

Name:

Date:

DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE  
**MASSACHUSETTS INSTITUTE OF TECHNOLOGY**  
CAMBRIDGE, MASSACHUSETTS 02139  
Spring Term 2007 Quiz 1  
6.101 Introductory Analog Electronics Laboratory

NOTE: USE CLOSEST 5% TOLERANCE RESISTOR VALUES FOR ALL RESISTORS.  
NOTE: SHOW ALL CALCULATIONS FOR ALL ANSWERS BUT THE MOST OBVIOUS!  
[If you want credit for work based on wrong answers!]

Please look through the whole quiz before beginning. There are lots of questions, but most of them are very easy. Some even involve just copying information given right here in the quiz! It's always good test-taking procedure to look over the whole quiz before deciding where to start, and so you can plan your time.

Each question is worth 2 points, except for problem 3, where each question is worth 5 points.

Problem 1: \_\_\_\_\_ / 24

Problem 2: \_\_\_\_\_ / 16

Problem 3: \_\_\_\_\_ / 15

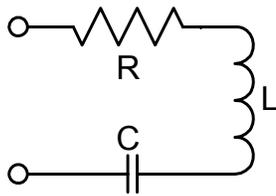
Problem 4: \_\_\_\_\_ / 22

Problem 5: \_\_\_\_\_ / 24

Total: \_\_\_\_\_ / 101

Grade in %: \_\_\_\_\_

C=1000 pF; L = 100 μH; R= 10 Ω



$$Z = R + j \left[ \omega L - \frac{1}{\omega C} \right]$$

1a. For the series circuit above, what kind of source should be used to drive it? \_\_\_\_\_

1b. Draw such a source on the schematic above and label it. \_\_\_\_\_

1c. What kind of response do we expect from this type of circuit; i.e. what will change as we vary the frequency of the source from below resonance through resonance to above resonance?

1d. Under what conditions will the impedance expression above be at a minimum? [Use math symbols, not numbers, to answer this!]

1e. Write an expression for the current in this circuit using Ohm's law and the impedance expression above.

1f. What are Ohm's first and middle names? \_\_\_\_\_

1g. Under what conditions will the expression you wrote in 1e above be a maximum? [Use math, not numbers.]

1h. Under what conditions will the expression you wrote in 1e above be 3 dB down from the maximum in 1g? [Math]

1i. What is the resonant frequency of the circuit above? [in Hz, not radians] \_\_\_\_\_

1j. What is the bandwidth of the circuit above? [Hz] \_\_\_\_\_

1k. What are the upper and lower -3dB frequencies for this circuit? [Hz] \_\_\_\_\_

1l. What is the "Q" of this resonant circuit? \_\_\_\_\_

2a. Draw a schematic for a full-wave rectifier using two real diodes with a  $V_F = 0.7$  volt, a power transformer whose primary is designed for 120 V RMS 60 Hz input and whose secondary is designed to put out 18 VCT under any load conditions [zero source resistance]. Use a 1000  $\mu$ F polarized electrolytic filter capacitor on the output, in parallel with a load resistor of value  $R_L$ .

2b. To what value of voltage will the capacitor charge when there is no load current? \_\_\_\_\_

2c. How much load current can we draw from this power supply [through  $R_L$ ] without exceeding an output ripple current of 1 volt peak-to-peak?  
\_\_\_\_\_

2d. What is the average value of the DC output voltage of this power supply when the current in 2c is being drawn from the supply?  
\_\_\_\_\_

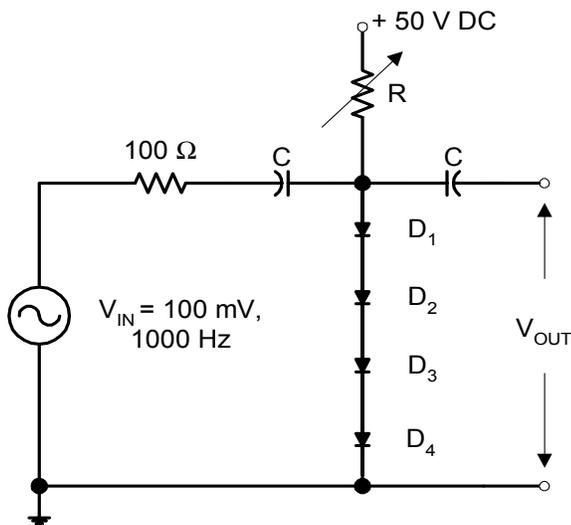
2e. What should be the voltage rating of the electrolytic capacitor?  
\_\_\_\_\_

