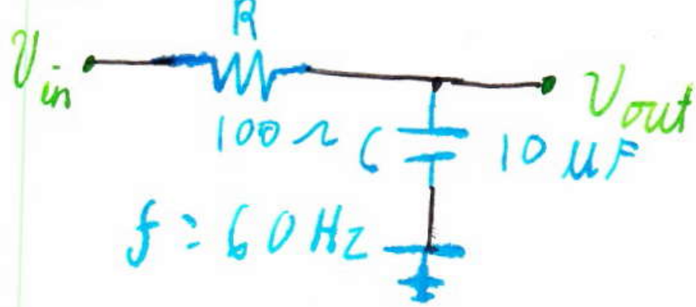
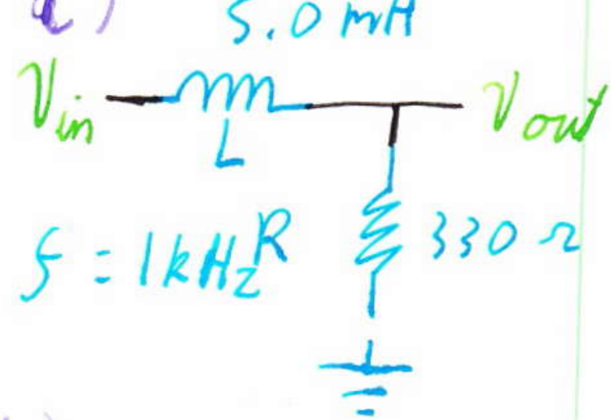
Cpe 1150 | Hw 5 | Bruce Liu

3) Determine the output voltage (V_{out}) of each Filter in Figure 18-40 at the specified frequency when $V_{in} = 10V$.

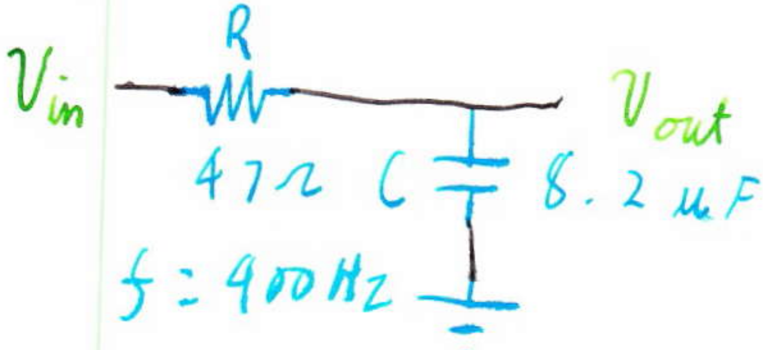
a)



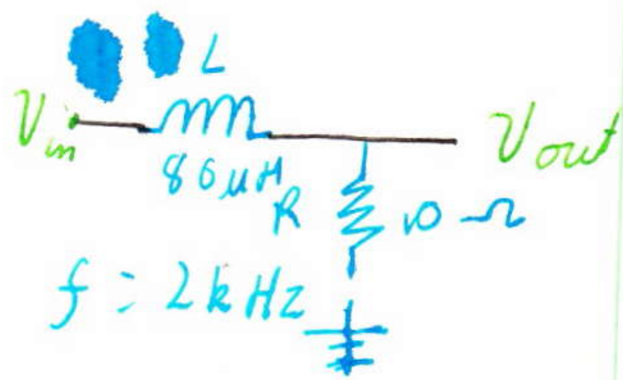
c)



b)



d)



a) RC low pass

$$v_{out} = \left(\frac{x_C}{\sqrt{R^2 + x_C^2}}\right) v_{in}$$

$$X_C = \frac{1}{2\pi f C}$$

$C = 10 \times 10^{-6}$ F $\quad v_{in} = 10$ V

$R = 100\ \Omega \quad v$

$f = 60$ Hz

$$X_C = \frac{1}{2\pi(60)\left(10^{-6} \times (10)\right)} \rightarrow \text{memory}$$

