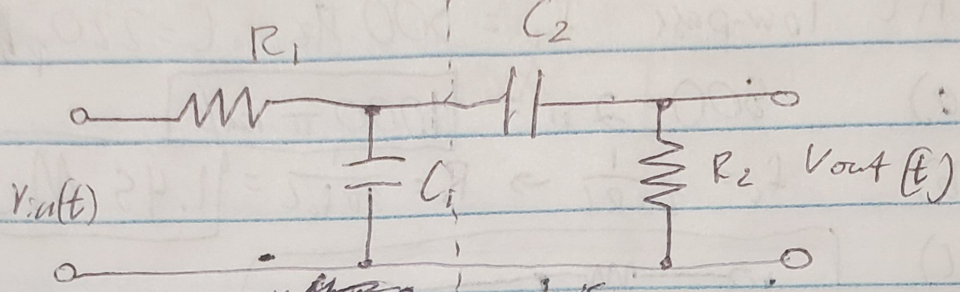
1)



$$H_1(s) = \frac{a_1}{s + a_1} \quad \frac{s}{s + a_2} = H_2(s)$$

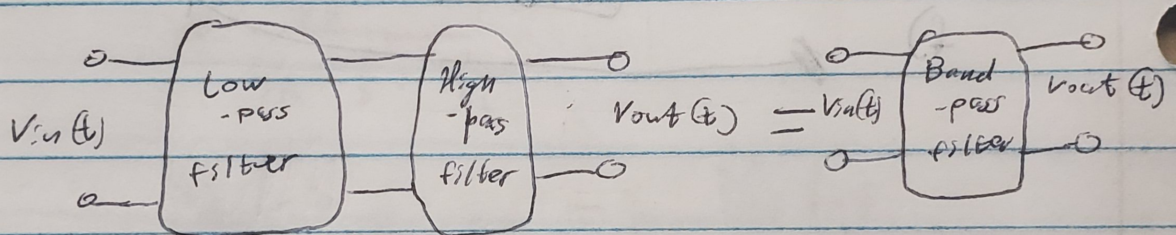
$$a_1 = 1/R_1C_1, \quad a_2 = 1/R_2C_2$$

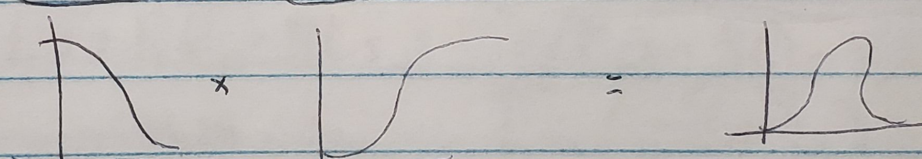
$$H(s) = H_1(s) * H_2(s)$$

a) $$= \frac{s/R_1C_1}{s^2 + s/R_1C_1 + s/R_2C_2 + 1/R_1R_2C_1C_2} = \frac{s/R_1C_1}{s^2 + \frac{(R_1C_1+R_2C_2)}{R_1R_2C_1C_2}s + \frac{1}{R_1R_2C_1C_2}}$$

$$\frac{sR_2C_2}{R_1C_1R_2C_2} + \frac{sR_1C_2}{R_1C_1R_2C_2}$$

b)





$$H_{max} = \sqrt{2} \cdot |H(j\omega_c)|$$

$$H(j\omega) = \frac{j\omega R_1C_1}{\omega^2 + \frac{R_1C_1 + R_2C_2}{R_1R_2C_1C_2} j\omega + \frac{1}{R_1R_2C_1C_2}}$$

$$|H(j\omega)| = \frac{\omega R_1C_1}{\sqrt{\omega^4 + \left(\frac{R_1C_1 + R_2C_2}{R_1R_2C_1C_2} j\omega\right)^2 + \left(\frac{1}{R_1R_2C_1C_2}\right)^2}}$$

