Lab 1: Introduction to Circuit Simulation using SPICE

January 9, 2019   6:08 PM

Preparation
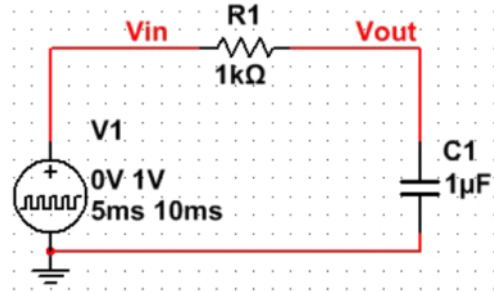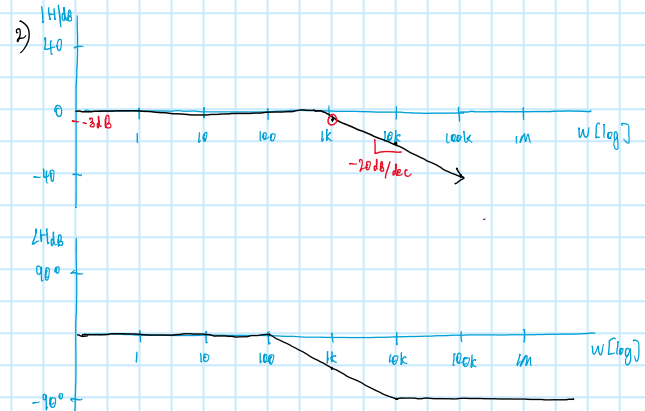
PE: 1, 2

Fig. 1: RC Circuit.

- Compute time constant, τ
- Sketch bode plot for $T(j\omega) = \dfrac{V_{out}}{V_{in}}$
  - Indicate -3 dB point

1) τ
$$\tau = RC$$
$$= (1k)(1\mu)$$
$$= 1ms$$

$$W_o = \frac{1}{\tau}$$
$$= 1k$$

$$\frac{V_0}{V_i} = \frac{Z_c}{Z_c + R_1}$$
$$= \frac{1}{1 + R_1(sC)}$$
$$= \frac{1}{1 + \frac{s}{1000}}$$

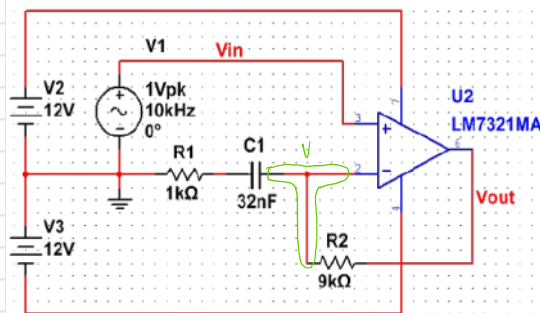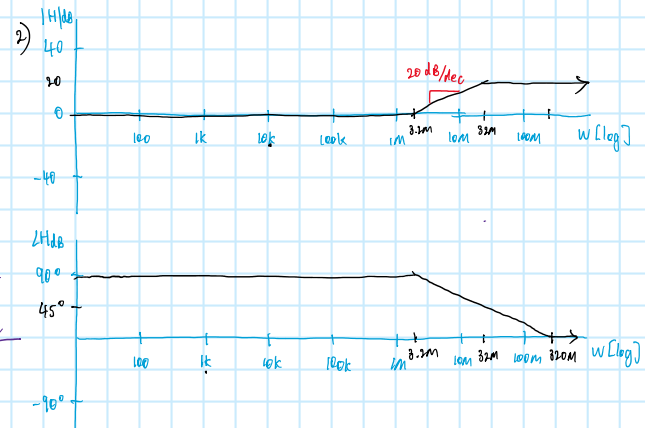2) bode plot $|H|dB$, 40, 0, $-3dB$, $-20dB/dec$, $\angle H dB$, $90°$, $-90°$

PE: 3

Fig. 2: Op-amp Circuit.

- Sketch $|T|$ as a bode plot
  - Indicate -3 dB point
- High-pass / low-pass / band-pass / notch filter?

1) $\dfrac{V_o}{V_i}$

$$\frac{V_0}{V_i} = 1 + \frac{R_2}{R_1}$$
$$= 1 + \frac{R_2}{R_1 + Z_1}$$
$$= \frac{R_1 + R_2 + Z_1}{R_1 + Z_1}$$
$$= \frac{1 + \frac{R_1 + R_2}{Z_1}}{1 + \frac{R_1}{Z_1}}$$
$$= \frac{1 + (R_1 + R_2)sC}{1 + (R_1)sC}$$
$$= \frac{1 + (32E-5)s}{1 + (32E-6)s}$$

2) bode plot $|H|dB$, 40, 20, 0, $20dB/dec$, $\angle H dB$, $90°$, $45°$, $-90°$

Part 1 RC Circuit

1.1 Transient Simulations

- E13. How does τ measured by the cursors compare to the theoretical value? What are some sources of error?

1.1 Part 2 Op-Amp Circuit

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1.2 Netlists
- E1. How are passive components (resistors/capacitors) represented? Explain the relationship between net names in the schematic and numbers in the netlist. What units for parameter values are used in SPICE netlists?

1.3 AC Simulations and Bode Plots
- What is the -3 dB frequency computed from the graph? How does it differ from the analytically computed point? What is the effect of the "Number of points per decade" parameter?

Part 2 Op-Amp Circuit
2.1 Circuit Characterization
- E4. Is there any non-ideality illustrated in this model? Describe how changing the power supply voltages affects the output.

- E5. Choose frequency ranges based upon the calculated value in the lab preparation.

- E6. How well do the simulated -3dB point values relate to the calculated values?

- E7. Explain how the changes in circuit behaviour relate to the circuit transfer function as determined in the preparation and above in the AC analysis.

1.2 Component and Parameter Variation

2.2 Component and Parameter Variation

- E11. What is the effect of variation of R1 on the circuit behavior?

- E12. What is an acceptable range for R1 in this circuit?

- E13. Repeat the above analysis for C1 to meet the same $|T(j\omega)|$ requirements. Assume that C1 is available with tolerances of ±30%