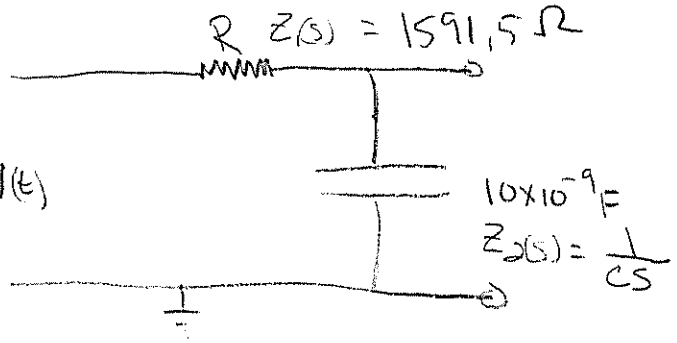
Problem 1.



Cutoff = 10 KHz

$$H(s) = \frac{Z_2}{Z_1+Z_2} = \frac{\frac{1}{Cs}}{\frac{1}{Cs}+R} = \frac{1}{1+RCs} = \frac{\frac{1}{RC}}{s+\frac{1}{RC}}$$

From notes:

$\omega_c = 2\pi F = 20\times10^3\,\pi$

$$\frac{1}{RC} = 20\times10^3\,\pi \Rightarrow R = \frac{1}{(20\times10^3\pi)(10\times10^{-9})} = 1591.5\,\Omega$$

a) see graph

b) $\frac{1}{RC} = \frac{1}{(1591.5)(10\times10^{-9})} = 62834$ $\quad -10\,db = .316$

$$|H(j\omega)| = \frac{62834}{j\omega + 62834} = \frac{62834}{\sqrt{\omega^2+62834^2}} = .316$$

$\omega = 188653 \quad f = \frac{\omega}{2\pi}$ $\quad$ **$f = 29{,}633$ KHz $\approx$ 30 kHz**

c) $\measuredangle H(j\omega) = \measuredangle \text{Top} - \measuredangle \text{Bottom} \Rightarrow 0 - \tan^{-1}\frac{\omega}{62834}$

$45 = \tan^{-1}\frac{\omega}{62834} \quad \omega \approx 62834 \quad f = \frac{\omega}{2\pi}$

f = 10 KHz

Problem #2

a) $Q = .707$ (best Q for 2nd order High Pass)

cut off = 7000π rad/sec because 2000π rad/sec is below cut off and $10{,}000\pi$ rad/sec + $20{,}000\pi$ rad/sec are above the cut off

b) assume $C = 10\ nF$

$$\omega_c = \frac{1}{\sqrt{LC}} \Rightarrow 5000\pi = \frac{1}{\sqrt{L\ 10\times10^{-9}}}$$

$$L = .405\ H$$

$$Q = \frac{1}{R}\sqrt{\frac{L}{C}} \Rightarrow .707 = \frac{1}{R}\sqrt{\frac{.207}{10\times10^{-9}}} \approx 9k$$

c) $$H(s) = \frac{s^2}{s^2 + \frac{\omega_0}{Q}s + \omega_0^2} \Rightarrow \frac{(j\omega)^2}{(j\omega)^2 + j\omega\frac{\omega_0}{Q} + \omega_0^2}$$

$$|H(j\omega)| = \frac{|\omega^2|}{\sqrt{(\omega_0^2 - \omega^2)^2 + \left(\frac{\omega_0}{Q}\omega j\right)^2}}$$

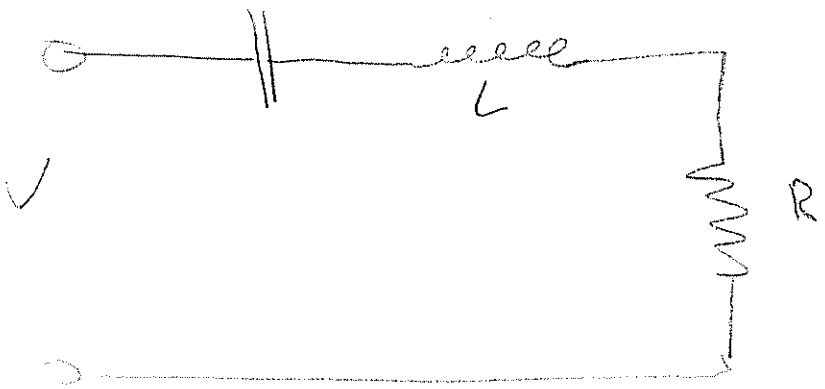
ω	$H(j\omega)$	$\angle H(j\omega)$
2000π	.158	.768
5000π	.707	—
$10{,}000\pi$	.970	−.6399
$20{,}000\pi$	.998	−.9504

