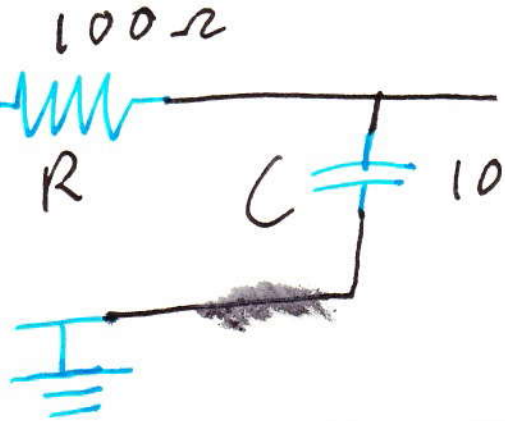
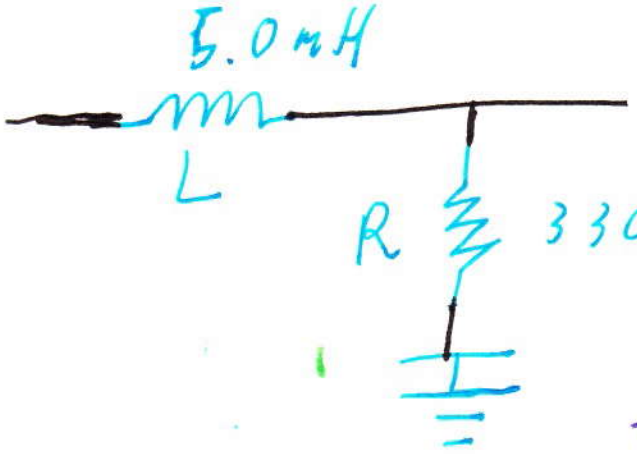
3.) Determine the output Vout of each filter in Figure 18-40 at the specified frequency when $V_{in} = 10$ V.

a)



$f_a = 60\ Hz$

c)



$f_c = 10^3\ Hz$

a)

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

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

$$X_C = \frac{1}{2\pi (60)(10 \times 10^{-6})}$$

$$V_{out} = \frac{2.6526 \times 10^2}{\sqrt{(100)^2 + (2.6526 \times 10^2)^2}} 10$$

$$V_{out} = 9.3572$$

$$\boxed{V_{out} = 9.4\ V}$$

C)

$X_L = f 2\pi L$

$X_L = (10^3) 2\pi (5.0 \times 10^3)$

$X_L = 31,416$

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

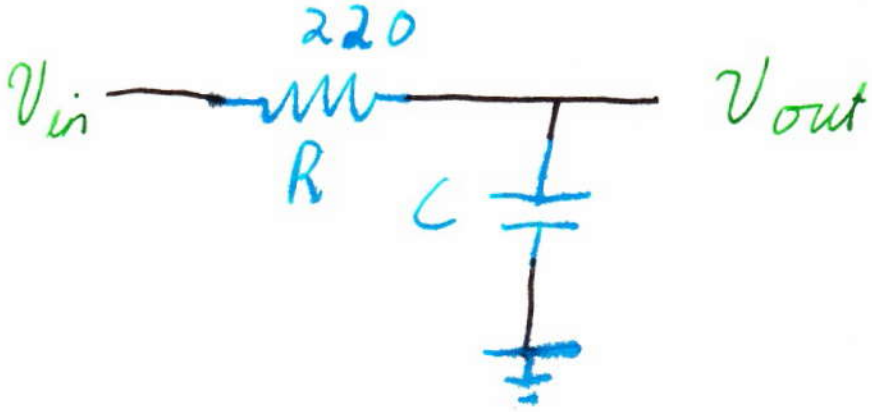
$$V_{out} = \frac{330}{\sqrt{330^2 + (31.416)^2}} (10)$$

$V_{out} = 9.955\ V$

$\boxed{V_{out} = 10.0V}$

5) For the filter in Figure 18-41, calculate the value of C required for each of the following critical frequencies:

b) 500 Hz d) 5×10^3 Hz



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

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

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

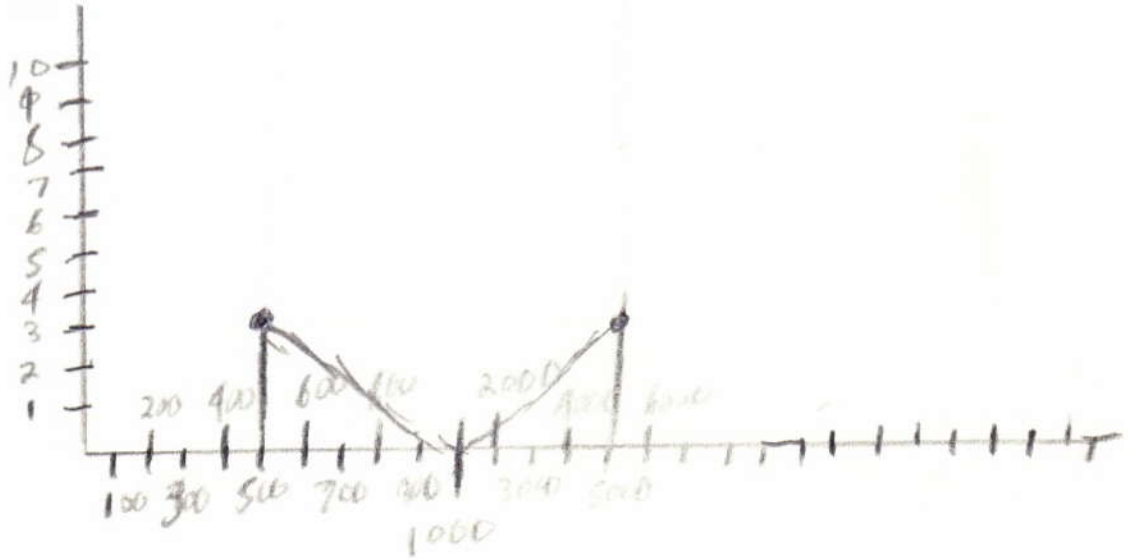
$$\frac{1}{(220)\,2\pi\,(500)} = 1.4469 \times 10^{-6} F$$

$$\frac{1}{(220)(2\pi)(5000)} = 0.14469 \times 10^{-6} F$$

b) $1.4\ \mu F$

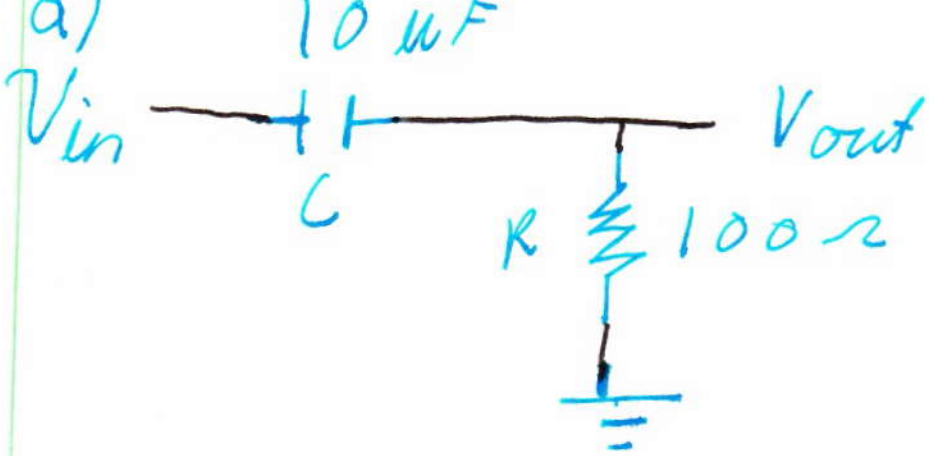
d) $0.144\ \mu F$

7) Draw a Bode ~~plot~~ plot of the magnitude for each part of problem 5.

