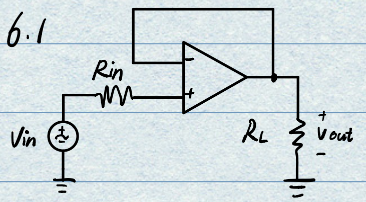
After-class assignment 3

6.1



Solution:

Since no current flows into either input terminal,

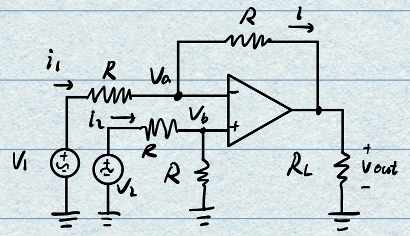
$V^+ = V_{in}$

Since there is no voltage difference between the two input terminal,

$V_{out} = V^- = V^+ = V_{in}$

Therefore $V_{out} = V_{in}$.

6.2



Solution:

Apply KCL to node a,

$$0 = \frac{V_1}{R} + \frac{V_{out} - V_a}{R}$$

Apply KCL to node b,

$$\frac{V_2}{R} = 0 + \frac{V_b}{R}$$

Since $V_a = V_b$

$V_{out} = V_a - V_1$

$V_{out} = V_b - V_1$

$V_{out} = V_2 - V_1$

7.1

(1) The current i is related to the voltage across the capacitor

$$i_1 = C\frac{dV_1}{dt} = 5\,mF \times \frac{d}{dt}(-20)$$

$$= 5mF \times 0$$

$$= 0\ A$$

(2) $$i_2 = C\frac{dV_2}{dt} = 5\,mF \times (-10e^{-5t})$$

$$= -50e^{-5t}\,(mA)$$

7.3

$$W_C(t) = \frac{1}{2}CV^2$$

$$= \frac{1}{2} \times 1000\,\mu F \times (1.5\cos 10^5 t)^2$$

$$= 1.125\times10^{-3}\cos^2(10^5 t)$$

$$W|_{t=50\mu s} = 1.125\times10^{-3}\cos^2(10^5\times50\times10^{-6})$$

$$= 1.125\times10^{-3}\cos^2(10^5\times5\times10^{-6}\times\frac{180^\circ}{\pi})$$

$$= 1.125\times10^{-3}\,(0.080466)$$

$$= 90.52\,\mu J$$

Hence, the energy stored in the capacitor at $t = 50\mu s$ is $90.52\,\mu J$

7.5

(a) $V = L\frac{di}{dt} = 3\frac{di}{dt}$

$V_{max} = 3\times10^3\ V = 3kV$

$V_{min} = 3\times(-10^3)\ V = -3\ kV$

(b) $V = L\frac{di}{dt} = 3\frac{di}{dt}$

$V_{max} = 3\times\frac{1}{12\times10^{-6}} = 250000\ V = 250\ kV$

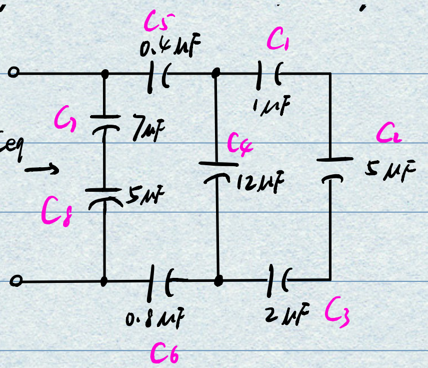
$V_{min} = 3\times(-\frac{1}{64\times10^{-6}}) = -46875\ V \approx -46.88\ kV$

(c) $V = L\frac{di}{dt} = 3\frac{di}{dt}$

$V_{max} = 3\times1 = 3\ V$

$V_{min} = 3\times(-\frac{1}{1\times10^{-9}}) = -3\times10^9\ V = -3GV$

7.8.

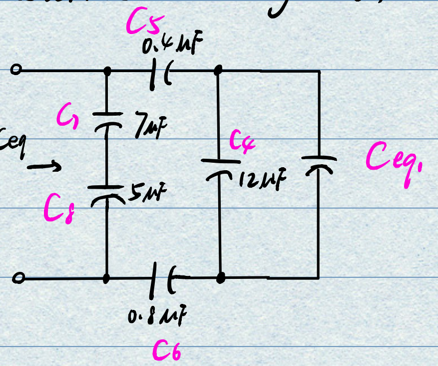


Solution:

Since capacitors C_1, C_2, C_3 are in series.

$$C_{eq_1} = \frac{1}{\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}} = \frac{1}{1+\frac{1}{5}+\frac{1}{2}} = \frac{10}{17}\ \mu F$$

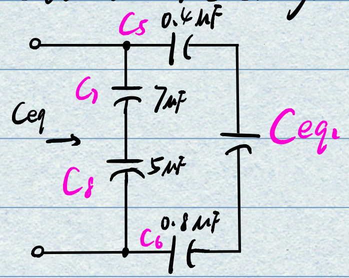
Rewrite the diagram.



Since capacitors C_4, C_{eq_1} are in parallel.

$$C_{eq_2} = C_4 + C_{eq_1} = (12+\frac{10}{17})\ \mu F$$

Rewrite the diagram.

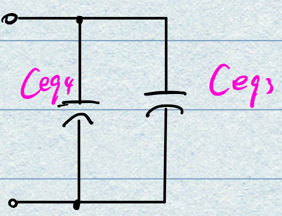


Since C_5, C_6, C_{eq_2} and C_7, C_8 are in series.

$$C_{eq_3} = \frac{1}{\frac{1}{C_5}+\frac{1}{C_6}+\frac{1}{C_{eq_2}}} = \frac{1}{\frac{1}{0.4}+\frac{1}{0.8}+\frac{1}{12+\frac{10}{17}}} = \frac{428}{1639} \approx 0.26\ \mu F$$

$$C_{eq_4} = \frac{1}{\frac{1}{C_7}+\frac{1}{C_8}} = \frac{1}{\frac{1}{7}+\frac{1}{5}} = \frac{35}{12} \approx 2.92\ \mu F$$

Rewrite the diagram.



Since C_{eq3} and C_{eq4} are in parallel,

$$C_{eq} = C_{eq3} + C_{eq4} = 0.26 + 2.92 = 3.18\ \mu F$$