



MACHAKOS UNIVERSITY

University Examinations

EXAMINATION FOR THE BACHELOR OF SCIENCE MATHEMATICS

SMA 130: INTRODUCTION TO ELECTRONICS

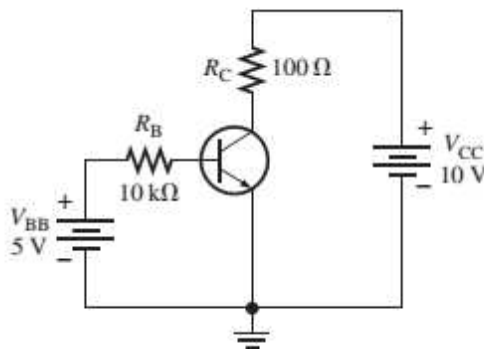
DATE: _____

TIME: _____

Instructions: Answer Question One and Any Other Two Questions.

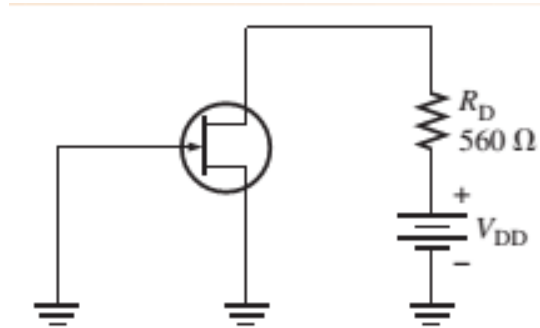
Question 1

- Explain the difference between a metal, semiconductor and insulator. Use band gap diagrams for illustration. (6 marks)
- Draw a diagram showing the V-I (voltage-current) characteristics of a pn-diode. Explain the diagram. (4 marks)
- Discuss how a BJT can be used as:
 - Amplifier
 - Switch(4 marks)
- Determine I_B , I_C , I_E , V_{BE} , V_{CE} and V_{CB} in the circuit in Fig. Q1-1. The transistor has $\beta_{DC} = 150$.



(4 marks)

- e. Describe the difference between enhancement mode MOSFET and depletion mode MOSFET. (4 marks)
- f. For the JFET in Fig. Q1-2, $V_{GS(off)} = -4V$ and $I_{DSS} = 12\text{ mA}$. Determine the minimum value of V_{DD} required to put the device in constant current region of operation when $V_{GS} = 0V$.



- (4 marks)
- g. Describe the difference between the following operation amplifier terms.
- Common mode vs differential mode
 - Non-inverting vs inverting amplifier
- (4 marks)

Question 2

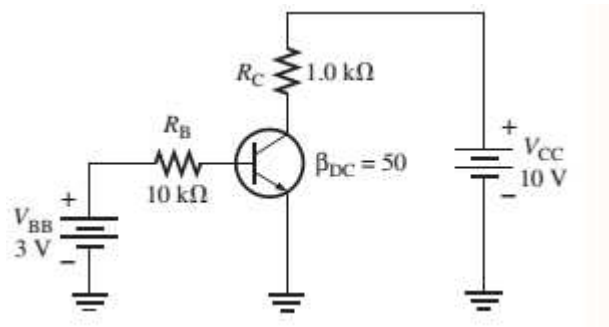
- Describe the difference between avalanche breakdown and Zener breakdown. (4 marks)
 - Explain how hole current come about in semiconductors. (3 marks)
 - Explain the effect of temperature in conduction in a semiconductor. (2 marks)
 - Explain how a p-type semiconductor is formed. (3 marks)
 - Describe the operation of the following diodes and state one application of each.
 - Zener diode
 - Light emitting diode
 - Photodiode
- (6 marks)

Question 3

- Discuss how a BJT operates (4 marks)
- Sketch an ideal family of collector curves for the circuit in Fig. Q4-1 for $I_B = 5\mu A$ to $25\mu A$ in $5\mu A$ increments. Assume that $\beta_{DC} = 100$ and that V_{CE} does not exceed breakdown. (4 marks)

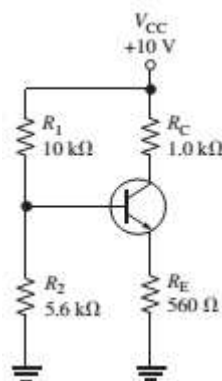
- c. Determine the Q-point for the circuit in Fig. Q4-2 and draw a DC load line. Find the maximum peak value of base current for linear operation. Assume $\beta_{DC} = 200$. (4 marks)

- d. Determine whether or not the transistor in Fig. Q4-3 is in saturation mode. Assume $V_{CE(sat)} = 0.2 \text{ V}$



(4 marks)

- e. Determine V_{CE} and I_C in the stiff voltage divider biased transistor circuit in Fig. Q4-4. Assume that $\beta_{DC} = 100$.