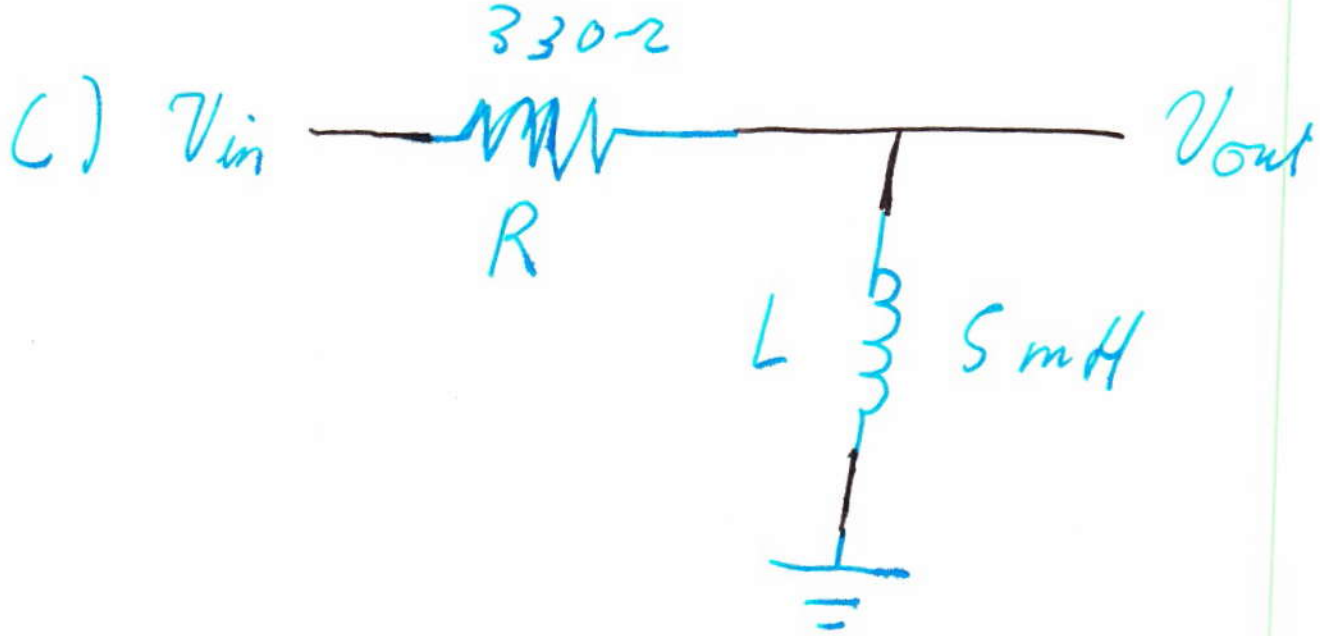


16) ~~a)~~ What is f_c for each filter in Figure 18-43? Determine ~~the~~ the output voltage at f_c in each case ($V_{in} = 10\ V$).

a)



c)



a)

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

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

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

$$\frac{1}{(100)(10\times10^{-6})2\pi} = f_C$$

$$f_C = 1.5915 \times 10^{2}$$

$$\boxed{f_C = 159.2}$$

$$V_{out} = \frac{100}{\sqrt{(100)^2 + (2\pi f C)}}\ 10$$

~~$\boxed{V_{out} = 5.32\ V}$~~

$$\boxed{V_{out} = 7.07095}$$

c)

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

$$R = X_L$$

$$R = 2\pi f L$$

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

$$\frac{330}{2\pi(5 \times 10^{-3})} = f_c$$

$$f_c = 10504.22624 \text{ Hz}$$

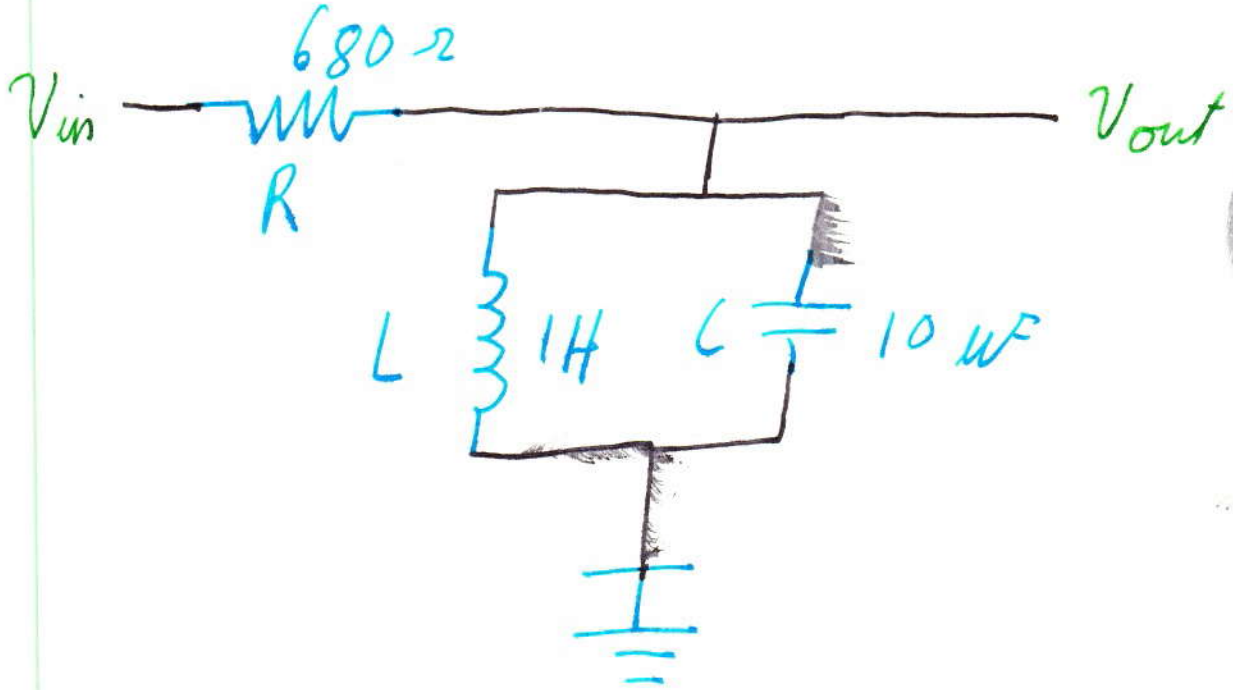
$$V_{out} = \frac{330}{\sqrt{330^2 + 330^2}} \; 10$$