$$X_C = 2.6526 \times 10^2$$

$$v_{out} = 9.3572$$

$$\boxed{v_{out} = 9.4\ \text{V}}$$

b) RC low pass

$R = 47$ $\quad V_{in} = 10V$

$C = 8.2 \times 10^{-6} F$

$f = 400 Hz$

$$X_C = \frac{1}{2\pi f C}$$

$$X_C = \frac{1}{2\pi(400)(8.2\times10^{-6})} = 48.523$$

$X_C \to$ memory A

$$V_{out} = \frac{X_C}{\sqrt{R^2 + X_C^2}}$$

$V_{out} = 0.21277\ V$

$\boxed{V_{out} = 0.21\ V}$

c) RC low pass

$$V_{out} = \frac{R}{\sqrt{X_L^2 + R^2}} V_{in}$$

$X_L = 2\pi f L$

$f = 10^3$ Hz $\quad V_{in} = 10V$

$R = 330$

$L = 5 \times 10^{-3}$ mH

$X_L = 2\pi(10^3)(5\times10^{-3})$

$X_L = 10\pi = 31.416 \rightarrow$ memory A

$V_{out} = 9.955$ V

$\boxed{V_{out} \approx 10 V}$

d) RL low pass

$$V_{out} = \frac{R}{\sqrt{R^2 + X_L}} V_{in}$$

$R = 10\,\Omega$

$V_{in} = 10V$

$L = 80 \times 10^{-6} H$

$f = 2\ kHz$

$X_L = 2\pi f L$

$X_L = 2\pi (2 \times 10^3)(80 \times 10^{-6})$

$X_L = 1.0053$ → memory A

$V_{out} = 9.9498$

$\boxed{V_{out} = 9.9\ V}$

10) For a basic RC low pass, filter, find the output voltage in dB relative to a 0 dB input for the following frequencies

($f_c = 10.0^3$ Hz)

a) 10.0^3 Hz b) 10.0^5 Hz

c) 10.0^6 Hz

$2^3 = 8$

$\log_2 8 = 3$

$\sqrt[3]{8} = 2$

<u>objective</u>

output voltage

$R = X_C$

$R = \frac{1}{2\pi f C}$

$2\pi R C = \frac{1}{f}$

$\frac{1}{2\pi RC} = f = f_C$

$$0\ dB = 20 \log_{10}\left(\frac{V_{out}}{V_{in}}\right)$$

$$10^{\frac{0}{20}} = \frac{V_{out}}{V_{in}}$$

$\boxed{V_{in} = V_{out}}$ all cases

14) a high pass filter has a critical frequency of 50 Hz. Determine which of the following frequencies are passed and which are rejected:

Rejected

a) 1Hz b) 20 Hz c) 50 Hz

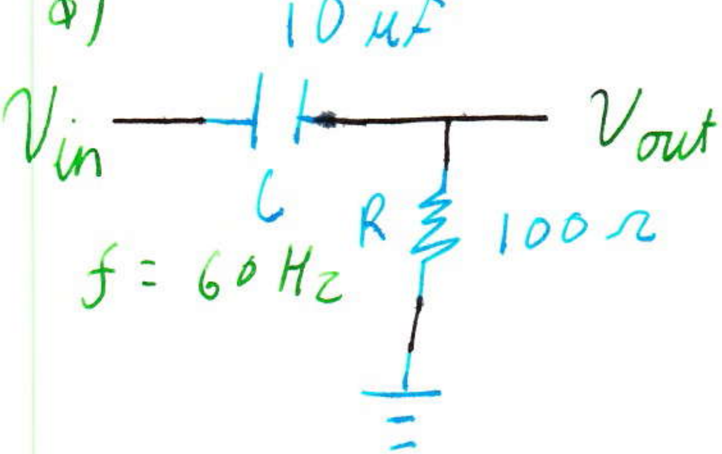
d) 60 Hz e) 30 kHz

passed

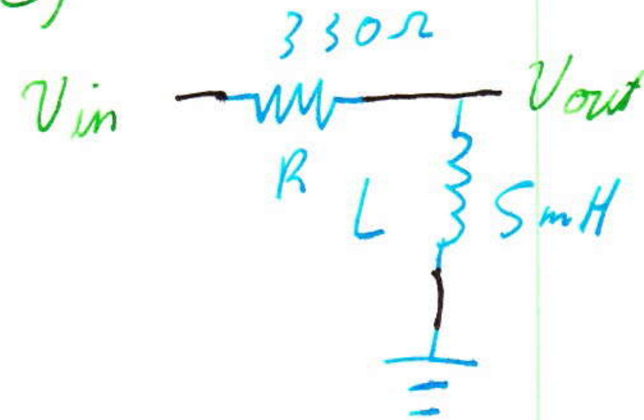
16) What is f_c for each filter in Figure 18-43?

Determine the output voltage at f_c in each case ($V_{in} = 10\,V$)

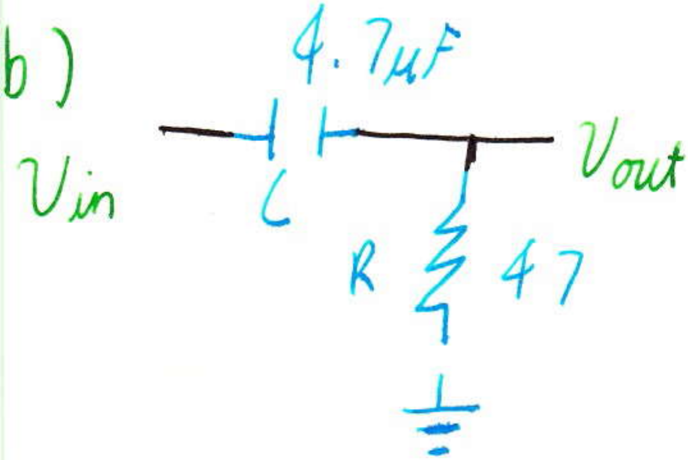
a)



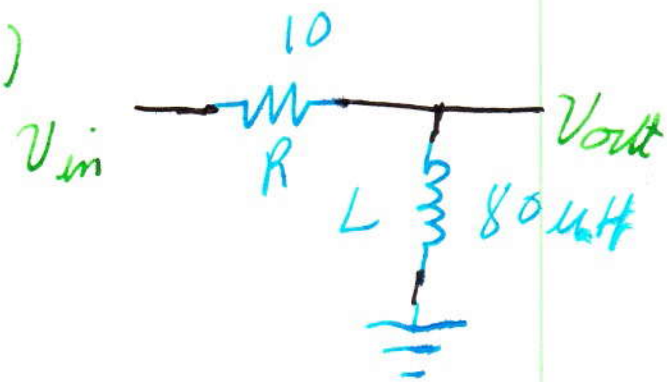
c)



b)



d)



$$dB = 20 \log_{10}\left(\frac{V_{out}}{V_{in}}\right)$$

$$R = \frac{1}{2\pi f_c C}$$

$f_c = -3\,dB$ definition

$$\frac{1}{R} = 2\pi f_c C$$

$$\frac{1}{R 2\pi C} = f_c$$

$$10^{\frac{-3\,db}{20}} = \frac{V_{out}}{V_{in}}$$

$$V_{in}\, 10^{-3/20} = V_{out} \quad \text{at } f_c$$

$$V_{in}\, 10^{\frac{-dB}{20}} = V_{out}$$

a)

$$\frac{1}{2\pi RC} = f_c$$

$$\frac{1}{2\pi(100)(10\times10^{-6})} = \boxed{159.2\text{ Hz}}$$

$$V_{in}\ 10^{-3/20} = v_{out}$$

$$(10)\left(10^{-3/20}\right) = v_{out}$$

$$V_{out} = 7.0795\text{ V}$$

$$\boxed{V_{out} = 7.1\text{ V}}$$

b)