2f. Now remove the load resistor and substitute a Zener regulator with a series current-limiting resistor and a 6.2 Volt Zener diode with a  $5\Omega$  dynamic internal resistance to ground. Choose a series resistor that is large enough to limit the output current to the value you found in question 2c. Draw a schematic below. In your schematic, replace the transformers, diodes, and filter capacitor with a DC voltage source in series with a ripple source [AC] and the series current limiting resistor; and use these to drive the Zener. Replace the Zener with a DC source in series with the Zener's  $5\Omega$  dynamic impedance.  
\_\_\_\_\_

2g. What is the value of the series current limiting resistor?  
\_\_\_\_\_

2h. Assuming that the load current plus the Zener current equals the value you found in 2c, and using your schematic from 2f, calculate the value of ripple voltage that will appear across the load.  
\_\_\_\_\_

NOTE: Each question for problem 3 is worth 5 points.



3a. In the figure above, assume that each diode has a  $V_F$  of 0.6 volts. If  $R$  is adjusted to 47.6 k $\Omega$ , then what is the small-signal [incremental] diode resistance for each diode? [The temperature is 25 $^\circ$  C.]

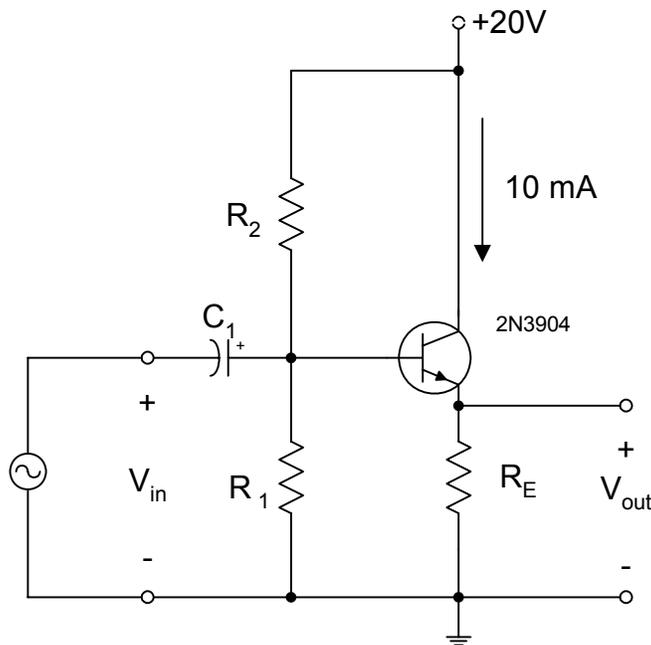
\_\_\_\_\_

3b. Assuming that the reactance of both capacitors is 0  $\Omega$  at 1000 Hz, then what will be the AC output voltage of this circuit?

\_\_\_\_\_

3c. What value will the rheostat have to be if we want to reduce the output voltage to 20 mV?

\_\_\_\_\_



- 4a. What is the configuration of the transistor amplifier above? \_\_\_\_\_
- 4b. Given that  $\beta_F = 200$  and  $\beta_o = 150$ , what is the DC base current  $I_B$  of the transistor? \_\_\_\_\_
- 4c. What value is required for  $R_E$  to make  $V_{RE} = V_{CE}$ ? \_\_\_\_\_
- 4d. If the current through  $R_2$  is  $100 \mu\text{A}$ , what is the value required for  $R_1$ , assuming that  $V_{BE} = 0.7 \text{ V}$ ?  
 \_\_\_\_\_
- 4e. What is the value of  $R_2$  ? \_\_\_\_\_
- 4f. What is the input impedance to this transistor amplifier, ignoring the effects of  $R_1$  and  $R_2$ ?  
 \_\_\_\_\_
- 4g. Now find the input impedance including the effects of  $R_1$  and  $R_2$ . \_\_\_\_\_
- 4h. What value of  $C$  is required for a  $-3\text{dB}$  point at  $10 \text{ Hz}$ ? \_\_\_\_\_
- 4i. What is the output impedance of this amplifier? \_\_\_\_\_
- 4j. What is the *approximate* voltage gain of this amplifier? \_\_\_\_\_
- 4k. Draw the load line for this amplifier on the transistor output characteristics on the next page. Label the value of the quiescent base current curve,  $I_B$ , and mark the Q-point.

