EXPERIMENT 8

Lab Practical

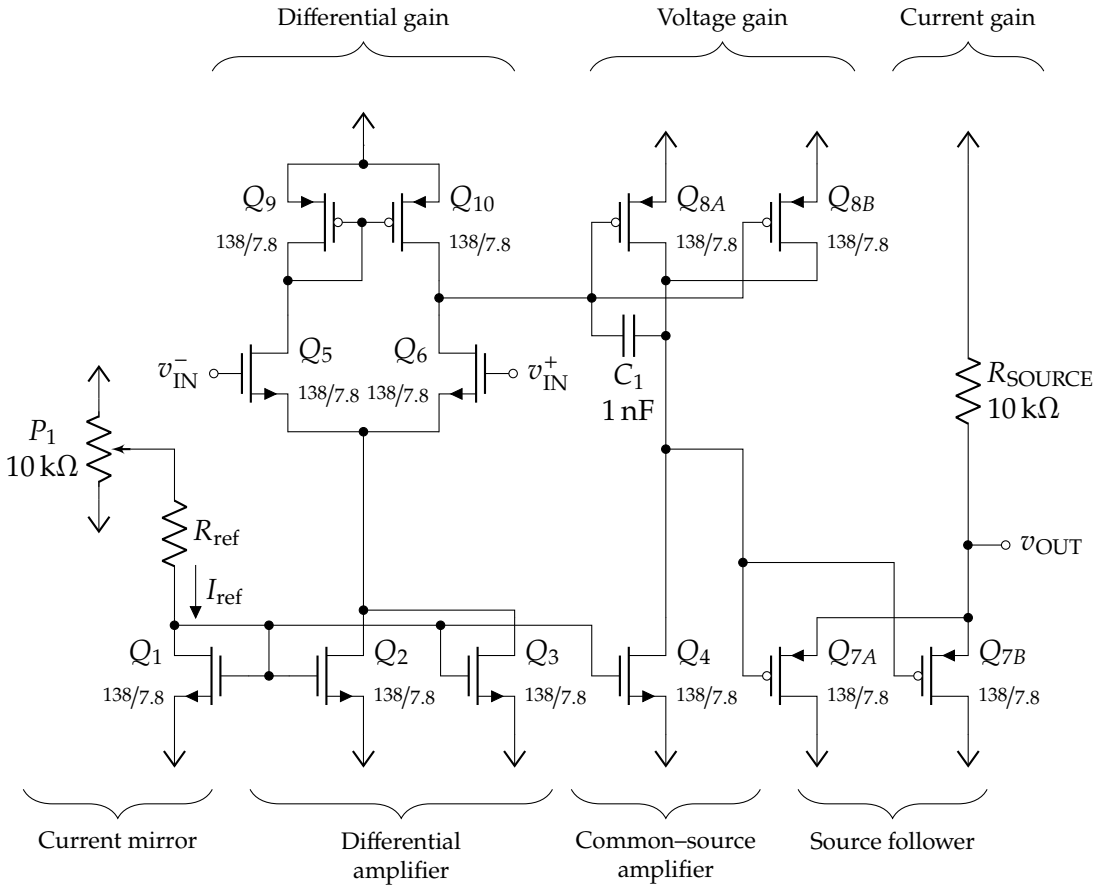


Figure 8.1: Complete metal-oxide-semiconductor field-effect transistor (MOSFET) based op amp design used in experiments 6 and 7.

Name: _____ Section: _____

8.1 Circuit construction problems (75)

Desired bias current

I_{REF} = _____ µA

note: 150 µA < I_{REF} < 250 µA.

Use the fully built op amp circuit in figure 8.1 for these tasks. Use $R_{REF} = 1\,k\Omega$.

1. **(0)** *Adjust* the potentiometer until I_{REF} is equal to the given value.
2. **(5)** *Measure* the voltage across R_{REF}: _____V

Desired gain

A_V = _____

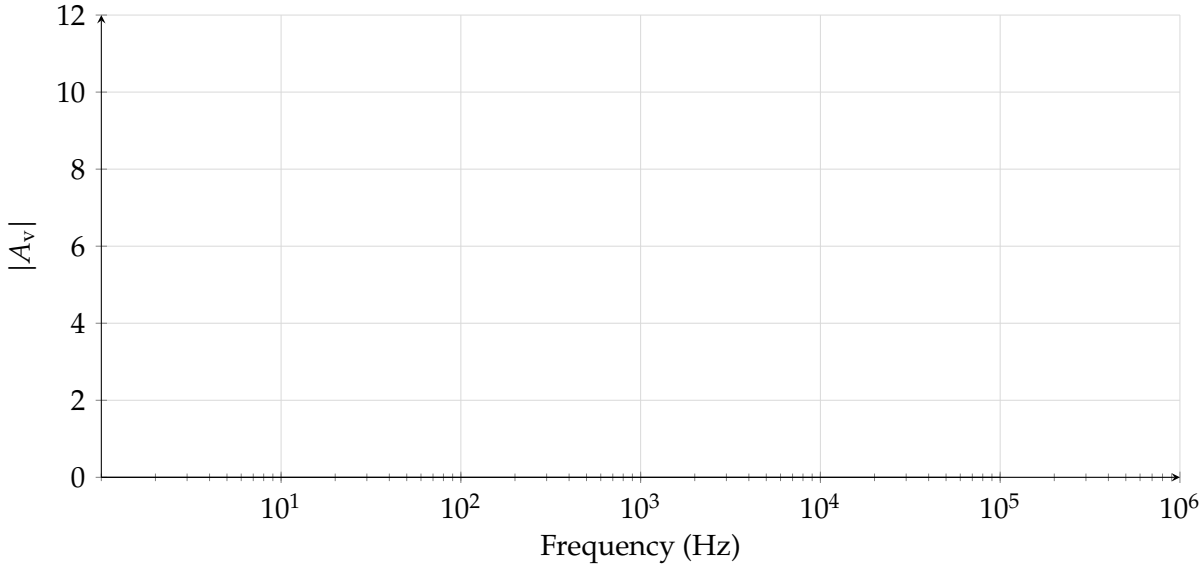
note: $-10 \leq A_V \leq 10$.

