ITESO

Electronics II
(02 SE048)

Lab Experiment 2:
Frequency Response

Objectives

The general objective of this experiment is to contrast the frequency response calculations made by hand with those obtained from circuit simulation. Other more specific objectives are:

a) to reinforce the application of the Open-circuit and Short-circuit Time Constant Methods for calculating the cutoff frequencies of an amplifier

b) to compare the frequency responses of the common-emitter and cascode amplifiers

c) to practice frequency response calculations (AC steady state analysis) using computer simulations.

Components and Instrumentation

A circuit simulation software: WinSpice, Electronic Work Bench, or something similar.

Theoretical Procedure, Part A

For the common-emitter amplifier shown in Fig. 1,

A.1.   Calculate all the DC voltages and currents

A.2.   Calculate the midband voltage gain v_o/v_s and input impedance v_s/i_s

A.3.   Calculate the distorsion limits for the output voltage v_o (maximum ouput voltage swing)

A.4.   Calculate the cutoff low and high frequencies.

Simulation Procedure, Part A

Using the selected software, enter to the simulator the circuit shown in Fig. 1. Make sure the BJT is using the model of a 2N3904.

A.5.   Perform transient analysis considering a sinusoidal voltage source of 10 mV of amplitude and 10KHz. Plot the input voltage v_s and the output voltage v_o, from 0 to 1 ms. Plot the collector voltage v_C from 0 to 1 ms. From these plots, what is the voltage gain at 10KHz?, what is the DC collector voltage V_C?
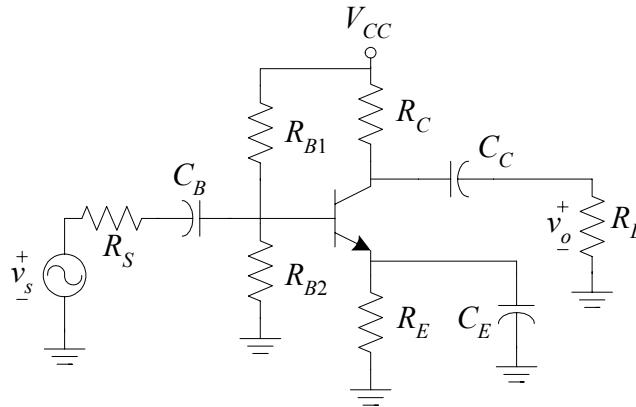
Fig. 1   Common-emitter amplifier: $R_S = 330\Omega$, $R_{B1} = 8K\Omega$, $R_{B2} = 4K\Omega$, $R_C = 6K\Omega$, $R_E = 3.3K\Omega$, $R_L = 4K\Omega$, $C_B = 1\mu F$, $C_E = 10\mu F$, $C_C = 1\mu F$, $V_{cc} = 12V$, Q: 2N3904.

A.6.   Perform transient analysis considering a sinusoidal voltage source of 1 V of amplitude and 10KHz. Plot the input voltage v_s and the output voltage v_o, from 0 to 1 ms. From these plots, what are the distorsion limits of the output voltage?

A.7.   Perform AC analysis from 10Hz to 100MHz. Plot the $|v_o/v_s|$ and $|v_o/v_s|$ in dB. Plot the input impedance $|v_s/i_s|$. From these plots, what is the voltage gain at mid frequencies? What are the cutoff frequencies f_L y f_H?, what is the amplifier's bandwidth?

A.8.   Perform AC analysis from 1 KHz to 100 KHz. Plot the input impedance $|v_s/i_s|$. What is the input impedance at mid frequencies?

A.9.   Create a table to display the simulaled quantities and the corresponding calculated quantities obtained in the theoretical procedure. Show in that table the corresponding percentage of error. Label this table as "Table I".