$$= \frac{\omega R_1C_1}{\sqrt{j\omega\left(\frac{R_1C_1 + R_2C_2}{R_1R_2C_1C_2}\right) + \left(\frac{1}{R_1R_2C_1C_2} - \omega^2\right)}}$$

$$H(j\omega) = \frac{j\omega R_1C_1}{\left(\frac{R_1C_1+R_2C_2}{R_1R_2C_1C_2}\right)j\omega + \left(\frac{1}{R_1R_2C_1C_2} - \omega^2\right)}$$

$$|H(j\omega)| = \frac{\omega R_1C_1}{\sqrt{\left(\frac{R_1C_1+R_2C_2}{R_1R_2C_1C_2}\,\omega\right)^2 + \left(\frac{1}{R_1R_2C_1C_2} - \omega^2\right)^2}}$$

$\rightarrow \omega = 0,\ |H(j\omega)| = 0$

$\rightarrow \omega = \infty,\ |H(j\omega)| = 0$

$$H_{max} = \frac{R_1C_1\cancel{\omega}}{\frac{R_1C_1+R_2C_2}{R_1R_2C_1C_2}\cancel{\omega}} = \frac{R_1C_1}{1}\cdot\frac{R_1R_2C_1C_2}{R_1C_1+R_2C_2} = \frac{R_1^2R_2C_1^2C_2}{R_1C_1+R_2C_2} \neq 1$$

$$1/R_1R_2C_1C_2 = \omega^2 \rightarrow \boxed{\omega_0 = \frac{1}{\sqrt{R_1R_2C_1C_2}}} \quad \boxed{H_{max} = \frac{1}{\sqrt{2}\sqrt{R_1R_2C_1C_2}}}$$

$$\boxed{\omega_{cL} = \frac{1}{2\pi R_1C_1}} \quad \boxed{\omega_{cH} = \frac{1}{2\pi R_2C_2}}$$

$$\beta = \frac{1}{2\pi R_2C_2} - \frac{1}{2\pi R_1C_1} = \frac{1}{2\pi}\left(\frac{1}{R_2C_2} - \frac{1}{R_1C_1}\right)$$

$$= \frac{R_1C_1}{R_2C_2R_1C_1} - \frac{R_2C_2}{R_1C_1R_2C_2} = \frac{R_1C_1 - R_2C_2}{2\pi R_1C_1R_2C_2}$$

$$Q = \omega_0/\beta = \frac{1}{\sqrt{R_1R_2C_1C_2}}\cdot\frac{2\pi R_1C_1R_2C_2}{R_1C_1-R_2C_2} = \boxed{\frac{2\pi R_1R_2C_1C_2}{(R_1C_1-R_2C_2)\sqrt{R_1R_2C_1C_2}}}$$