$$\frac{1}{2\pi RC} = f_c$$

$$\frac{1}{2\pi(4.7\times10^{-6})(47)} = f_c$$

$$\boxed{f_c = 720.5\ Hz}$$

$$V_{in}\ 10^{-3/20} = V_{out}$$

$$10\ 10^{-3/20} = V_{out}$$

$$V_{out} = 7.0795\ V$$

$$\boxed{V_{out} = 7.1\ V}$$

c)

$$R = X_L$$

$$R = 2\pi f L$$

$$\frac{R}{2\pi L} = f_c$$

$$\frac{330}{2\pi(5\times10^{-3})} = f_c$$

$$f_c = 10.504 \text{ kHz}$$

$$\boxed{f_c = 10.5 \text{ kHz}}$$

$$V_{in}\, 10^{-3/20} = V_{out}$$

$$10 \cdot 10^{-3/20} = 7.0795\text{ V} = V_{out}$$

$$10 \cdot 10^{-3/20} = \boxed{7.07\text{ V} = V_{out}}$$

d)

$R = X_L$

$R = 2\pi f L$

$\frac{R}{2\pi L} = f_c$

$\frac{10}{2\pi 80 \times 10^{-6}} = f_c$

$f_c = 19.894\ kHZ$

$\boxed{f_c = 19.9\ kHz}$

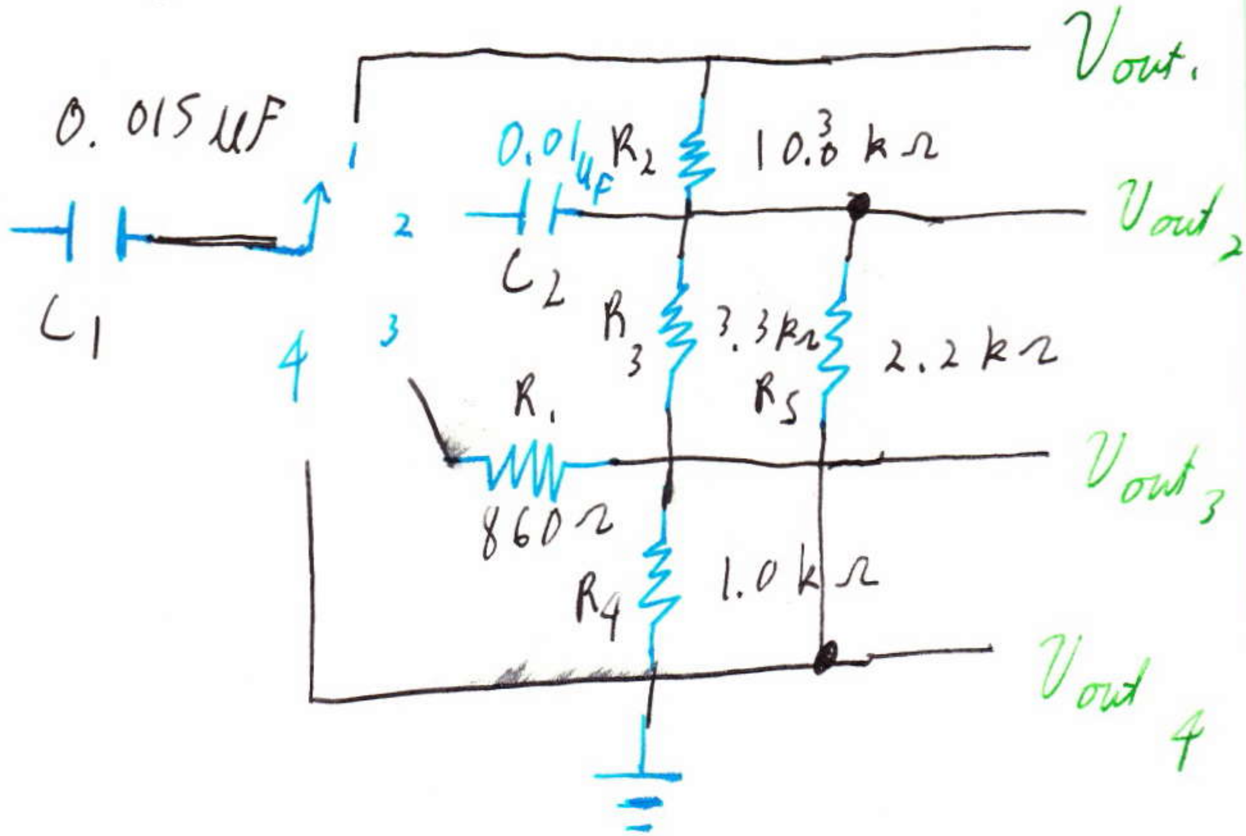
$V_{out} = V_{in} 10^{dB/20}$

$V_{out} = 10\ 10^{-3/20}$

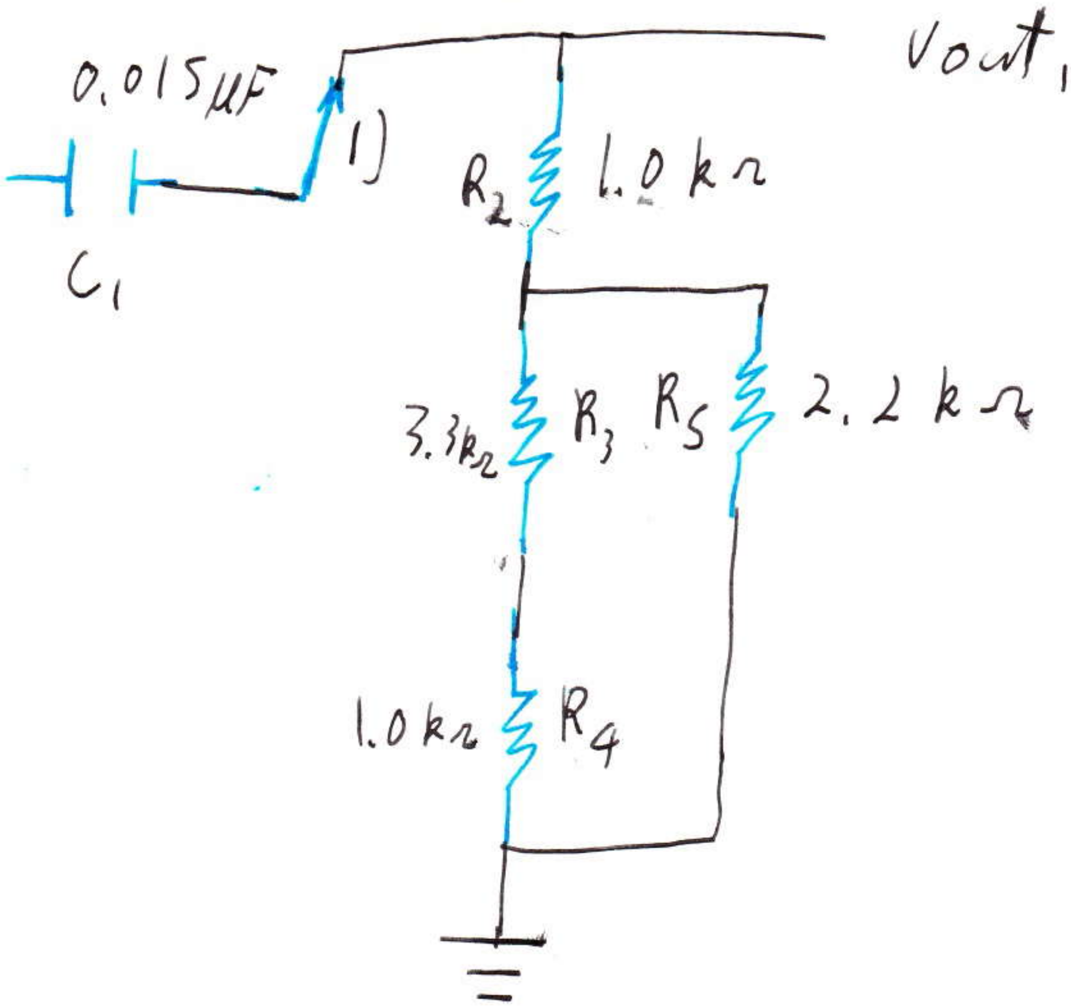
$V_{out} = 10\ 10^{-3/20}$

$V_{out} = 7.0795\ V$ $\boxed{V_{out} = 7.1\ V}$

18) Determine f_c for each switch location in Figure 18-44



