20}{4m} = -5\text{k}$

$$i = c\,\frac{dv}{dt} = (2\mu) \cdot (-5\text{k})$$

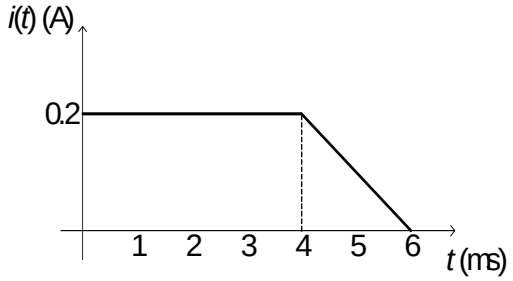
$$= -10\text{ mA}$$



$10\text{ms} < t < 16\text{ms}$, $\frac{dv}{dt} = 0$

$$i = c\,\frac{dv}{dt} = 0$$

6.4



C = 10μF

v_o = -0.1 v

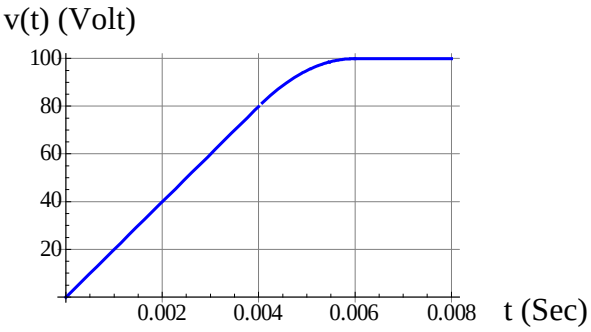
$v(t_2) - v(t_1) = \frac{1}{c}\int_{t1}^{t2} i\,dt$.

$0 < t < 4$ ms, $v(t) = v_o$ = -0.1 v

i = 0.2 A

$$v = \frac{1}{10\mu}\int_0^t (0.2)dt + (-0.1)$$

$$= (20 * 10^3)\, t - 0.1 \text{ (v)}$$



$4\text{ms} < t < 6\text{ms}$, $v(t_1) = (20*10^3)\,(4\text{m}) - 0.1$

$$= 0.8 - 0.1 = 79.9 \text{ v}$$

$$i = -0.1\, t$$

$$v = \frac{1}{10\mu}\int_{4m}^{t} (-100t + 0.6)dt + 79.9$$

$$= 10^5\left[\frac{-100t^2}{2} + 0.6t\right]_{4m}^{t} + 79.9$$

$$= (5*10^6)\, t^2 + 60*10^3\, t - 80.1 \text{ (v)}$$

$t \geq 6$ ms, $v(t_1 = 6\text{ms}) = (5*10^6)\,(6*10^{-3}) = 99.9$ (v)

6.5

$\frac{di}{dt} = \frac{100m}{2m}$, v = 100 mv

Find L:

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

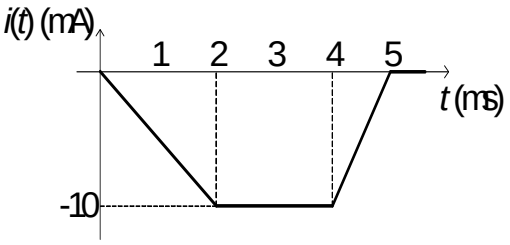
$$100m = L \cdot \frac{100m}{2m}$$

L=2 mH

6.6

L =10 mH

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



$0 < t < 2ms : \frac{di}{dt} = -5$

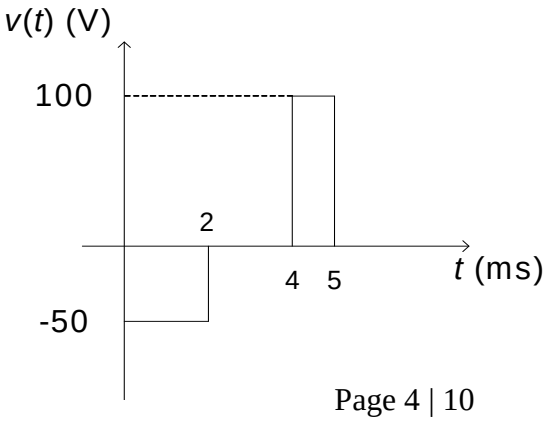
$$v = L \frac{di}{dt} = -50 \text{ mv}$$

