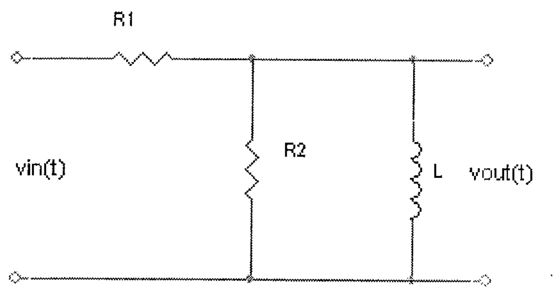
Consider the circuit below. Find:

a) The filter type
b) The value of the maximum voltage gain
c) The 3-dB bandwidth



a) Inductor is short @ low frequencies, so a high-pass circuit

b) By inspection, maximum gain will occur @ $\omega = \infty$,

$$H(s) = \frac{\frac{1}{\frac{1}{R_2}+\frac{1}{sL}}}{R_1 + \frac{1}{\frac{1}{R_2}+\frac{1}{sL}}} = \frac{\frac{R_2 sL}{R_2+sL}}{R_1+\frac{R_2 sL}{R_2+sL}} = \frac{R_2 sL}{R_1R_2+R_1 sL+R_2 sL}$$

$$= \frac{s(R_2 \cancel{L})}{s(R_1L+R_2L)+R_1R_2} = \frac{s\left(\frac{R_2}{R_1+R_2}\right)}{s+\frac{R_1R_2}{(R_1+R_2)L}}$$

$$H_{max} = s(\infty) = \frac{\frac{R_2}{R_1+R_2}}{1} =$$ $V_{divider}$ R_2 & R_1, which is what we would expect.

c. $$H(\omega_c) = \frac{R_2}{\sqrt{2}(R_1+R_2)} = \frac{\left|j\omega_c \frac{R_2}{R_1+R_2}\right|}{\left|j\omega_c + \left(\frac{R_1R_2}{R_1+R_2}\right)\frac{1}{L}\right|} = \frac{\omega_c \frac{\cancel{R_2}}{R_1+\cancel{R_2}}}{\sqrt{\omega_c^2+\left(R_1\|R_2 \frac{1}{L}\right)^2}} = \frac{\cancel{R_2}}{\sqrt{2}(R_1+\cancel{R_2})}$$

$$\frac{1}{\sqrt{2}} = \frac{\omega_c}{\sqrt{\omega_c^2+\left(\frac{R_1\|R_2}{L}\right)^2}} \Rightarrow \frac{1}{2\omega_c^2} = \frac{1}{\omega_c^2+\left(\frac{R_1\|R_2}{L}\right)^2}$$

$$2\omega_c^2 - \omega_c^2 = \omega_c^2 = \left(\frac{R_1\|R_2}{L}\right)^2$$

$$\boxed{\omega_c = \frac{R_1\|R_2}{L}}$$

Very similar to the R/L we are familiar with, except these 2 R's are in ||. Food for thought!