$$\angle H(j\omega) = \angle \text{top} - \angle \text{bottom}$$

$$= \tan^{-1}(-1) - \tan^{-1}\frac{\omega_0^2 - \omega^2}{\frac{\omega_0}{Q}\omega}$$

$$y_{ss} = .0158\cos(2000\pi t + 1.82) + .970\cos(10000\pi t - .6399) + 1.098\cos(20000\pi t - .165)$$

Problem #3 100×10^{-12} 9th

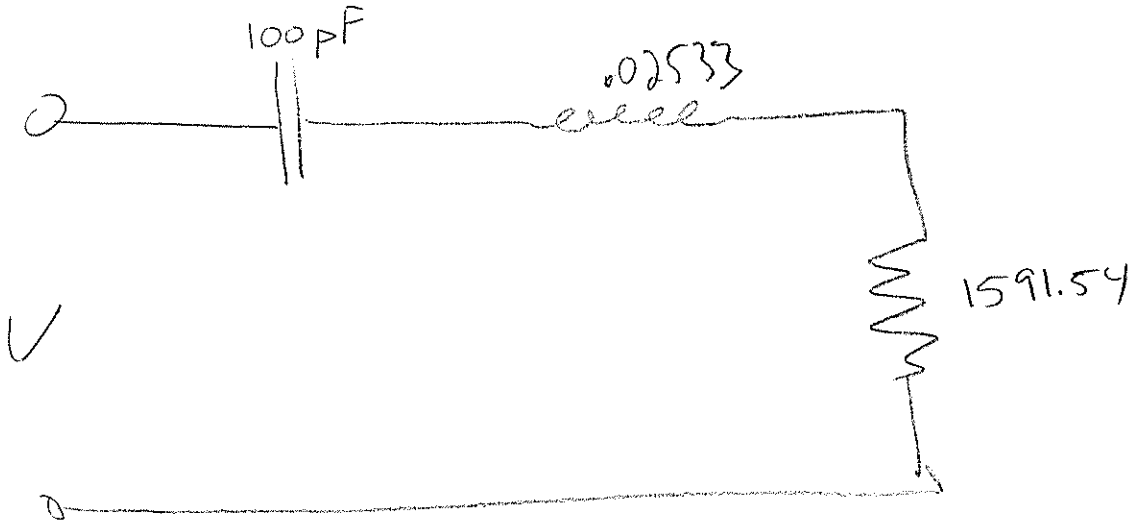


$$Q = \frac{\omega_0}{\text{Bandwidth}} = \frac{100{,}000}{10{,}000} = 10$$

Center = 100 kHz

$$2\,100{,}000\,\pi = \frac{1}{\sqrt{L\ 100 \times 10^{-12}}} \qquad L = .02533$$

$$10 = \frac{1}{R}\sqrt{\frac{.02533}{100 \times 10^{-12}}} \qquad R = 1591.54$$



Problem 3 part c

		C	ω	Center f	Q
100×10^{-12}	$\times .80 =$	8×10^{-11}	702486	111804	11.18
100×10^{-12}	$\times .90 =$	9×10^{-11}	662310	105410	10.54
100×10^{-12}	$\times .95 =$	9.5×10^{-11}	644645	102598	10.25
100×10^{-12}	$\times 1.05 =$	11.05×10^{-10}	613180	97590.6	9.76
100×10^{-12}	$\times 1.1 =$	1.1×10^{-10}	599082	95346.9	9.53
100×10^{-12}	$\times 1.2 =$	1.2×10^{-10}	573577	91287.6	9.13

$\omega = \frac{1}{\sqrt{LC}}$

$L = .02533$

$f = \frac{\omega}{2\pi}$

$Q = \frac{1}{R}\sqrt{\frac{L}{C}}$

$R = 1591.54$

$L = .02533$