(4 marks)

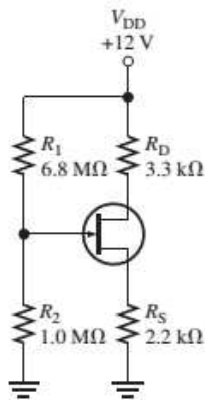
Question 4

- a. Describe how a JFET operates.

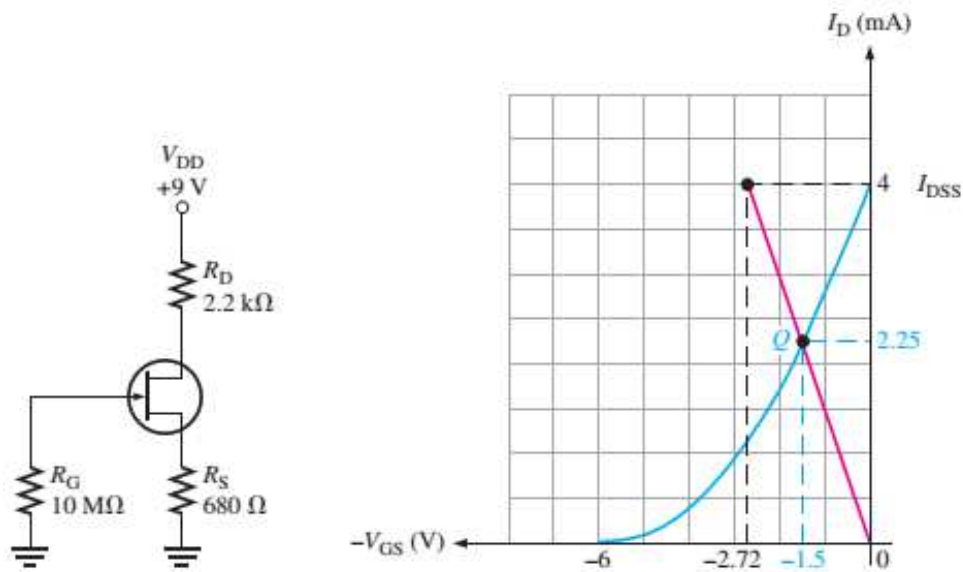
(4 marks)

- b. The partial data sheet in Fig for a 2B5459 JFET indicates that typically I_{DSS} for 9mA and $V_{GS(off)} = -8V$ (maximum). Using these values, determine the drain current for $V_{GS} = 0V$, $-1V$ and $-4V$. (4 marks)

- c. Determine I_D and V_{GS} for the JFET with voltage-divider bias in Fig. Q4-1, given that for this particular JFET the parameter values are such that $V_D \cong 7V$. (4 marks)

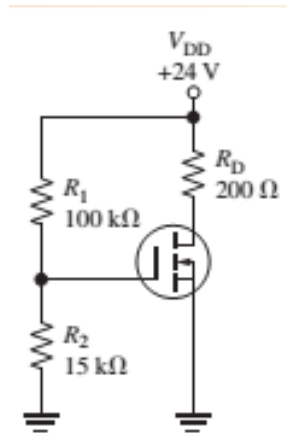


- d. Determine the Q-point for the JFET circuit in Fig. Q4-3. The transfer characteristic curve is shown. (4 marks)



- e. Determine V_{GS} and V_{DS} for the E-MOSFET in Fig. Q4-4. Assume that this particular MOSFET has minimum values of $I_{D(on)} = 200 \text{ mA}$ and $V_{GS} = 4\text{V}$ and $V_{GS(th)} = 2\text{V}$.

(4 marks)



Question 5

- a. Draw a diagram showing practical op-amp

(3 marks)

- b. Define the following Op-amp parameters:

- i. Common mode rejection ratio
- ii. Open-loop voltage gain
- iii. Slew rate

(3 marks)

- c. For a certain D-MOSFET, $I_{DSS} = 10 \text{ mA}$ and $V_{GS(off)} = -8\text{V}$.

- i. Is this an n-channel or a p-channel?
- ii. Calculate I_D at $V_{GS} = -3 \text{ V}$
- iii. Calculate I_D at $V_{GS} = +3\text{V}$

(6 marks)

- f. Describe the following BJT terms:

- i. Emitter bias
- ii. Collector bias

(4 marks)

- g. Determine the dc current gain $\beta_{DC} = 100$ and the emitter current I_E for a transistor where $I_B = 50 \mu\text{A}$ and $I_C = 3.65 \text{ mA}$.

(4 marks)