$0 < t < 4ms : \frac{di}{dt} = 0$

v = 0

$0 < t < 5ms : \frac{di}{dt} = 10$

$$v = L \frac{di}{dt} = 10 \text{ m} \cdot 10 = 100 \text{ mv}$$



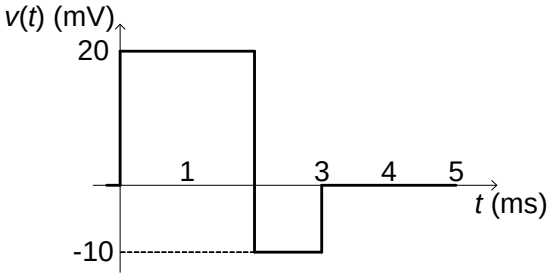
$t > 5ms : \frac{di}{dt} = 0$

v = 0

6.7

$i_o = 0$ mA

L = 20 mH



$$i(t_2) - i(t_1) = \frac{1}{L}\int_{t1}^{t2} v\,dt$$

$0 < t < 2$ ms : v = 20 m

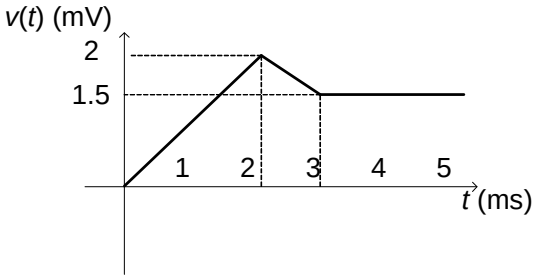
$$i(t_1) = i_0 = 0$$

$$i = \frac{1}{L}\int_{0}^{t} (20m)\,dt$$

$$= \frac{1}{20m} \cdot (20\text{m} \cdot t)$$

$$= t$$

$2 < t < 3$ ms : v = -10 m



$$i(t_1) = 2\text{ m}$$

$$I = \frac{1}{L}\int_{2m}^{t} (-10m)\,dt + 2\text{m}$$

$$= \frac{1}{20m}(-10)(t - 2\text{m}) + 2\text{m}$$

$$= \frac{1}{20m}(20\text{m}^2 - 10\text{mt}) + 2\text{m}$$

$$= 3m - \frac{t}{2}$$

3 ms< t < ∞ : v = 0

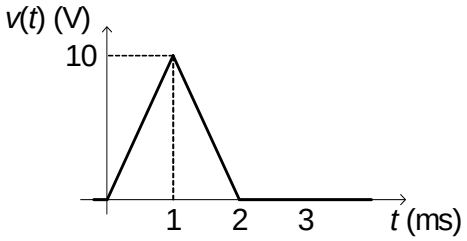
