1. Explain in your own words:
   a. What is a DC signal? Give an example
   b. What is an AC signal? Give an example

2. The amplifier has: $A_v = 50$, $R_i = 200k$, $R_o = 1k$
   (a) Evaluate the overall voltage gain ($\frac{v_o}{v_s}$). Express your answer in factor form and in dB form.
   (b) Evaluate the overall current gain ($\frac{i_o}{i_s}$). Express your answer in factor form and in dB form.
   (c) Evaluate the overall power gain ($\frac{P_o}{P_s}$). Express your answer in factor form and in dB form.
   (d) What is the output voltage (peak-to-peak)?
   (e) A $2k\Omega$ resistor is placed in parallel with the load resistor. What is the new output voltage (peak-to-peak)?
4. You have two amplifiers, a & b (one of each) with the following characteristics:

amplifier a:  \( R_{ia}=1\,\text{k}\Omega \)  \( A_{voa}=5 \)  \( R_{oa}=20\,\Omega \)  
Clipping levels:  \( L_a=\pm12\,\text{V} \) (unloaded)

amplifier b:  \( R_{ib}=20\,\text{k}\Omega \)  \( A_{vob}=20 \)  \( R_{ob}=500\,\Omega \)  
Clipping levels:  \( L_b=\pm12\,\text{V} \) (unloaded)

Let \( R_s=20\,\text{k}\Omega \) and \( R_L=40\,\Omega \)

(a) Redraw the above circuit by replacing each amplifier with its model. Place the amplifiers in order (a first, then b; or b first, then a) to maximize the overall gain \( \frac{v_{out}}{v_S} \). Show the values of all the parts.

(b) Find the overall gain \( \frac{v_{out}}{v_S} \). Express your answer in two ways – as a factor \( \frac{V}{V} \) and in dB.

(c) I don’t want clipping at the output \( v_{out} \). What is the maximum input voltage \( v_S \)? Express your answer in \( \text{V}_{pp} \)(peak-to-peak voltage).

5. Draw the Bode plot of the filter circuit below. \( v_{in} \) is the input and \( v_o \) is the output of this circuit.
6. Sedra&Smith book: 2.15, 2.16, 2.49, 2.72

7. You are given the following characteristics for a real amplifier along with the circuit on the right.

**Op amp Characteristics**
- Input offset voltage: $V_{ios} = 2.0 \text{ mV}$
- Input offset current: $I_{os} = 100 \text{ nA}$
- Input bias current: $I_{ib} = 500 \text{ nA}$
- Input resistance: $R_i = 2 \text{ MΩ}$
- Output resistance: $R_o = 75 \text{ Ω}$
- Open-loop gain: $A_{o1} = 106 \text{ dB}$
- Unity-gain bandwidth: $f_T = 4 \text{ MHz}$
- Output swing limits: within 2 V of supplies
  - $V_{+} = V_{+} - 2V$
  - $V_{-} = V_{-} + 2V$
- Slew rate: $SR = 2 \frac{V}{\mu s}$

(a) What is the voltage gain of the circuit? (make sure the sign is right)
(b) For small input signals, what is the bandwidth of the circuit?
(c) For an output signal of 12Vpp, what is the bandwidth of the circuit?
(d) What is the maximum peak-to-peak output you can get without clipping?
(e) What is the input impedance?
(f) What is the output impedance?
  
  Hint: Express $A_{o1}$ as a factor, then use the following expression to find the output impedance with feedback

  $$R_{owf} = \frac{R_o}{1 + A_{o1} \frac{R_1}{R_1 + R_2}}$$

(g) Find the effect of the input offset voltage ($v_{in}=0V$).
(h) How should the circuit be modified to minimize the effect of the input bias current? Show the modification on the schematic above and find the value of any added parts.