**Electronics II**
**(02 SE048)**

**Lab Experiment 3:**
**Feedback and Stability**

## Objectives

The objectives of this experiment are:

a) to reinforce the application of the feedback analysis technique for estimating the performance of practical feedback amplifiers

b) to compare the accuracy of the feedback analysis technique with respect to direct analysis as well as to full circuit simulation

c) to practice feedback amplifiers analysis using simulation software.

## Components and Instrumentation

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

## Theoretical Procedure

For the feedback amplifier shown in Fig. 1,

1. Calculate the DC output voltage $V_o$, assuming that the DC component of the source voltage $v_s$ is zero. Fill in the second column of Table I.
2. Direct analysis of the feedback amplifier:
    a. Draw a low-frequency equivalent circuit for the whole amplifier
    b. Analize the equivalent circuit obtained in the previous step and derive its voltage gain $v_o/v_s$ and its input impedance $v_s/i_s$. Fill in the second column of Table II.
3. Analysis of the amplifier using feedback concepts:
    a. What kind of feedback is the original amplifier using? (Series-Shunt, Series-Series, etc.)
    b. Calculate the transfer function of the feedback network $B$
    c. Assuming that the amount of feedback is large, estimate the low-frequency current gain $i_o/i_s$, the input impedance $v_s/i_s$, and the voltage gain $v_o/v_s$. Fill in the second column of Table III.
    d. Calculate the transfer function of the the basic amplifier $A$' without feedback, but taking into account the loading of the feedback network
    e. Calculate the input impedance $R_i'$ of the amplifier without feedback, but taking into

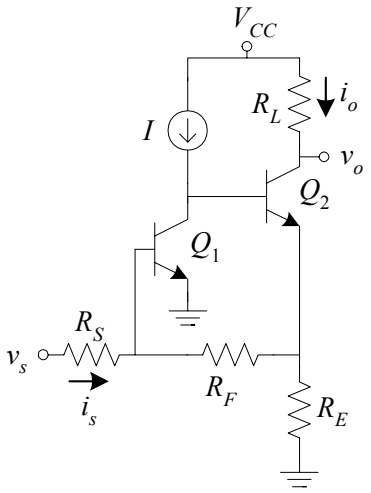


Fig. 1. Feedback amplifier: $R_S$ = 1KΩ, $R_F$ = 10KΩ, $R_E$ = 100Ω, $R_L$ = 100Ω, $V_{cc}$ = 18V, $I$ = 1mA, $Q_1$, $Q_2$: 2N3904.

account the loading of the feedback network

f. Re-calculate the current gain $i_o/i_s$, the input impedance $v_s/i_s$, and the voltage gain $v_o/v_s$ using the information obtained in the previous steps b, d and e. Fill in the second column of Table IV.

**Simulation Procedure**

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

4. Perform transient analysis considering a sinusoidal voltage source of 100 mV of amplitude and 1KHz. Plot the input voltage $v_s$ and the output voltage $v_o$, from 0 to 5 ms. Plot the output voltage $v_O$ from 0 to 5 ms. From these plots, what is the voltage gain at 1KHz?, what is the DC output voltage $V_O$?
5. Perform AC analysis from 10Hz to 900MHz. 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 low and mid frequencies? What is the cutoff frequency $f_H$?, what is the amplifier's bandwidth?
6. Create and fill in four tables with the following entries:

Table I

| Parameter | Estimated | Simulated | Error (%) |
|---|---|---|---|
| $V_O$ (DC value) | | | |

Table II

| Parameter | Estimated by direct calculation | Simulated | Error (%) |
|---|---|---|---|
| $\lvert v_o/v_s \rvert$ (low frequencies) | | | |
| $\lvert v_s/i_s \rvert$ (low frequencies) | | | |

Table III

| Parameter | Estimated assuming $AB >> 1$ | Simulated | Error (%) |
|---|---|---|---|
| $\lvert v_o/v_s \rvert$ (low frequencies) | | | |
| $\lvert v_s/i_s \rvert$ (low frequencies) | | | |

Table IV

| Parameter | Estimated by calculating $A$' and $B$ | Simulated | Error (%) |
|---|---|---|---|
| $\lvert v_o/v_s \rvert$ (low frequencies) | | | |
| $\lvert v_s/i_s \rvert$ (low frequencies) | | | |

**Report**

Write a report including all the theoretical and simulation procedures as well as your conclusions.

**Deadline and Assessment**

The deadline for submitting the report is on Monday November 17, 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.