MACHAKOS UNIVERSITY

University Examinations for 2020/2021 Academic Year

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

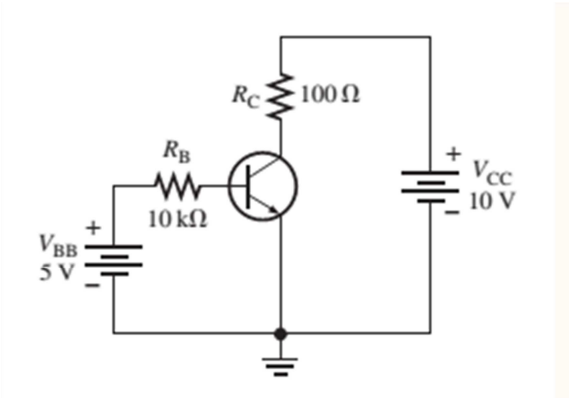
a. Explain the difference between a metal, semiconductor and insulator. Use band gap diagrams for illustration. (6 marks)

b. Draw a diagram showing the V-I (voltage-current) characteristics of a pn-diode. Explain the diagram. (4 marks)

c. Discuss how a BJT can be used as:
   i. Amplifier
   ii. Switch

(4 marks)

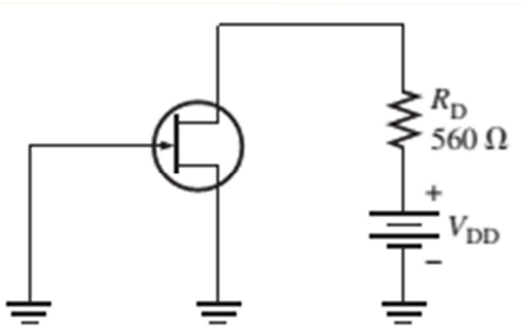
d. Determine I_B, I_C, I_E, V_{BE}, V_{CE} and V_{CB} in the circuit in Fig. Q1-1. The transistor has $\beta_{DC} = 150$.



(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 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.
   i. Common mode vs differential mode
   ii. Non-inverting vs inverting amplifier (4 marks)

Question 2

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

Question 3

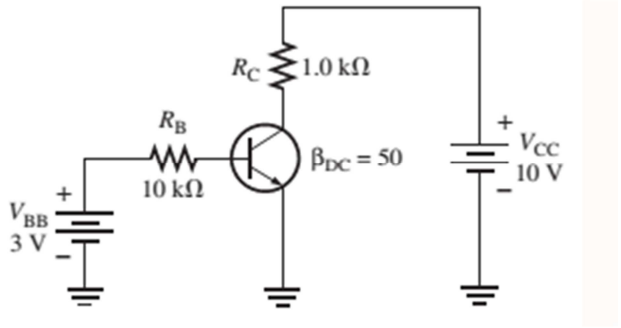
a. Discuss how a BJT operates (4 marks)

b. Sketch an ideal family of collector curves for the circuit in Fig. Q4-1 for I_B = 5µA to 25 µA in 5µA increments. Assume that β_{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 β_{DC} = 200.

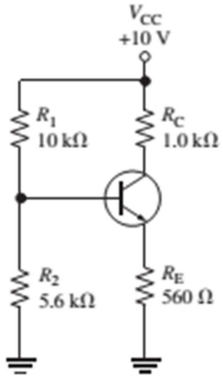
(4 marks)

d. Determine whether or not the transistor in Fig. Q4-3 in is saturation mode. Assume $V_{CE(sat)}$=02.V



(4 marks)

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



(4 marks)

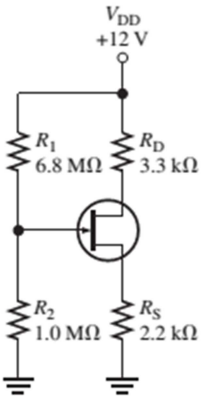
Question 4

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)

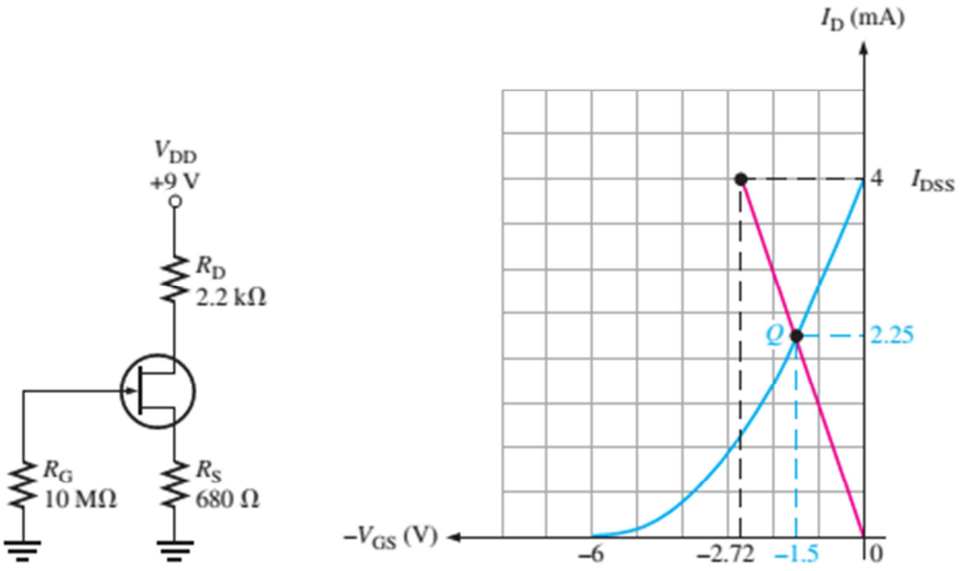
c. Determine I_D and V_{GS} for the JFET with voltage-divider bias in Fig. Q4-1, given that for this particular JFET the parameter values are such that $V_D \cong$ 7V.

(4 marks)



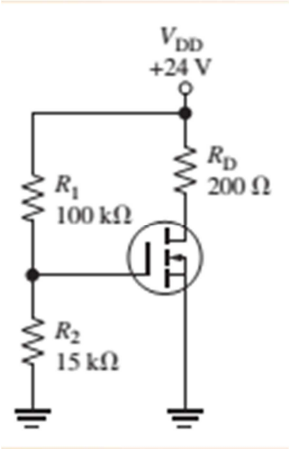
d. Determine the Q-point for the JFET circuit in Fig. Q4-3. The transfer characteristic curve is shown.

(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 $I_{D(on)} = 200$ mA and $V_{GS} = 4V$ and $V_{GS(th)} = 2V$.

(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, $I_{DSS} = 10$ mA and $V_{GS(off)} = -8V$.

i. Is this an n-channel or a p-channel?

ii. Calculate I_D at $V_{GS} = -3$ V

iii. Calculate I_D at $V_{GS} = +3V$

(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 $I_B = 50$ µA and $I_C = 3.65$ mA.

(4 marks)