$$i(t_1) = 3m - \frac{3m}{2} = 1.5m$$

$$i = i(t_1) + 0 = 1.5\ m$$

6.8

$I_o = -0.4$ A

L = 10 mH



$$i(t_2) - i(t_1) = \frac{1}{L}\int_{t1}^{t2} v\,dt$$

0< t < 1ms : $i(t_1) = i_o = -0.4$ A

$$v = \frac{10}{1m}\,t = (10k)\,t$$

$$i = \frac{1}{L}\int_{0}^{t} v\,dt + i(t_1)$$

$$= \frac{1}{10m}(10k)\frac{t^2}{2} - 0.4$$

$$= (0.5 * 10^6)\,t^2 - 0.4 \quad (A)$$

1ms < t < 2ms : $i(t_1) = (0.5 * 10^6)\,(1m)^2 - 0.4 = 0.1$ A

$$v = (-10k)t + 20$$

$$i = \frac{1}{L}\int_{1m}^{t}[(-10k)t + 20]dt + 0.1$$

$$= \frac{1}{10m}[(-10k)\frac{t^2 - (1m)^2}{2} + 20\,(t - 1m)] + 0.1$$

$$= (-500k)t^2 + (2k)\,t - 1.4$$

$2ms < t < \infty$: $i(t_1) = (-500k)\,(2m)^2 + (2k)(2m) - 1.4$

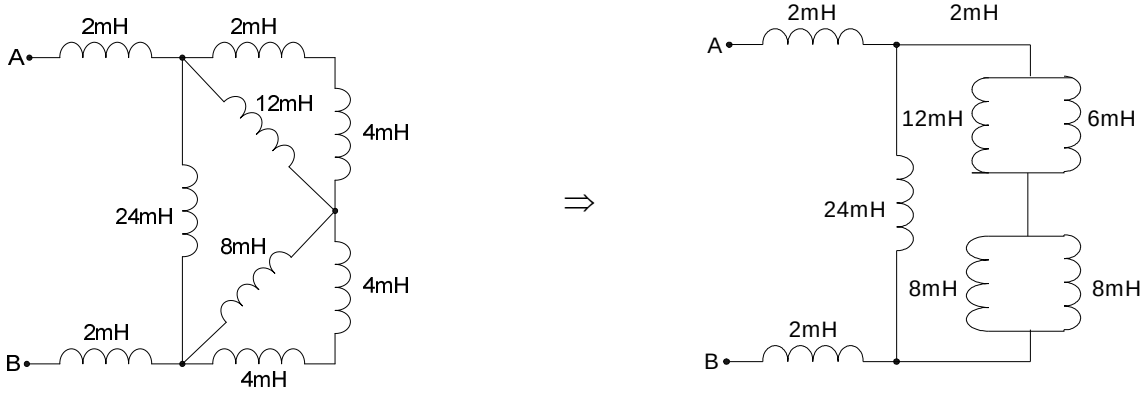
$= -2 + 4 - 1.4$

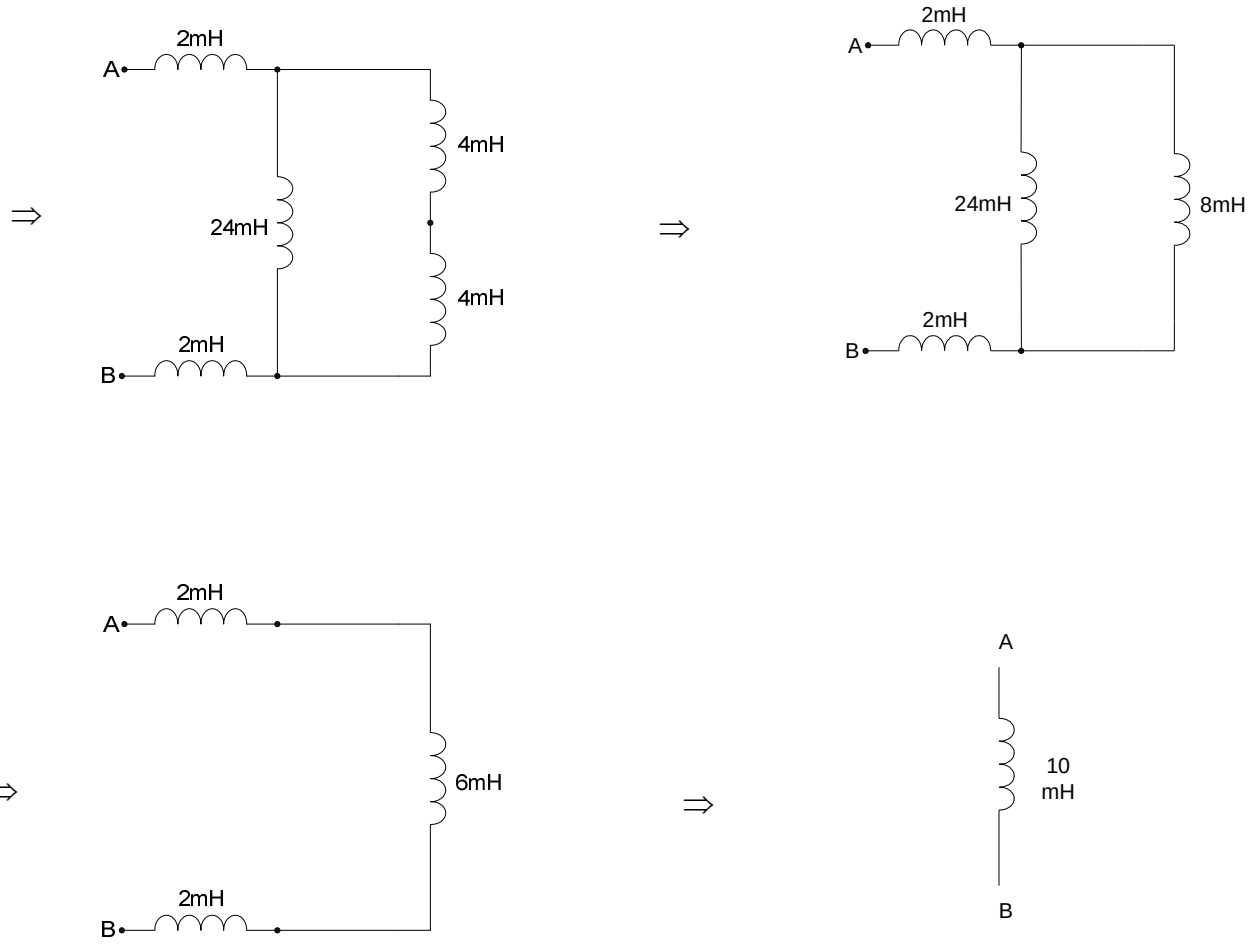
$= 0.6$ (A)