18.1)



$$R_{SW_1} = (R_3 + R_4 \parallel R_5) + R_2$$

$$R_{SW_1} = (3.3 + 1.0 \times 10^3) \parallel (2.2 \times 10^3) + 10^3$$

$$R_{SW_1} = \left(\frac{4.3 \times 10^3 \times 2.2 \times 10^3}{6.5 \times 10^3} \right) + 10^3$$

$$R_{SW_1} = 2.4554 \times 10^3 \, \Omega$$

$$R = X_C$$

$$R = \frac{1}{2\pi f_c C}$$

$$RC2\pi = \frac{1}{f}$$

$$f_c = \frac{1}{2\pi RC}$$

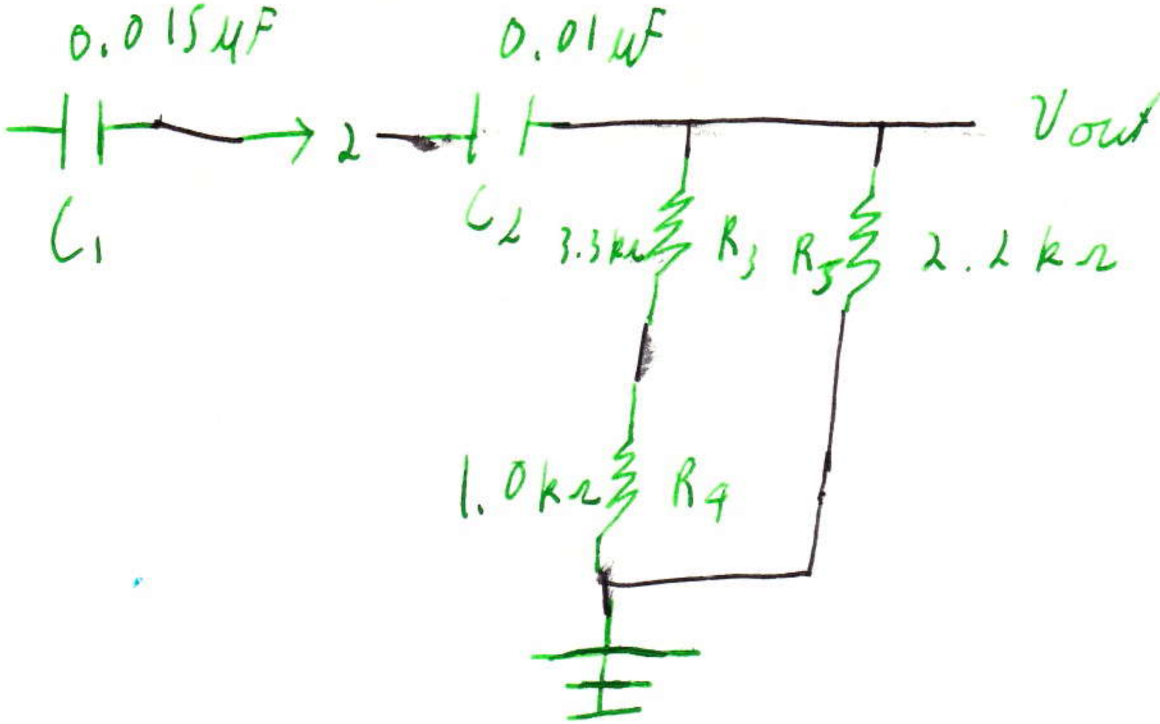
$$f_c = \frac{1}{2\pi (2.4554 \times 10^3) \times (0.015 \times 10^{-6})}$$