Theoretical Procedure, Part B

For the cascode amplifier shown in Fig. 2,

B.1.   Calculate all the DC voltages and currents

B.2.   Calculate the midband voltage gain v_o/v_s and input impedance v_s/i_s

B.3.   Calculate the distorsion limits for the output voltage v_o (maximum ouput voltage swing)

B.4.   Calculate the cutoff high frequency ω_H.
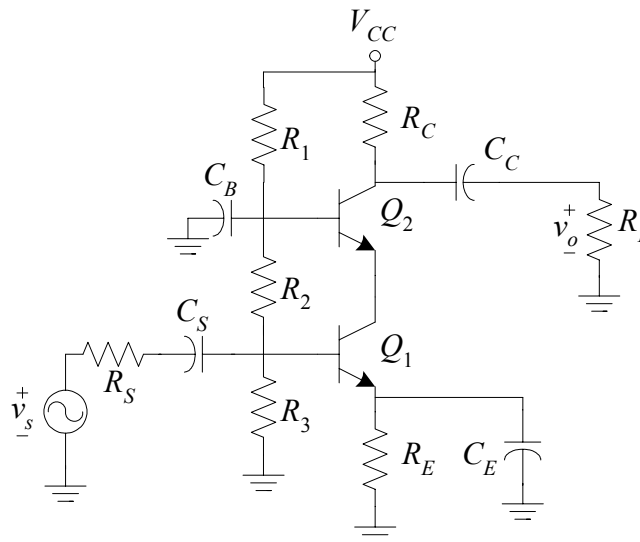
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Fig. 2. Cascode amplifier: $R_S = 330\Omega$, $R_1 = 18K\Omega$, $R_2 = 4K\Omega$, $R_3 = 8K\Omega$, $R_C = 6K\Omega$, $R_E = 3.3K\Omega$, $R_L = 4K\Omega$, $C_S = 1\mu F$, $C_B = 10\mu F$, $C_E = 10\mu F$, $C_C = 1\mu F$, $V_{cc} = 15V$, Q_1, Q_2: 2N3904.

Simulation Procedure, Part B

Using the selected software, enter to the simulator the circuit shown in Fig. 2. Make sure both BJTs are using the model of a 2N3904.

B.5.   Perform transient analysis considering a sinusoidal voltage source of 10 mV of amplitude and 10KHz. Plot the input voltage v_s and the output voltage v_o, from 0 to 1 ms. Plot the collector voltage v_{C2} from 0 to 1 ms. From these plots, what is the voltage gain at 10KHz?, what is the DC collector voltage V_C?

B.6.   Perform transient analysis considering a sinusoidal voltage source of 1 V of amplitude and 10KHz. Plot the input voltage v_s and the output voltage v_o, from 0 to 1 ms. From these plots, what are the distorsion limits of the output voltage?

B.7.   Perform AC analysis from 10Hz to 100MHz. Plot the $|v_o/v_s|$ and $|v_o/v_s|$ in dB. Plot the input impedance $|v_s/i_s|$. From these plots, what is the voltage gain at mid frequencies? What are the cutoff frequencies f_L y f_H?, what is the amplifier's bandwidth?

B.8.   Perform AC analysis from 1 KHz to 100 KHz. Plot the input impedance $|v_s/i_s|$. What is the input impedance at mid frequencies?

B.9.   Create a table to display the simulated quantities and the corresponding calculated quantities

obtained in the theoretical procedure. Show in that table the corresponding percentage of error. Label this table as "Table II".

Report

Write a report including all the theoretical and lab procedures as well as your conclusions. Make sure to include in your report the 2 tables described before. For each table, indicate the percentage of error of the quantities measured with respect to those calculated theoretically.

Deadline and Assessment

The deadline for submitting the report is on Wednesday October 15, 2003. The report can be written either in English or in Spanish.

This lab experiment can be realized in teams of up to 3 students. The evaluation of the report will be as follows:

Quality of the report	30%
Accuracy of the theoretical analysis	30%
Simulation procedures	40%

If the report is written in acceptable English, an extra 10% can be granted.