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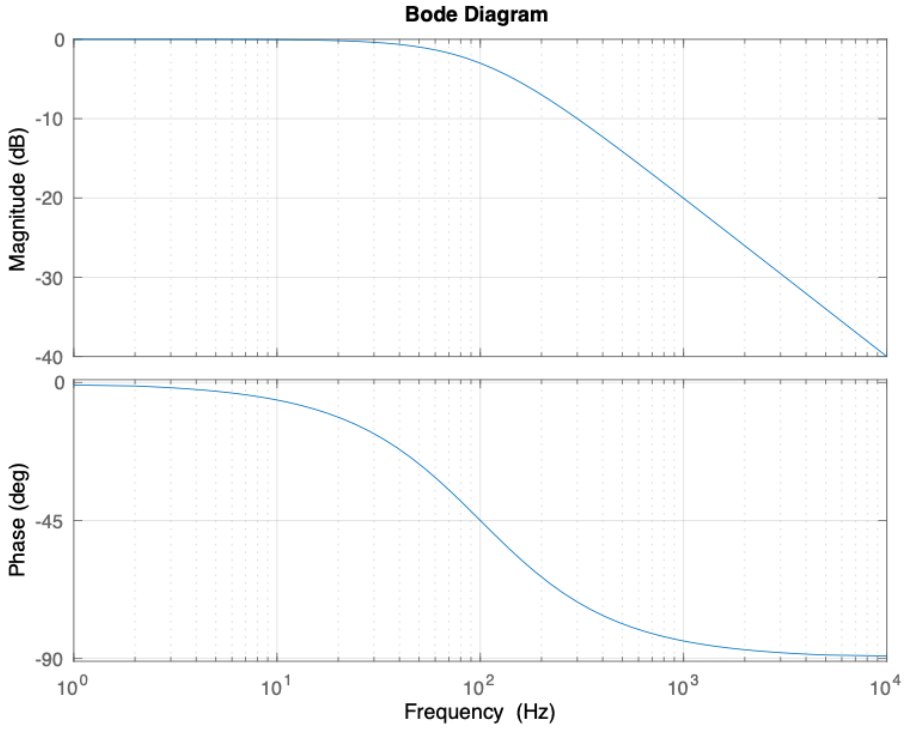
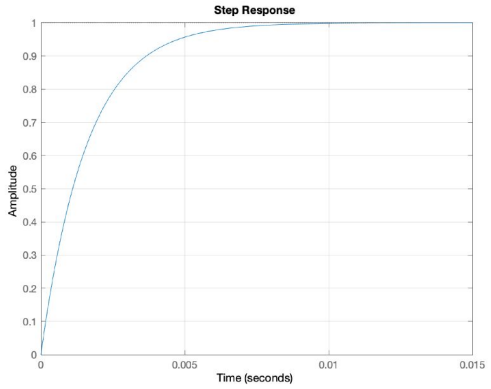
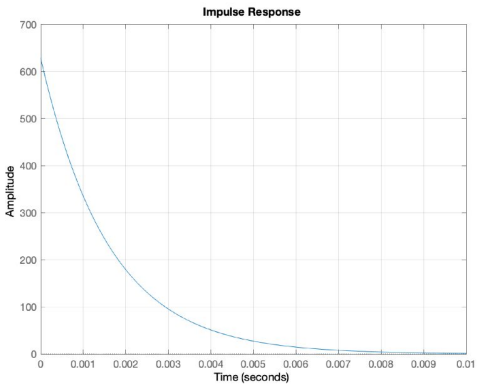
PreLab03:

- **Q1: How many separate voltage comparators are there on the LM319N?**
  - Two (that are independent)
- **Q2: To which pin/pins on the LM319N must we connect the supply voltage?**
  - Supply Voltage: V_{CC} - Pin 11
  - Output to Negative Supply Voltage: V_O - V_{EE} - Pin 6
  - Ground to Negative Supply Voltage: V_{EE}
  - Ground to Positive Supply Voltage: V_{CC}
- **Q3: On which pin/pins can we obtain the output of the LM319N?**
  - Pin 7 - Output 2 and pin 12 - Output 1
- **Q4: Think of a real world application where you could use the LM319N IC. Explain it briefly (in less than four sentences).**
  - We want to turn on the heating when the temperature of the room goes beneath a certain level. For this we use the comparator LM319N so that we can act when our sensor gives us the signal that we are under that desired level. If we use a comparator with a hysteresis we can make sure we don't oscillate (turn heating on and off) when we are near the critical level because we can set a specific temperature level we have to reach before we turn off the heating again.
- **Q5: How much do you think a single LM319N IC costs?**
  - 0.50 CHF (found on Alibaba)
- **Q6: Using MATLAB, plot the bode plot (both magnitude and phase response) of a first order low pass filter with unity gain and a cut-off frequency of 100Hz. Make sure the plots have frequency in unit 'hertz'.**



- **Q7: Plot the impulse and step response of the same transfer function (You can use the functions impulse() and step())**





- **Q8: What's the maximum phase shift introduced by the filter?**
  - Max. phase shift: 90° (from bode plot)
- **Q9: What is the gain at the cut-off frequency?**
  - $H(s) = \frac{1}{1+\frac{s}{\omega_c}} \rightarrow H(s=j\omega_c) = \frac{1}{1+j\frac{\omega_c}{\omega_c}} = \frac{1}{1+j} \rightarrow |H(j\omega_c)| = \frac{1}{\sqrt{1^2+1^2}} = \frac{1}{\sqrt{2}}$
- **Q10: Can the filter be used to change the input frequency of your signal? Why or why not?**
  - No, generally filters can only amplify or attenuate certain frequencies but cannot change the given input frequency itself.
    A filter is basically a change in magnitude and a phase shift of the original input signal. The filter cannot change the frequency because the output is the product of the input and the transfer function, which is merely a complex number with magnitude and phase for any given frequency.