Multi-Stage Amplifier with Feedback Analysis

This project consists of design the circuit below. Instead of an operational amplifier chip, you are to design a two stage differential operational amplifier with discrete transistors. You can use multi-stages, with a minimum of two stages. The overall gain should be 20dB. There may not be any distortion for a 0.5V input signal.

The load will be a resistor equal around 200ohm. (This load is not shown below).

You may design the operational amplifier using any configuration that you desire. If you would like a starting place, you may choose the following configuration:

There are also several examples in the text which include Example 7.4-7.6, or Fig. 9.1, or you may implement the 741 discretely from Fig. 9.13.
Whichever configuration that you choose, you will need to supply the following:

Differential amplifier without feedback:
- DC analysis to determine all voltages and currents in all branches of your amplifier.
- Determine $R_i$, $R_o$, and gain, $A_{vo}$ for your differential amplifier. (i.e. you want to turn the multi-stage circuit into the following model:)

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\[ V_i R_i \quad A_{vo} V_i \quad V_o \]
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- Determine Bode Plot for your configuration (you just need to get the midband gain and cutoff frequency)

Differential amplifier with feedback:
- Perform feedback analysis by identifying the feedback topology and doing a theoretical analysis for $R_{11}$, $R_{22}$, and $\beta$, the A-circuit midband gain with feedback, $A_f$, $R_{in}$, and $R_{out}$.
- Measure the overall gain $A_f$, $R_{in}$, and $R_{out}$ and compare your theoretical values with your measured values.
- Determine the Bode plots (midband gain and cut-off frequencies) for the circuit with feedback.
- Comment on the effects of the negative feedback in terms of linearity, voltage gain and amplifier bandwidth.

- Build the feedback circuit with a 741 operational amplifier and compare results of this circuit with your differential amplifier with feedback in terms of linearity, voltage gain and amplifier bandwidth.