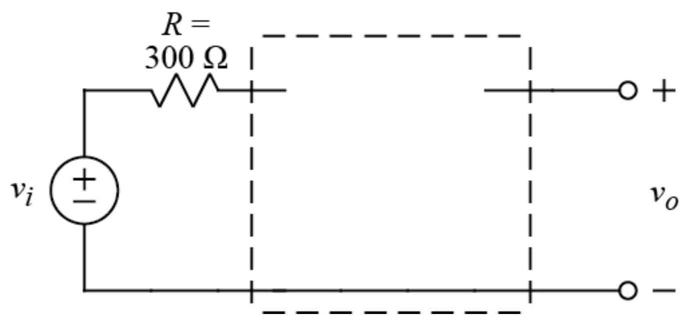
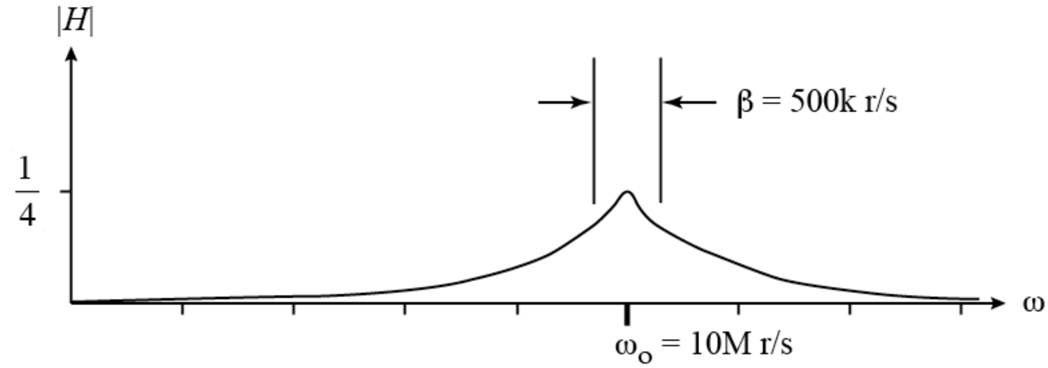
HOMEWORK #4

1.





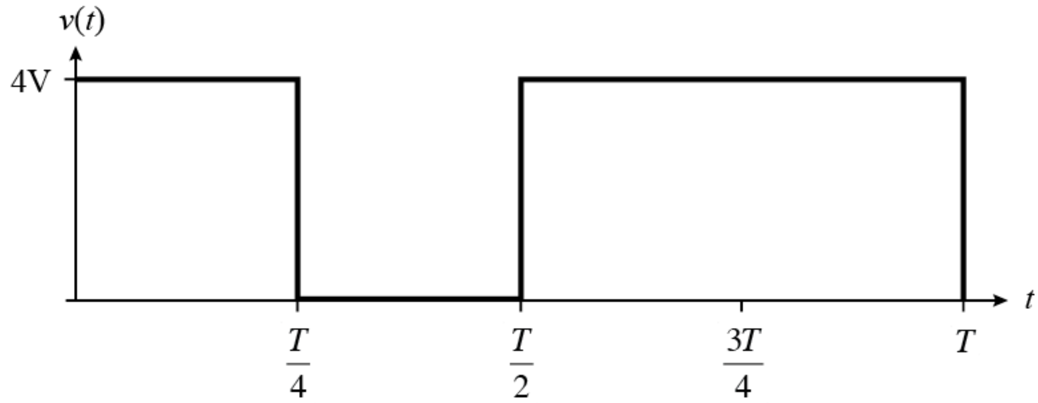
Given the resistor connected as shown and using not more than one each *R*, *L*, and *C* in the dashed-line box, design a circuit to go in the dashed-line box that will produce the **band-pass** |H(*j*ω)| vs. ω shown above. That is:

$$\max_{\omega} |H(j\omega)| = \frac{1}{4} \text{ and occurs at } \omega_0 = 10 \text{ M r/s}$$

The bandwidth, β, of the filter is 500k r/s.

$$|H(j\omega)| = 0 \text{ at } \omega = 0 \qquad \text{and} \qquad \lim_{\omega \to \infty} |H(j\omega)| = 0$$

2.



One period, T, of a function $v(t)$ is shown above. The formula for $v(t)$ is

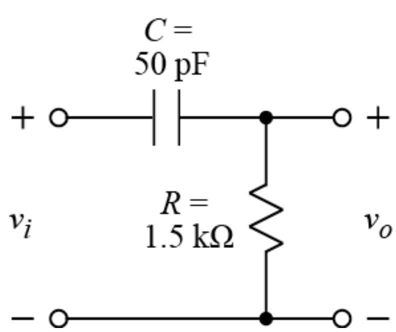
$$v(t) = \begin{cases} 4\text{ V} & 0 < t < T/4 \\ 0\text{V} & T/4 < t < T/2 \\ 4\text{ V} & T/2 < t < T \end{cases}$$

Find the numerical value of the following coefficients of the Fourier series for $v(t)$:

a) a_v b) a_2

3. Find the value of b_2 and b_4 for the Fourier series in problem 2.

4.



$$v_i(t) = -4 + 2\sum_{k=1}^{\infty} \frac{1}{k^2+1} \sin(k\omega_0 t) \text{ V}$$

For the above circuit, determine the transfer function $H(j\omega) = V_o/V_i$.

5. Assume the circuit in problem 4, has the following input signal:

$$v_i(t) = -4 + 2\sum_{k=1}^{\infty} \frac{1}{k^2+1} \sin(k\omega_0 t) \text{ V}$$

Note: $\omega_o = \frac{10}{3}$M r/s for the Fourier series.

Write the time-domain expression of the third harmonic (i.e., $k = 3$) of $v_o(t)$.