Your report has five sections:

- **Introduction**, explain the benefits of using feedback in amplifiers in one paragraph.

- **Theory**, draw the schematic (Fig. 1, page 3.3 of the lab manual) in your report and write the value of each component beside it. You have calculated the values of components based on the given requirements in the manual (DC supplies: +10V and -10V, I_{CQ1}=I_{CQ2}=I_{CQ3}=1mA, \( V_{EQ4}=0V \), \( R_1=500\Omega \), \( R_4=R_5=R_8=5k\Omega \), \( R_{11}=2.2k\Omega \), output swing of +5.5V and -5.5V, transistors are 2N3904(npn) and 2N3906(pnp)). By hand calculations, find the collector bias current of Q4, and Q5, also find the bias voltage of all the nodes in the circuit. Write these values neatly on the schematic with a different color, so you may want to draw the schematic as big as possible in a landscape format. Find the open-loop gain, input resistance (seen from \( R_1 \) to right), and output resistance (seen from \( R_{11} \) to the left) of the circuit. Nodes 2 and 10 have a DC value of 0V so connecting the feedback resistor between them won’t disturb the biasing of the circuit. Calculate the value of the feedback resistor to give a voltage gain of 20 from node 1 to node 10. Assuming the feedback resistor is connected in the circuit, find the closed-loop input resistance, and output resistance. (all values are expected only at mid-frequencies.)

- **SPICE**: draw the circuit (with feedback resistor) in spice schematic editor, use parts named Q2N3904/EVAL & Q2N3906/EVAL as your NPN and PNP transistors. Make sure the values that you’re using for the resistors are the one that you’ve measured from trimming the resistors on your hybrid circuit board. Run "bias point analysis", show the bias points on the schematic then print it. (show node voltages and branch currents on the schematic). Run "ac analysis" and plot the transfer function of your circuit (\( V_{10}/V_1 \)) using spice (for both with and without feedback resistor cases). Use decade scale for your frequency axis and dB for your amplitude. Use enough points in your spice analysis so that you see a smooth plot. Find the upper and lower -3dB frequencies on your plot and write them on the plot (for both with and without feedback resistor cases). Check if your circuit can swing +5V and -5V at the output without clipping (run a "transient analysis"). Plot the input impedance (seen from \( R_1 \) to right) and output impedance (seen from \( R_{11} \) to the left) of your circuit as a function of frequency (for both with and without feedback resistor circuits), what are their values at 10 kHz? Attach all the schematics, plots, and results to the report.

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• Measurement: basically repeat whatever that you did in the SPICE part in the lab and compare the results with the SPICE results and theory in a three-column table. This means measuring DC bias points, transfer function of your circuit \( \frac{V_{10}}{V_1} \) for both without and with feedback DC bias points, transfer function of your circuit \( \frac{V_{10}}{V_1} \) for both without and with feedback resistor in the circuit, the input impedance at 10 kHz (seen from R1 to right) and the output impedance at 10 kHz (seen from R11 to the left) for both without and with feedback resistor in the circuit, and the upper -3dB frequency of circuit transfer function \( \frac{V_{10}}{V_1} \) for both without and with feedback resistor in the circuit. Also measure the maximum voltage swing at the output. In the table, report the gains at 10 kHz and in a plot show \( \frac{V_{10}}{V_1} \) from SPICE and measurement for both without and with feedback resistor in the circuit.

• Conclusion, in a paragraph, write what you have learned from this experiment.

Few general rules about writing your reports:
1. A lab report shall be concise, brief, and to-the-point.
2. Long reports with unnecessary description of theory or the procedure are strongly discouraged.
3. Reports shall be typed and the graphs shall be drawn by computer. Make sure that the graphs are large enough to show the details.
4. There shall be a cover page for the report with your name, your partner’s name, your SIDs, experiment name, and delivery date on it.

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Ali Karimi, 28th February 2005