

Figure 1: Electrical circuit with input voltage  $u_{in}(t)$  and output voltage  $u_{out}(t)$ . The physical parameters of the circuit are the resistances  $R_1$ ,  $R_2$  and the capacitance  $C$ .

Analyze the circuit depicted in Figure 1 above by answering the following questions:

1. Derive the expression for the complex transfer function  $H(s)$  of the circuit. (20 points)
2. Derive the expression for the transfer function magnitude (gain)  $|H(j\omega)|$ . (20 points)
3. What are the transfer function magnitude (gain) values at  $\omega=0$  and  $\omega=\infty$ ? How can these values be explained from the physical properties of the circuit? (20 points)
4. Give the expression for the impulse response  $h(t)$  of the circuit. (20 points)
5. Sketch the transfer function magnitude and the impulse response of the circuit qualitatively in the blank graphs provided in Figure 2. Set the transfer function magnitude at  $\omega = 0$  to 0 dB and the amplitude of the impulse response at  $t = 0$  to 1. (20 points)

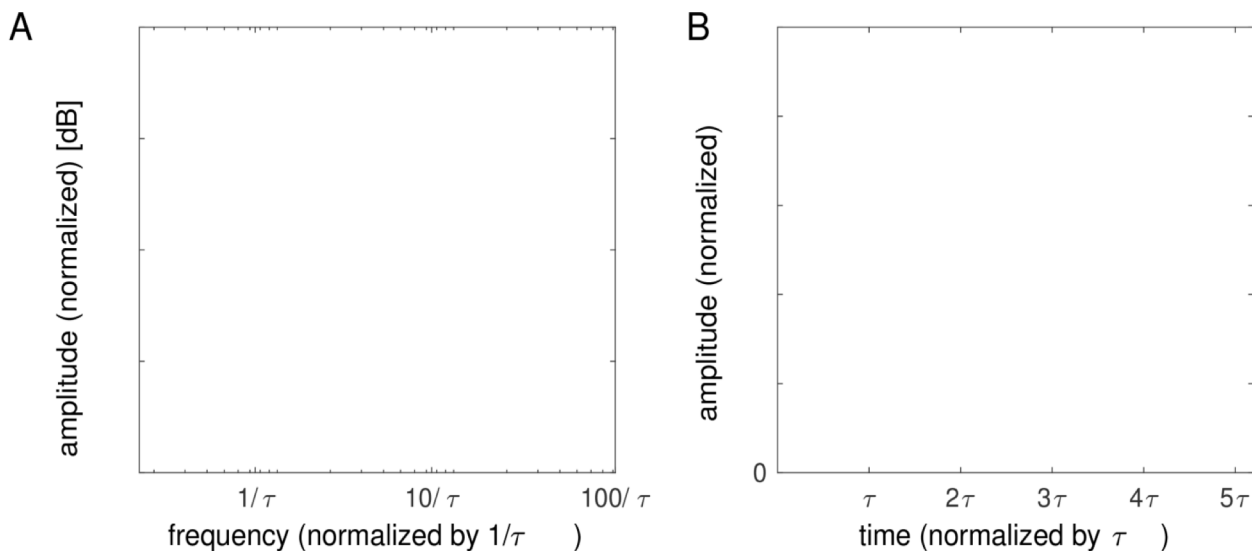


Figure 2: Qualitative sketch of (a) transfer function magnitude and (b) impulse response of the circuit in Figure 1. The frequency axis is normalized by the inverse of the circuit's time constant and the time axis by the time constant.