14-21 $Q = 2$ $w_0 = 8000$ $C = 5nF$

$\beta = w_0 / Q = 4000$

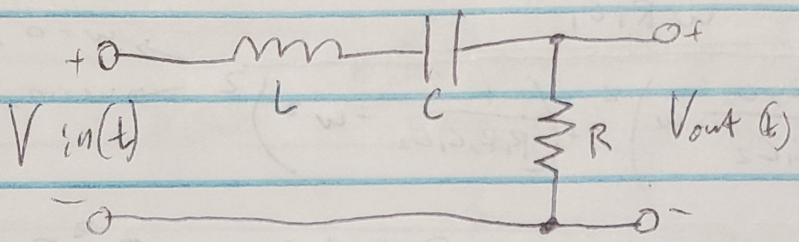
$$w_0 = \frac{1}{2\pi\sqrt{LC}}$$

$$\sqrt{LC} = \frac{1}{2\pi w_0}$$

$$\sqrt{L} = \frac{1}{2\pi w_0 \sqrt{C}}$$

$$L = \left(\frac{1}{2\pi w_0 \sqrt{C}}\right)^2$$

$$= 79\,mH$$



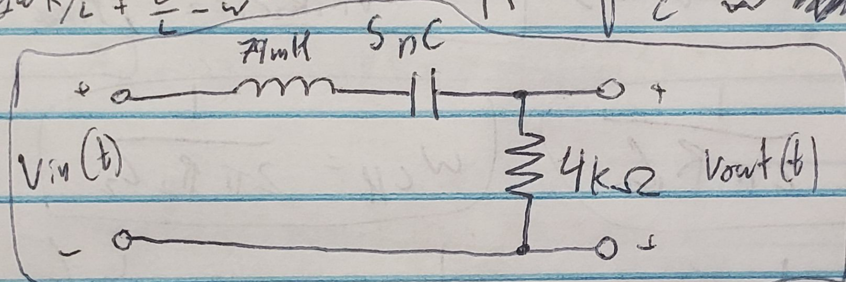
$$H(s) = \frac{R}{LS + \frac{1}{CS} + R} = \frac{SR}{LS^2 + SR + C}$$

$$= \frac{S\,R/L}{S^2 + s\,R/L + C/L}$$

$$H(jw) = \frac{jw\,R/L}{jw\,R/L + \frac{C}{L} - w^2}$$

$$R = \sqrt{\frac{L}{C}} \approx 4K\Omega$$

a)



$$w_{cL} = -\frac{R}{2L} + \sqrt{\left(\frac{R}{2L}\right)^2 + \frac{1}{LC}}$$

$$\approx -25316 + \sqrt{25316^2 + 2531645570} \approx \boxed{31009}$$

$$w_{cH} = \frac{R}{2L} + \sqrt{\left(\frac{R}{2L}\right)^2 + \frac{1}{LC}}$$

$$= 25316 + \sqrt{25316^2 + 2531645570} = \boxed{81641}$$

$R/L =$

$$w_{cH} - w_{cL} = \boxed{50633}$$

14-22

$$V_{out}(t) = A_{in} \cdot |H(jw)| \cdot \cos(wt + \theta_{in} + \angle H(jw))$$

$$V_{in}(t) = 20\cos(wt)$$

$$|H(jw)| = \frac{w\frac{R}{L}}{\sqrt{\left(\frac{1}{LC} - w^2\right)^2 + \left(w\frac{R}{L}\right)^2}} \qquad \angle H(jw) = \tan^{-1}\left(\frac{1}{wRC} - \frac{wL}{R}\right)$$

$$\cancel{= \frac{50633\, w_0}{\sqrt{(2531645570 - w_0^2)^2 + (50633\, w_0)^2}}}$$

$$\cancel{6.4E^{18} - 5063291140\, w_0^2 + w_0^4 + 2563700689\, w_0^2}$$

$$\cancel{|H(jw)| = \frac{50633\, w_0}{\sqrt{w_0^4 - 2499590451 + 6.4E^{18}}}}$$

a) $\boxed{19.998 \cos(50633t - 0.716^\circ)}$

b) $\boxed{14.142 \cos(31009t + 45.000^\circ)}$

c) $\boxed{14.142 \cos(81641t - 44.999^\circ)}$

d) $\boxed{2.035 \cos(5063.3t + 84.159^\circ)}$

e) $\boxed{2.010 \cos(506330t - 84.233^\circ)}$

14-23

$$|H(j\omega)| = \frac{\left|\frac{1}{LC} - \omega^2\right|}{\sqrt{\left(\frac{1}{LC} - \omega^2\right)^2 + \left(\omega \frac{R}{L}\right)^2}}$$

$$\angle H(j\omega) = -\tan^{-1}\left(\frac{\omega RC}{1 - \omega^2 LC}\right)$$

a) $\boxed{0.250 \cos(50633t + 89.284^\circ)}$

b) $\boxed{14.142 \cos(31009t - 44.999^\circ)}$

c) $\boxed{14.142 \cos(81641t + 45.001^\circ)}$

d) $\boxed{19.896 \cos(5063.3t - 5.841^\circ)}$

e) $\boxed{19.899 \cos(506330t + 5.767^\circ)}$