ECS Undergraduate

Problem #1:

An operational amplifier is used to make a feedback amplifier as shown above. Its open-loop Bode gain plot is approximated as sketched on the right side with straight lines. Assume that the second pole frequency $\omega_{p2}$ of the open-loop transfer function is the same as the unity-gain frequency.

1. What is the low-frequency gain of this amplifier?

2. Estimate the bandwidth of this amplifier.

3. Using the same straight-line approximation, sketch the frequency response of the amplifier on the same plot, and mark important points with proper gain and frequency.

4. Approximate the phase margin of this feedback configuration.

5. Repeat the above questions 2 and 3 if the feedback resistor $R_2$ is bypassed using a 100pF capacitor.
Problem #2:

A BJT amplifier is shown with the input bias voltage \( V_i \) to set the collector current. Both the input and output small signals are marked as the low-case \( v_i \) and \( v_o \), respectively. Neglect other parameters unless specified except for the followings: \( kT/q = 25 \text{mV} \), \( V_{BE} = 0.7 \text{V} \), \( V_{CEsat} = 0.2 \text{V} \). First assume that the emitter resistor \( R_E \) is set to 0.

1. Sketch the DC transfer function of \( V_o \) vs. \( V_i \) in the above space, and add proper voltage scales.

2. If the DC bias voltage \( V_i \) is applied to set the collector current to be 1mA, what is the output DC voltage?

3. Estimate the low-frequency small-signal voltage gain \( v_o/v_i \) and the -3dB bandwidth.

4. Estimate \( V_i \) to set the collector current to be 1mA if the emitter resistance \( R_E \) is 1k\( \Omega \).

5. Repeat the above question 3 with the emitter resistance \( R_E \) set to 1k\( \Omega \).