



DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY
UNIVERSITY EXAMINATIONS 2021/2022

**SECOND YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE OF
 BACHELOR OF SCIENCE IN MECHATRONIC ENGINEERING**

EEE 3101 ANALOGUE ELECTRONICS

DATE: DECEMBER 2021

TIME: 2 HOURS

INSTRUCTIONS

This paper contains THREE printed pages with FIVE Questions.

Answer QUESTION ONE (**COMPULSORY**) and ANY OTHER TWO Questions

QUESTION ONE [COMPULSORY – 30 MARKS]

- a) What is a *hole* and how does it contribute to conduction? [2 Marks]
- b) In the three regions of operation, how are the BJT junctions biased? Illustrate the following three regions of operation of a Bipolar Junction Transistor (BJT) on Common Emitter (CE) configuration output (collector) characteristics. [6 Marks]
 - i. Active region
 - ii. Saturation region
 - iii. Cut off region
- c) Explain the operation of a zener diode and sketch its symbol. [2 Marks]
- d) What is meant by diffusion of charge carriers? How is it different from drift? [2 Marks]
- e) The Opamp circuit in Fig. Q1(e) is that of an inverting amplifier. Determine the output voltage V_0 . [3 Marks]

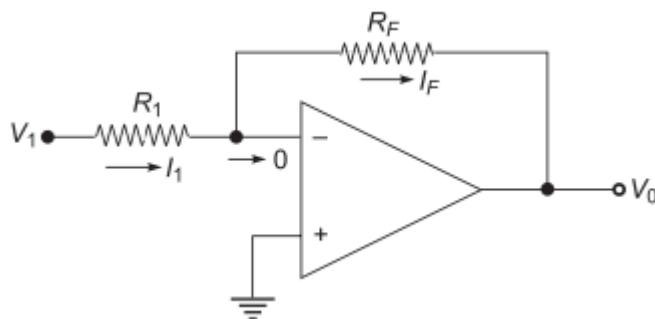


Fig. Q1(e)

- f) With the aid of a well-labeled diagram, explain the formation of a depletion region in a *PN*-junction diode? [5 Marks]
- g) For the diode circuit of Fig. Q1(g), determine the currents I_1 , I_2 and I_{D2} . [6 Marks]

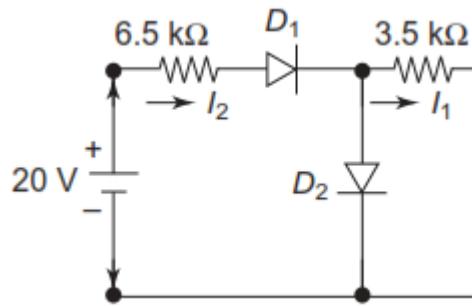


Fig. Q1(g)

- h) A Silicon diode has a reverse saturation current $I_s = 10 \text{ nA}$, operating at 25°C . Calculate the diode current I_D for a forward bias voltage of 0.6 V . [3 Marks]
- i) State ONE difference between a Field Effect Transistor (FET) and a Bipolar Junction Transistor (BJT)? [1 Mark]

QUESTION TWO [20 MARKS]

- a) Show the two-dimensional picture of a silicon crystal containing: [6 Marks]
 i. Donor impurity atoms
 ii. Acceptor impurity atoms.
- b) The collector current I_C in a *NPN* Bipolar Junction Transistor (BJT) is given by $I_C = \alpha I_E + I_{CBO}$, where α is the common-base forward-current gain, I_E is the emitter current and I_{CBO} is the reverse saturation current. Show that the collector current can also be given by;

$$I_C = \beta I_B + (1 + \beta) I_{CBO}$$

where β is the common-emitter forward-current gain and I_B is the base current. [5 Marks]

- c) With the aid of diagrams, discuss the THREE types of configurations in which a Bipolar Junction Transistor (BJT) can be connected in a circuit operation. [9 Marks]

QUESTION THREE [20 MARKS]

- a) Sketch the frequency response of an op-amp open-loop mode. [5 Marks]
- b) Sketch the *IV* characteristics of a silicon *PN*-junction diode and describe the shapes of the characteristics drawn. [5 marks]
- c) For the fixed-bias configuration shown in Fig. Q3(a), determine R_B , R_C , I_C and V_{CE} , given that $\beta = 100$ [10 Marks]

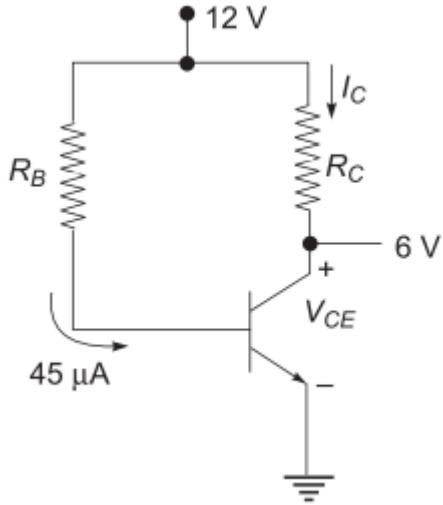


Fig. Q3(c)

QUESTION FOUR [20 MARKS]

- Sketch an n -channel JFET. Explain how the pinch off takes place for $V_{GS} = 0$. What is meant by I_{DSS} . [8 Marks]
- Define the following terms as used in Electronics. [4 Marks]
 - Recombination
 - Threshold voltage
 - Slew rate
 - Common Mode Rejection Ratio (CMRR)
- Given $\alpha_{dc} = 0.997$, determine; [8 Marks]
 - I_c if $I_E = 5 \text{ mA}$
 - α_{dc} if $I_E = 2.8 \text{ mA}$ and $20 \mu\text{A}$
 - I_E if $I_B = 40 \mu\text{A}$ and $\alpha_{dc} = 0.98$

QUESTION FIVE [20 MARKS]

- What is a tunnel diode? With the aid of a sketch, explain the IV characteristics of a tunnel diode. [5 Marks]
- With the aid of a well labeled diagram, describe the flow of carriers (holes and electrons) in a NPN transistor. [7 Marks]
- For the diode circuit of Fig. Q5(c), determine I , V_1 , V_2 and V_0 . [8 Marks]

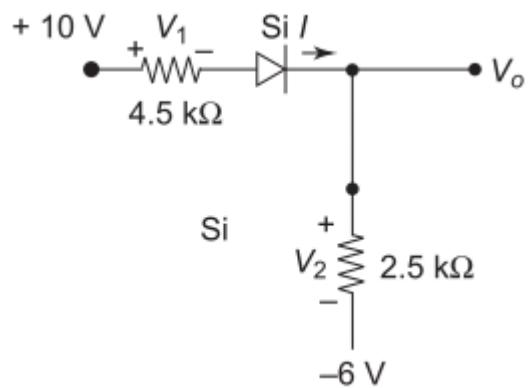


Fig. Q5(c)