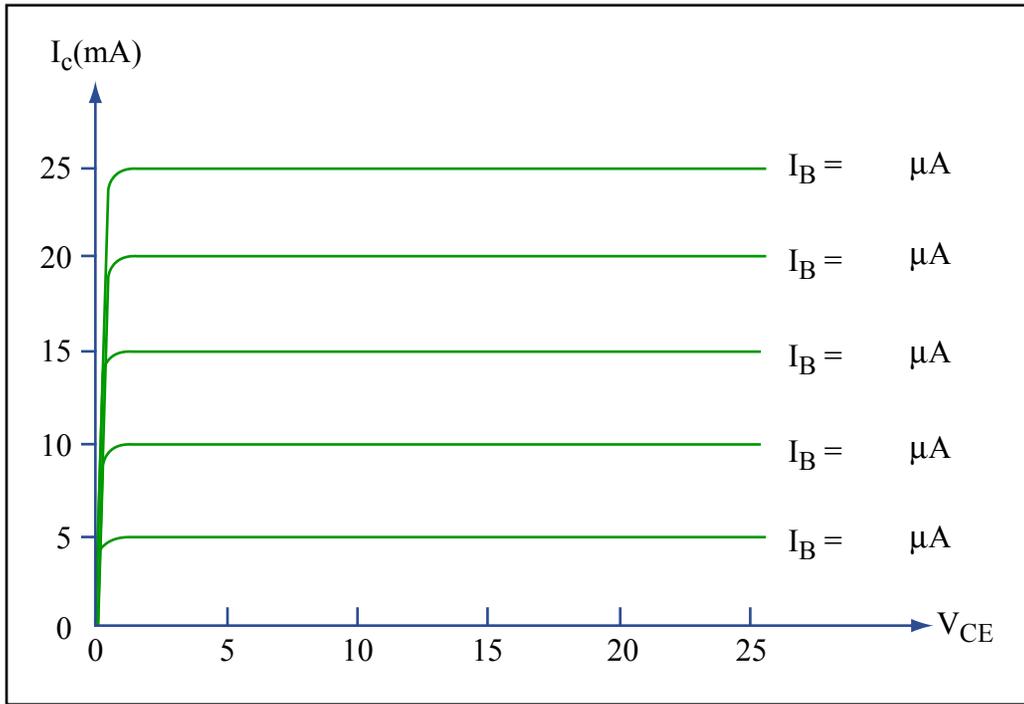
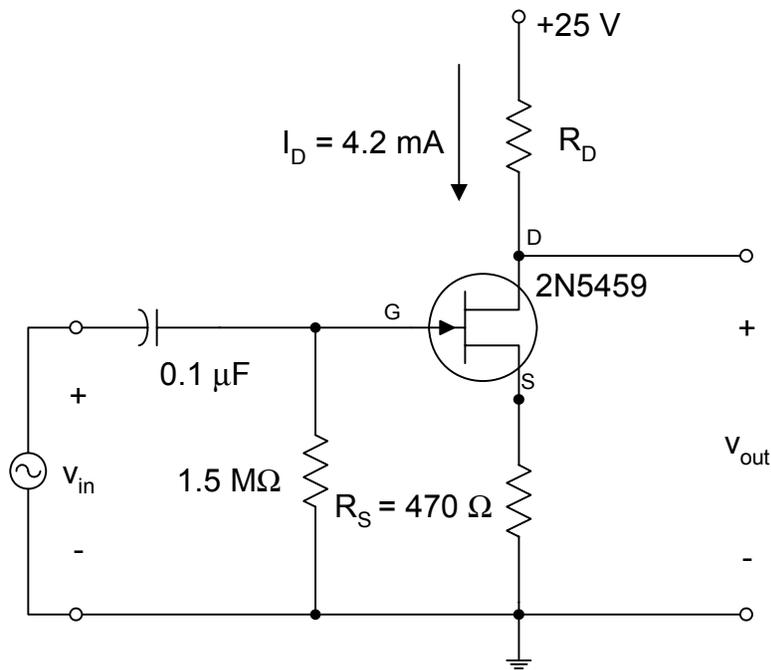


Figure by MIT OpenCourseWare.



**[NOTE: Essential characteristics for this JFET are shown on the next page.]**

- 5a. What is  $I_{DSS}$  for this JFET at  $V_{DS} = 10$  volts? \_\_\_\_\_
- 5b. What is  $V_{GS(OFF)}$  for this JFET? \_\_\_\_\_
- 5c. What is the quiescent value of  $V_{GS}$  for this amplifier? \_\_\_\_\_
- 5d. Find a standard value for  $R_D$  that makes  $V_{RD}$  equal to  $V_{DS}$ . \_\_\_\_\_
- 5e. What is the output impedance of this amplifier? \_\_\_\_\_
- 5f. What is the input impedance of this amplifier? \_\_\_\_\_
- 5g. What is the configuration of this amplifier? \_\_\_\_\_
- 5h. What is  $f_{LO}$ , the low frequency  $-3dB$  point for this amplifier? \_\_\_\_\_
- 5i. What is the voltage gain for this amplifier? \_\_\_\_\_
- 5j. What would be the voltage gain for this amplifier if  $R_S$  were bypassed by a BFC? \_\_\_\_\_
- 5k. Draw the load line for this amplifier on the JFET characteristics on the next page. Label the Q-point, and mark the  $I_D$  and  $V_{DS}$  Q-point values on the appropriate axes.
- 5l. Name three reasons for preferring a JFET over a BJT. \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