$$V_{out} = 7.07106781 \; V$$

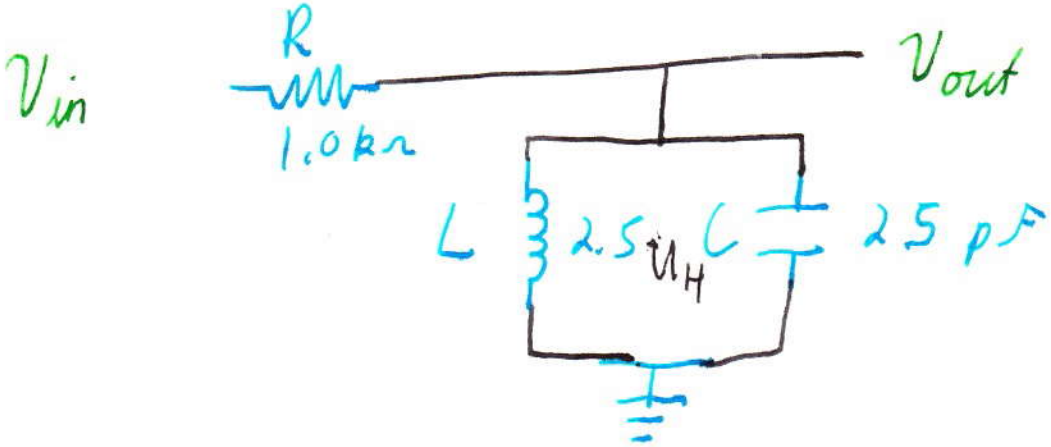
$$\boxed{V_{out} = 7.1 \; V}$$

23) If the coils in Figure 18-46 have a winding resistance 4 Ω, what is the output voltage at resonance when $V_{in} = 120$ V?

a)



b)



$$f_0 = \frac{\sqrt{1 - \frac{(R\omega^2 C)}{L}}}{2\pi\sqrt{LC}}$$

$$f_0 = \frac{\sqrt{1 - \frac{(4)^2 \times (10\times10^{-6})}{1}}}{2\pi\sqrt{(1)\times10\times10^{-6}}}$$

$$f_0 = 50.32518\ Hz$$

$$\boxed{f_0 = 50\ Hz}$$

$$X_L = 2\pi f L$$

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

$$X_L = 2\pi(50)(1) = 314.159265\ \Omega$$

$$X_L = \frac{1}{2\pi(50)(10)(10^{-6})}$$

$$X_C = 318.3098862\ \Omega$$

$$Z_L = 4 + 314.159265\ j\Omega$$

$$Z_{L\|C} = Z_L \| X_C = 1734.431 \angle 45.329$$

$$\frac{Z_{LIIC}}{R + Z_{LIIC}} V_{in} = V_{out}$$

$$V_{out} = \frac{17349.436 \angle 45.329}{680 + 17349.436 \angle 45.329}$$

$$V_{out} = 116.73914\,06 \angle 1.5538202^{\circ}$$

$$\boxed{V_{out} = 116.7 \angle 1.6^{\circ}}$$

30) Assume you want to reject 60Hz line noise by constructing the parallel resonance band stop filter shown in Figure 18-51. What size capacitor do you need to complete the filter?

$X_C = X_L$ is required for resonance

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

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

$$C = \frac{1}{(2\pi)^2 f^2 L}$$

$$C = \frac{1}{(2\pi f)^2 L}$$

$$C = \frac{1}{(2\pi 60)^2 \times 700 \times 10^{-3}}$$

$$C = 10.0052 \times 10^{-6}$$

$$\boxed{C = 10\ \mu F}$$