$$f_c = 4.3212 \times 10^3 \, Hz$$

$$f_c = 4.32 \times 10^3 \, Hz$$

$$\boxed{f_c = 4320 \, Hz}$$

18.2)



$$C_1 + C_2 = \frac{(0.015 \times 10^{-6})(0.01 \times 10^{-6})}{(0.015 \times 10^{-6}) + (0.01 \times 10^{-6})}$$

$$C_{1+2} = 6 \times 10^{-9}$$

$$R = \frac{\left(\overset{4.3 \times 10^{3}}{\cancel{3.3 \times 10^{3} + 10^{3}}}\right) \times (2.2 \times 10^{3})}{\underset{(6.5 \times 10^{3})}{\left(\cancel{4.3 + 2.2 \times 10^{3}}\right)}}$$

$$R = 1.4554\ k\Omega$$

f_c is when $R = X_C$

$$R = \frac{1}{2\pi f C}$$

$$\frac{1}{R} = 2\pi f C$$

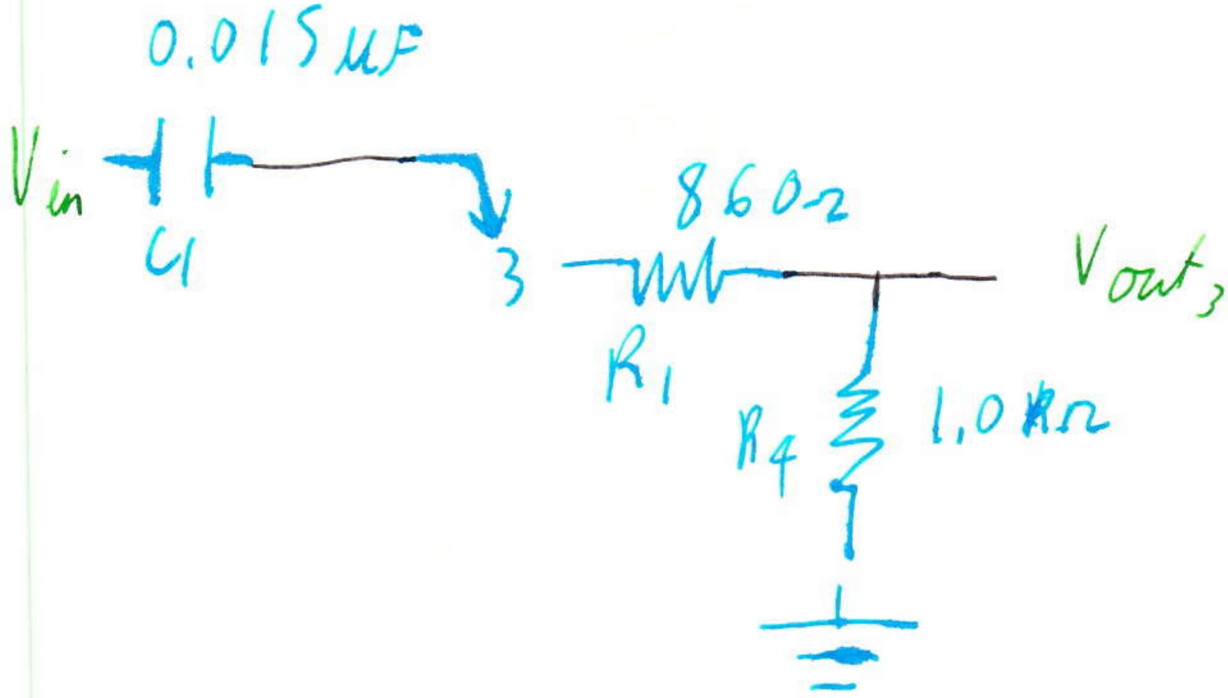
$$\frac{1}{2\pi R C} = f_c$$

$$\frac{1}{2\pi (1.4554 \times 10^3) \times (6.0 \times 10^{-9})}$$

$$f_c = 18.226 \text{ kHz}$$

$$\boxed{f_c = 18.23 \text{ kHz}}$$

(8.3)