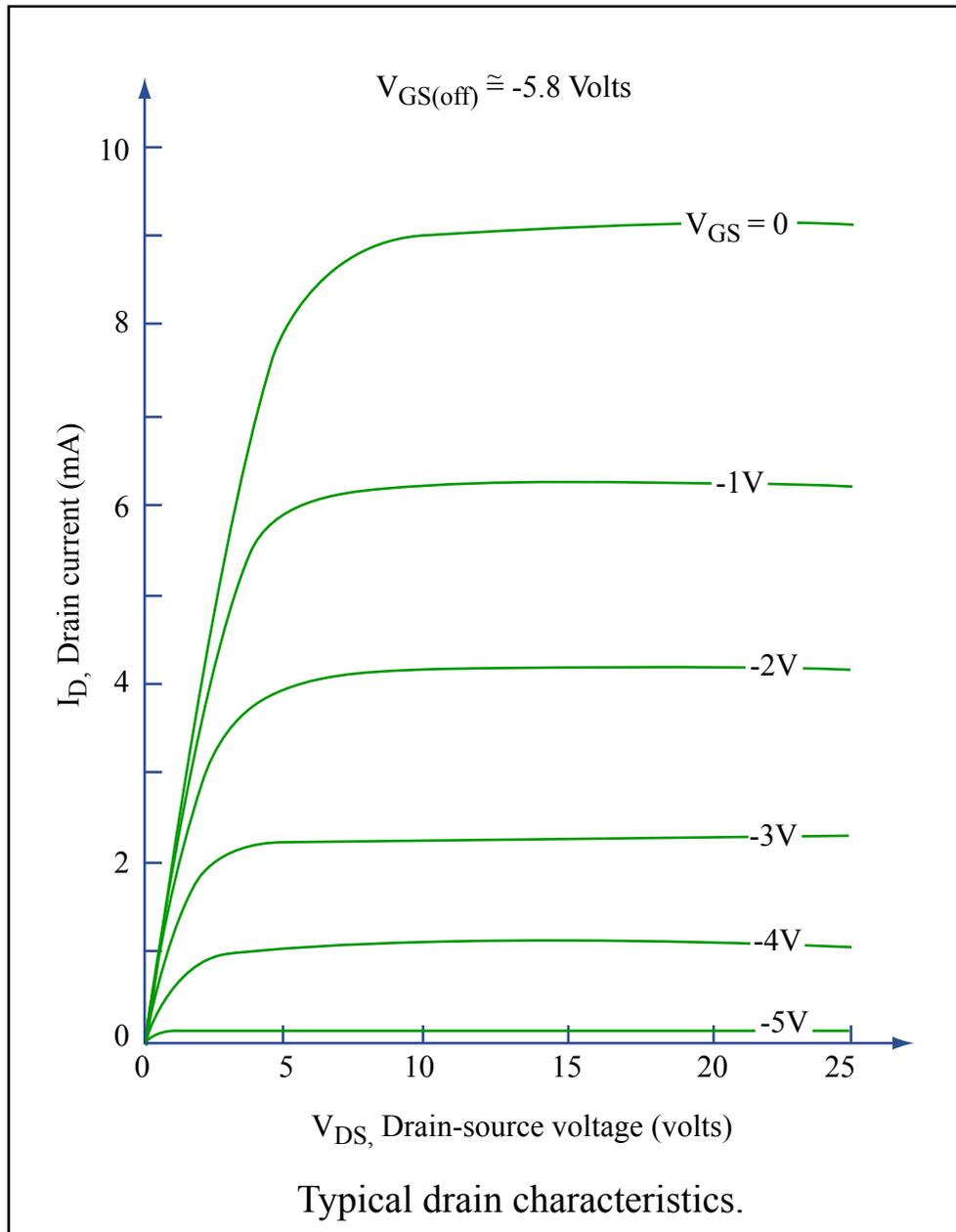


Figure by MIT OpenCourseWare.