*Note: When apply equations $v(t_2) - v(t_1) = \frac{1}{c}\int_{t1}^{t2} idt$, $i(t_2) - i(t_1) = \frac{1}{L}\int_{t1}^{t2} vdt$

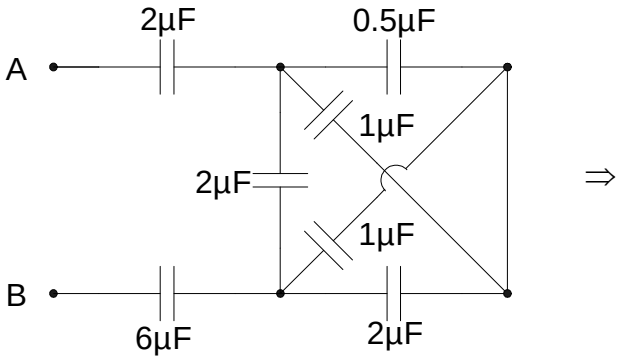
keep in mind that $v(t_1)$ and $i(t_1)$ refer to initial conditions at t_1 . $v(t_2)$ and $i(t_2)$ are functions of t .Not a specific value at time t_2 . Therefore, in the integral ,the upper limit t_2 should be a variable of t .

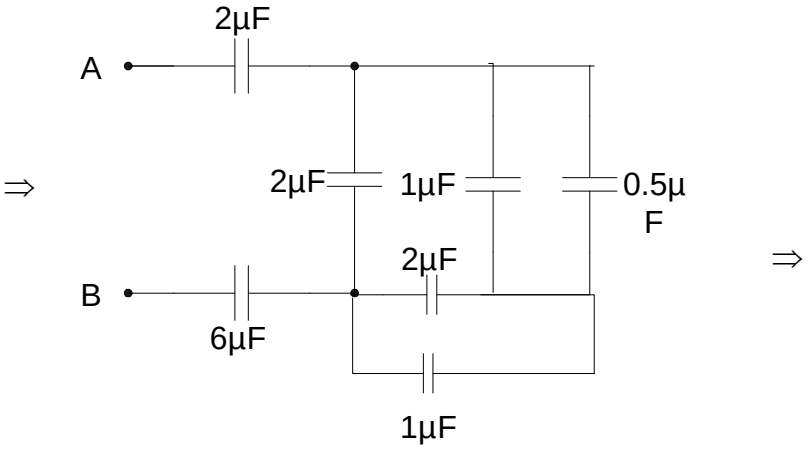
6.9

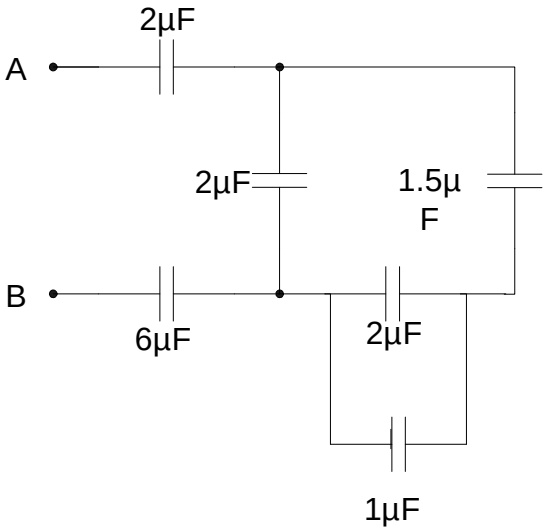


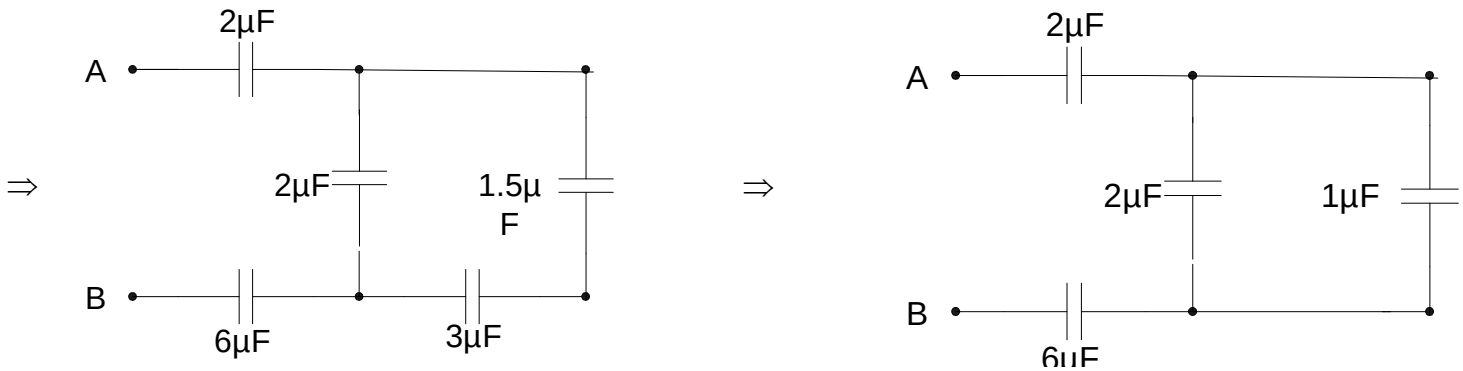

2mH
A
4mH
24mH
4mH
2mH
B
2mH
A
24mH
8mH
2mH
B
2mH
A
6mH
2mH
B
A
10
mH
B

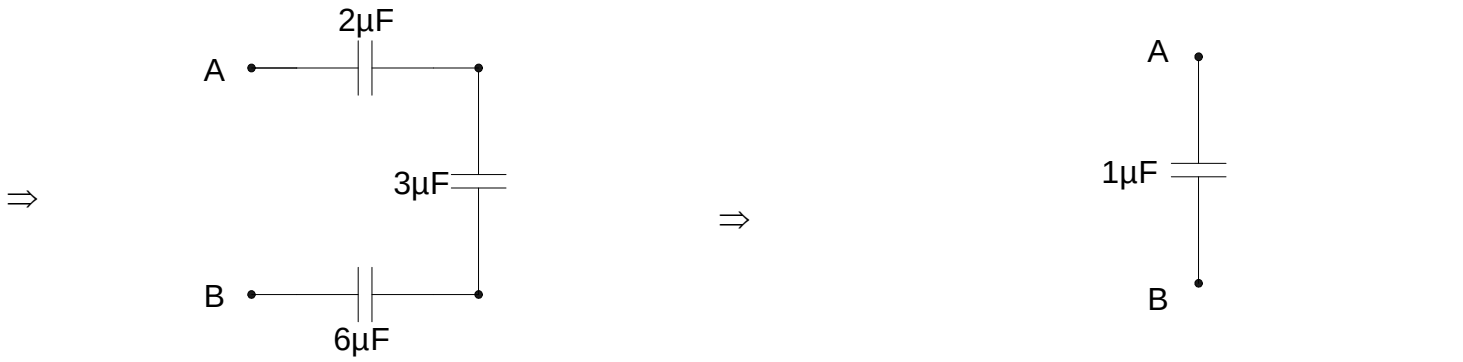
6.10


2μF
0.5μF
A
1μF
2μF
1μF
B
6μF
2μF


2μF
A
2μF
1μF
0.5μ
F
2μF
B
6μF
1μF


2μF
A
2μF
1.5μ
F
B
6μF
2μF
1μF


2μF
A
2μF
1.5μ
F
B
6μF
3μF
2μF
A
2μF
1μF
B
6μF


2μF
A
3μF
B
6μF
A
1μF
B