

SOLUTION

MAE 106 Post-Laboratory Quiz

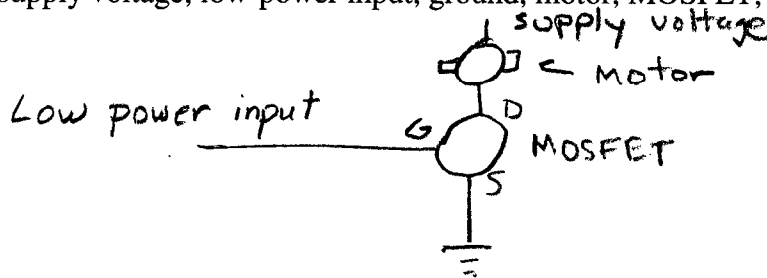
Laboratory Exercise #1: Laboratory Tools and Control of a Motor

In Lab 1, you learned how to use the oscilloscope, function generator, breadboard, ohmmeter and potentiometer. You also learned how to use a low power signal, power transistor, and operational amplifier to control the speed of a motor.

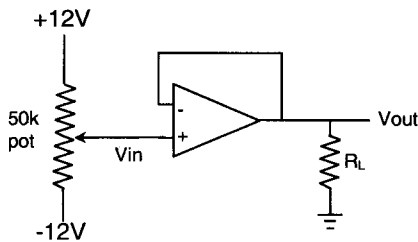
25 pts 1. Match the instrument with its use.

- | | |
|-------------------------|--|
| 5 a. Oscilloscope | <u>c</u> 1. Building circuits |
| 5 b. Function generator | <u>e</u> 2. Controlling a voltage (b is OK.) |
| 5 c. Breadboard | <u>d</u> 3. Measuring a resistance |
| 5 d. Ohmmeter | <u>a</u> 4. Measuring voltage as a function of time |
| 5 e. Potentiometer | <u>b</u> 5. Producing sine, square, and triangle waves |

25 pts 2. Draw a circuit for controlling power to a motor, using a low-power input and a MOSFET. Make sure to label supply voltage, low-power input, ground, motor, MOSFET, gate, drain, source, motor.



25 pts 3. Prove that $V_- = V_+$ for the following voltage follower circuit, using the fact that $V_o = K(V_+ - V_-)$ for an op amp, with $K = 10,000$.



$$V_{out} = K(V_+ - V_-) = V_-$$

$$KV_+ = (1+K)V_-$$

$$V_- = \frac{K}{1+K} V_+ \approx V_+ \text{ because } K \text{ is big}$$

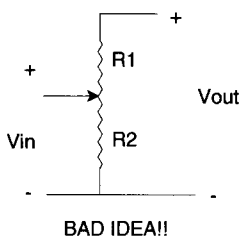
also OK

$$V_o = K(V_+ - V_-)$$

$$V_+ - V_- = \frac{V_o}{K} \approx 0$$

$$\Rightarrow V_+ = V_-$$

25 pts 4. Shown below is a 10 K Ω potentiometer wired incorrectly. Assume the potentiometer has a 1/4 watt power rating (remember power = IV). Assume that $V_{in} = 10$ Volts. When the pot's shaft angle = 0 $^\circ$, then $R_1 = 0$ and $R_2 = 10$ K Ω . When the pot's shaft angle = 180 $^\circ$ then $R_2 = 0$ and $R_1 = 10$ K Ω . Assume that you start with the pot angle = 0 $^\circ$, and slowly turn it toward 180 $^\circ$. At what angle will the pot begin to smoke?



$$P = \frac{V^2}{R_2} = \frac{1}{4} \text{ watt} = \frac{(10V)^2}{R_2} = \frac{100}{R_2} \Rightarrow R_2 = 400 \Omega$$

When power rating is exceeded

At what angle is $R_2 = 400 \Omega$?

$$\frac{\theta}{180} = \frac{9,600}{10,000} \Rightarrow \theta = \frac{(180)(9,600)}{10,000}$$

$$= 1.8 \times 96$$

$\theta = 172.8^\circ$

$$\begin{array}{r} 4 \\ 96 \\ 1.8 \\ \hline 768 \\ 96 \\ \hline 172.8 \end{array}$$