$R = 1.0 \times 10^3 + 860 = 1860\ \Omega$

$R = X_C$

$R = \dfrac{1}{2\pi f C}$

$\dfrac{1}{R} = 2\pi f C$

$\dfrac{1}{R 2\pi C} = f_c$

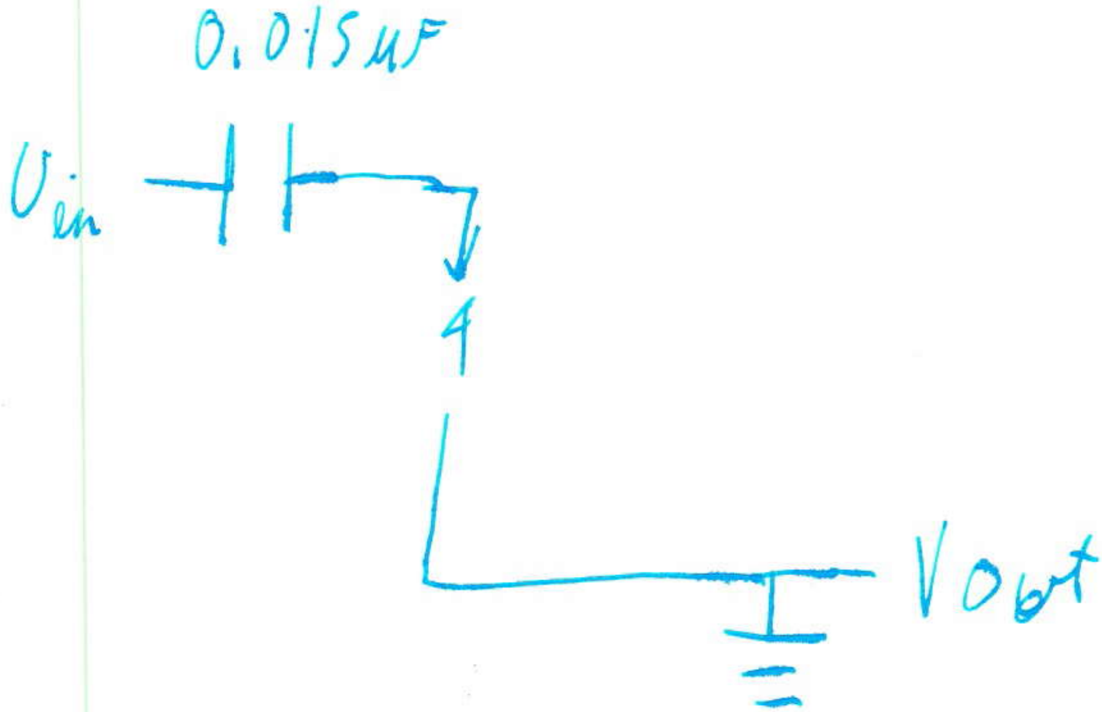
$\dfrac{1}{1860 \times 2\pi \times 0.015 \times 10^{-6}} = f_c$

$f_c = \cancel{5.7 \times 10^3\ Hz}$

$5.7045 \times 10^3\ Hz$

$\boxed{f_c = 5.7\ kHz}$

(8.4)



assumpton wire 1 ohm

$$R = \frac{1}{2\pi f C} \quad f_c = \frac{1}{1\,2\pi(0.015\times10^{-6})}$$

$$\frac{1}{R2\pi C} = f_c \quad \boxed{f_c = 10.610 \text{ mhz}}$$