1. Consider the two multistage amplifiers shown below.

a. Express $V_x$, $V_y$, and $V_o$ in terms of $V_s$ and resistances for the upper amplifier.

b. Express $V_x$, $V_y$, and $V_o$ in terms of $V_s$ and resistances for the lower amplifier.
2. Consider the circuit in Figure 1. Sketch each of the following variables as \(v_{in}\) is varied over the domain \([0, 4]\): \(v_{out}\), \(v_{-}\), \(i_{in}\). Include equations and/or annotate your sketches so that slopes of the various line segments in your graphs are obvious.

3. Consider again the circuit in Figure 1. Sketch \(v_{out}(t)\) corresponding to each of the three \(v_{in}(t)\) waveforms shown in Figure 2.

4. Problem 4.24 of the text.

5. Problem 4.30 of the text.
6. Problem 5.1 of the text.
7. Problem 5.9 of the text.
8. Problem 5.14 of the text.
9. Suppose that the op amp in Figure 3 saturates at ±12 V. Sketch the region in the $V_{s1}-V_{s2}$ space where operation of the overall amplifier remains linear.
10. Problem 5.20 of the text.
11. Problem 5.28 of the text.
12. Problem 5.34 of the text.
13. Problem 6.2 of the text. You may sketch the plot of $P_L$ vs $R_L$ rather than using MATLAB or another software package.
14. Problem 6.7 of the text.
15. Problem 6.11 of the text. You may solve the network equations using any method (i.e., you are not required to use MATLAB).

![Figure 3.](image)
Homework 5  
EE 210  
Section ____

Name_______________________

1.

![Circuit Diagram](image-url)

\[ V_x \]

\[ V_y \]

\[ V_o \]
2. The circuit diagram shows an operational amplifier with input voltage $v_{in}$, output voltage $v_{out}$, and feedback resistor $50 \, k\Omega$. The input voltage $v_{in}$ is connected to a $10 \, k\Omega$ resistor. The voltage levels are $+15 \, V$ and $-15 \, V$. The graphs represent the relationship between $v_{out}$ and $v_{in}$, $v_{-}$ and $v_{in}$, and $i_{in}$ and $v_{in}$.
3.

The circuit diagram shows an operational amplifier with input and output terminals labeled. The amplifier has two inputs, $v_{in}^+$ and $v_{in}^-$, and one output, $v_{out}$. The amplifier is connected to a voltage source of +15 V and -15 V. The input terminals are connected to a current source $i_{in}$ through a 10 kΩ resistor. The output $v_{out}$ is connected to a 50 kΩ resistor.

The graphs on the right show the output voltage $v_{out}(t)$ as a function of time $t$. There are three graphs, each representing different scenarios or conditions for the circuit.
4. Problem 4.24 of text.
5. Problem 4.30 of text.
6. Problem 5.1 of text.

![Linear circuit diagram](image)
7. Problem 5.9 of text.
8. Problem 5.14 of text.
9. \[ V_{out} = \frac{V_{s2}}{10 \, \text{k}\Omega + 20 \, \text{k}\Omega} \cdot 20 \, \text{k}\Omega \]
10. Problem 5.20 of text.
11. Problem 5.28 of text.
12. Problem 5.34 of text.
13. Problem 6.2 of text.
14. Problem 6.7 of text.
15. Problem 6.11 of text.