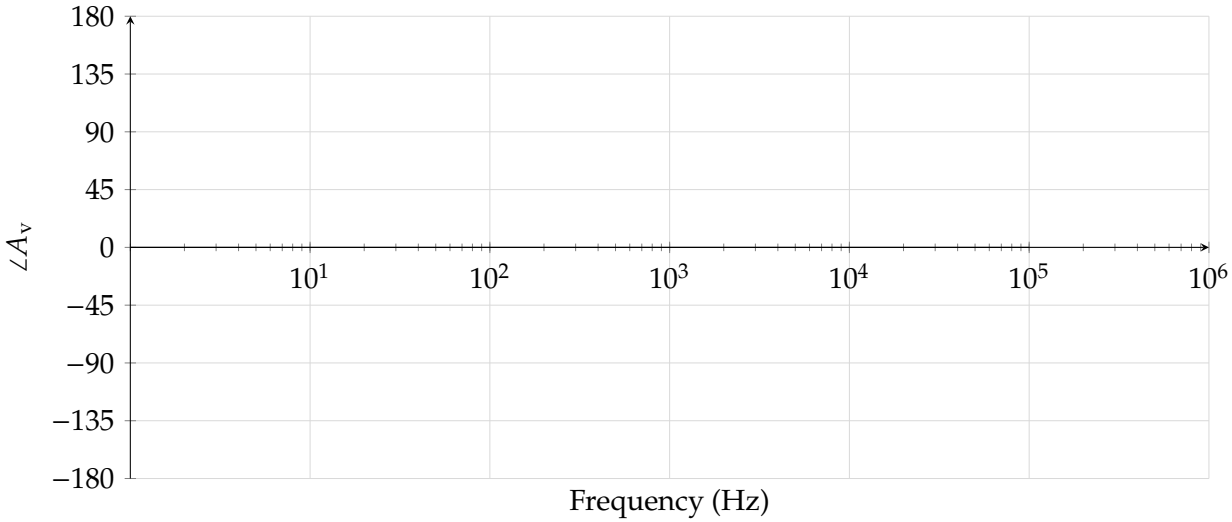
6. **(10)** *Draw* the schematic for an op amp circuit that will provide the desired gain. Pick all resistors to be larger than 10 kΩ. Ensure that the resistors you pick are available in your kit.

7. **(10)** *Build* the designed circuit and apply an input sine wave at 1 kHz that will create a $1\,V_{p-p}$ output.
8. **(10)** *Measure* A_V =_____
9. **(5)** *Calculate* the percent error between the measured and expected A_V. _____%
10. **(5)** What nonidealities of the op amp could cause this error?

11. **(25)** *Measure* and *Plot* the frequency response of the circuit
12. **(5)** *Calculate* the gain bandwidth product of this op amp GBW: _____Hz.
Use the −3 dB definition of bandwidth.

	10 Hz	50 Hz	100 Hz	500 Hz	1 kHz	5 kHz	10 kHz	50 kHz	100 kHz	500 kHz
$v_{\text{in,pp}}$										
$v_{\text{out,pp}}$										
$\lvert A_v \rvert$										
$\angle A_v$										



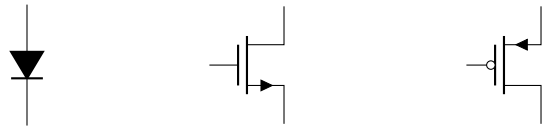


TA Checkpoint: Your TA will have you verify several of the measurements you have made.

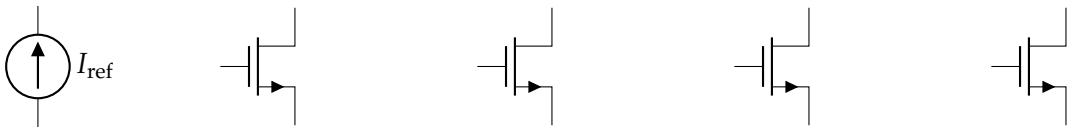
Before disassembling your circuit please get a TA check off: _____

8.2 Work out problems (25)

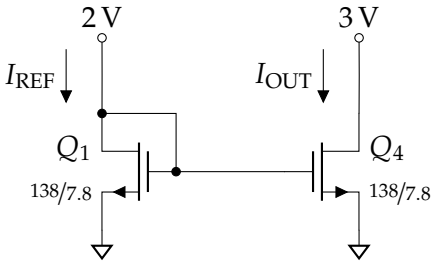
1. **(3)** Match the symbols with the options: NMOS, PMOS, or diode. Label of all device terminals.



2. **(5)** Given 4 equally sized and matched transistors, draw a two output current mirror. One output should equal the reference current and the other output should double it. Assume $\lambda = 0$.



3. **(5)** Why does $I_{\text{REF}} \neq I_{\text{OUT}}$ in the circuit below? Assume both transistors are matched and in saturation.



4. **(2)** What is the purpose of the source follower output of the op amp?

5. **(10)** The waveforms in the following plots of v_{IN}^{+} and v_{IN}^{-} are input into an ideal op amp with ±5 V supply rails. Sketch the expected v_{out}.