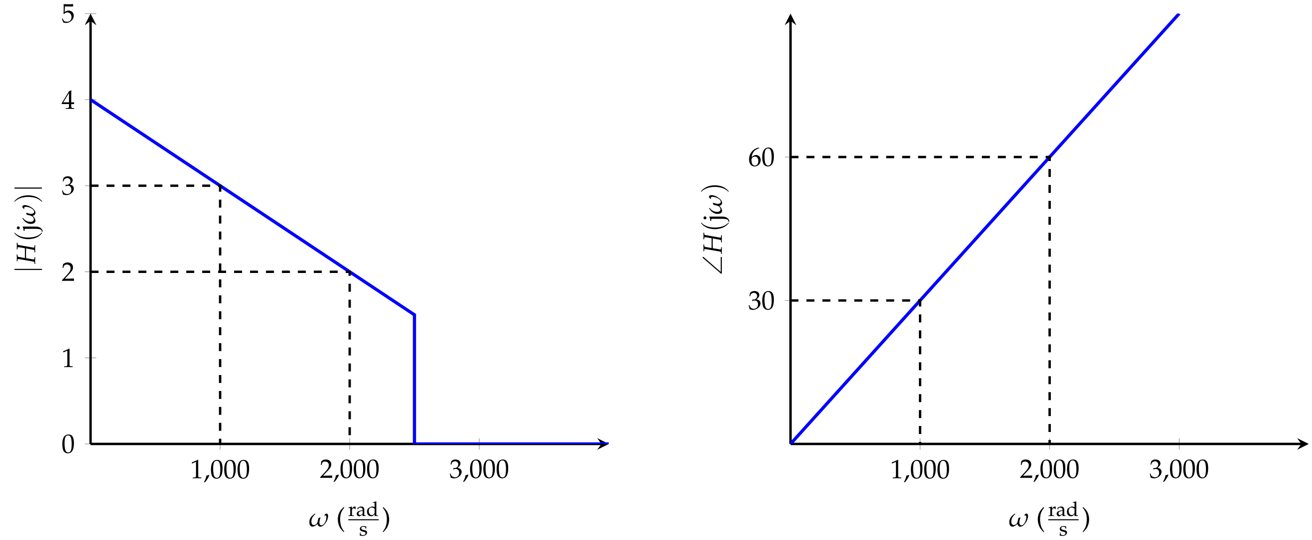
Discussion 4A

1. Using the Transfer Function to Determine the Output (Adapted from Hambley Example 6.1)

The transfer function $H(\mathrm{j}\omega)$ of a filter is shown in Figure 1.



(a) Transfer Function Magnitude

(b) Transfer Function Phase

Figure 1: Transfer Function $H(\mathrm{j}\omega)$

If the input signal is given by

$$v_{\text{in}}(t) = 2\cos(1000t + 40^\circ) + 2\cos(2000t) \tag{1}$$

find an expression for the output of the filter $v_{\text{out}}(t)$.

2. RC Filter (Hambley Example 6.3)

Suppose you have the RC circuit shown in Figure 2.

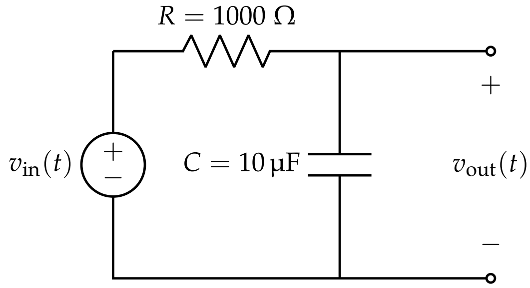


Figure 2: RC Lowpass Circuit

(a) **Determine the transfer function $H(\mathrm{j}\omega)$ of the given circuit. Then, classify what type of filter this circuit is.** Recall that the transfer function $H(\mathrm{j}\omega)$ is defined as the ratio of the output phasor to the input phasor.

$$H(\mathrm{j}\omega) = \frac{\widetilde{V}_{\text{out}}}{\widetilde{V}_{\text{in}}} \tag{2}$$

(b) Suppose, that you are given:

$$v_{\text{in}}(t) = 5\cos(10t) + 5\cos(100t) + 5\cos(1000t) \tag{3}$$

Find an expression for the output signal $v_{\text{out}}(t)$ (please use approximations to simplify the calculations).

3. LR Filter (Hambley Exercise 6.5)

Suppose you are given the following circuit:

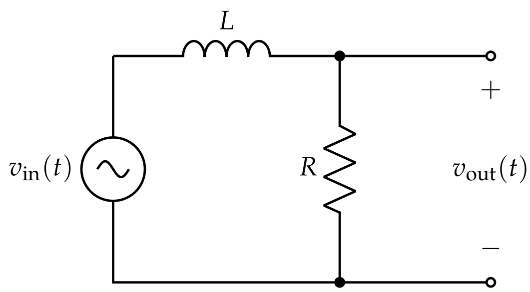


Figure 3: LR Circuit

Derive the transfer function of this filter, classify what type of filter it is, and determine an expression for the cutoff frequency ω_c. (Note: The cutoff frequency can also be called the -3dB frequency, -3dB point, half-power frequency, break frequency, etc. You should be familiar with these equivalent terms since different books and courses may use different terminology to refer to the same concept.)