NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING

DEPARTMENT OF ELECTRONIC ENGINEERING

ELECTRONIC ENGINEERING CIRCUITS AND DEVICES (**EIE Only**)

EEE 1203

FINAL EXAMINATION PAPER
MARCH 2025

This paper consists of 10 printed pages.

EXAMINATION DURATION : **3 HOURS**

TOTAL MARKS : **100**

SPECIAL REQUIREMENTS : **Multiple Choice Answer Sheet**

EXAMINER'S NAME : **FUNANI. J**

INSTRUCTIONS TO CANDIDATES

i. Answer **ALL** questions in **Section A** and **any THREE** from **Section B**

ii. Each question in **Section B** carries **20 marks.**

iii. Show any calculations and assumptions clearly.

iv. Start each question on a fresh page.

$Boltman\ constant = 1.381\ X\ 10^{-23}\ J/K$

$eV = 1.602\ X\ 10^{-19}\ J$

SECTION A

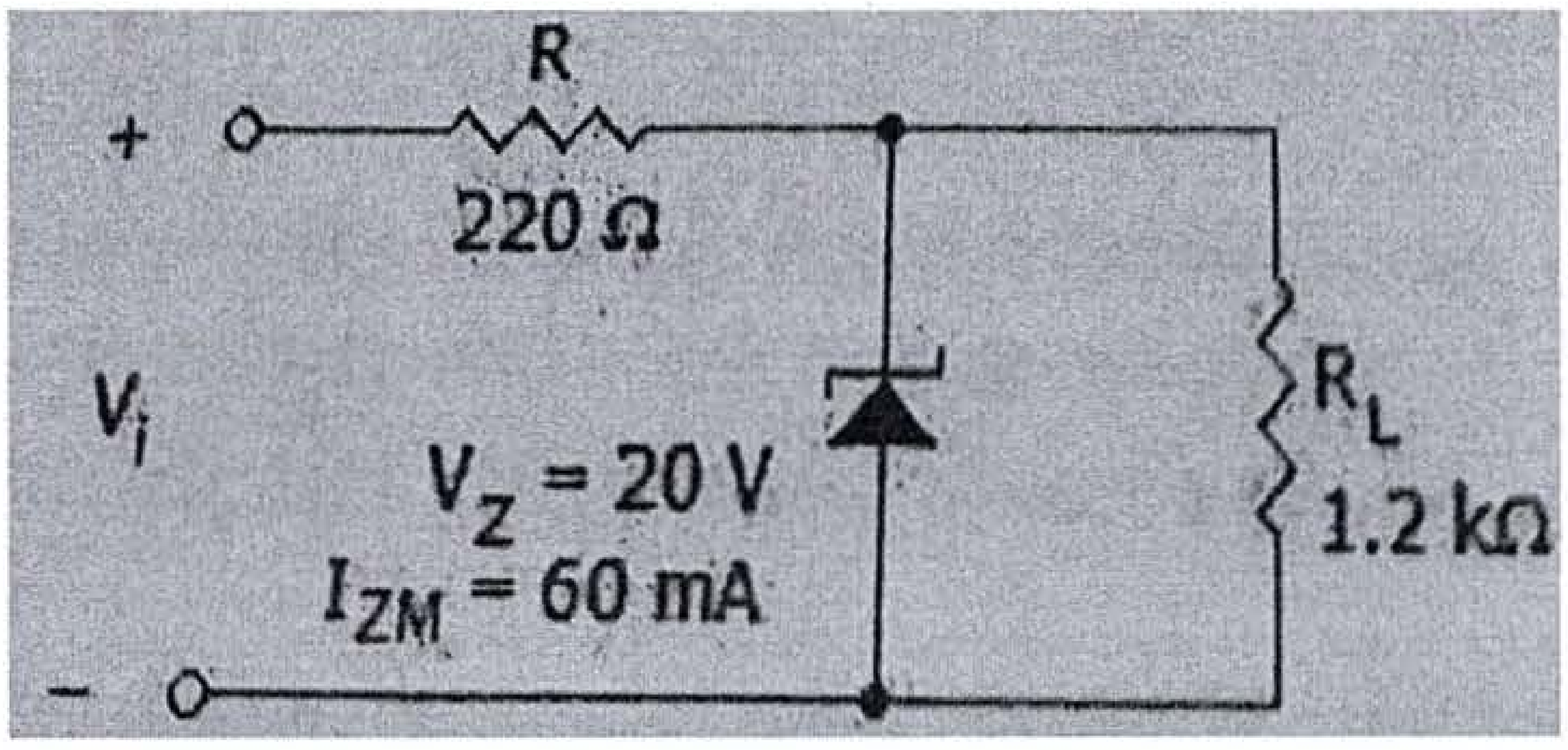
1. Electrons found in the outermost shell of an atom are called
   A. Outer shell electrons
   B. Inner shell electrons
   C. Semiconductor electrons
   D. Valence electrons
2. A good conductor has how many electrons in its outer shell
   A. 1
   B. 7
   C. 3
   D. 4
3. What bond is formed when one or more electrons in the outer energy orbit of an atom are transferred to another atom
   A. Metallic bond
   B. Atomic bond
   C. Ionic bond
   D. Van de Waals bond
4. Electromotive force in a circuit
   A. Maintains circuit resistance
   B. Is needed to make the circuit complete
   C. Causes free electrons to flow
   D. Causes formation of valence electrons
5. In a Zener diode large reverse current is due to
   A. Collision
   B. Presence of impurities
   C. Rapture of bonds
   D. Lower resistance in reverse biased region
6. Which of the following diodes is operated in reverse bias mode?
   A. P-N junction
   B. Zener
   C. Tunnel
   D. Schottky
7. Which of the following doping will produce a P-type semiconductor?
   A. Germanium with phosphorus
   B. Silicon with Germanium
   C. Germanium with antimony
   D. Silicon with Indium
8. When a P-N junction is forward biased
   A. The depletion layer decreases
   B. The depletion layer increases
   C. The depletion layer disappears
   D. The depletion layer spreads out
9. The barrier voltage V_T or V_B in a junction diode is the effect of
   A. The p-side and n-side of the junction forming a battery
   B. The emf required to move the holes fast enough to have the mobility equal to that of the electrons

C. The recombination of charge carriers across the junction leaving behind the opposite charge ions.
D. The voltage needed to make the semiconductor material behave as a conductor

10. The current flow through a Ge PN junction diode with a forward bias of 0.22 volts and reverse saturation current of 1 mA at 25°C is around
A. 6.2A
B. 5.22A
C. 4mA
D. 5.1mA

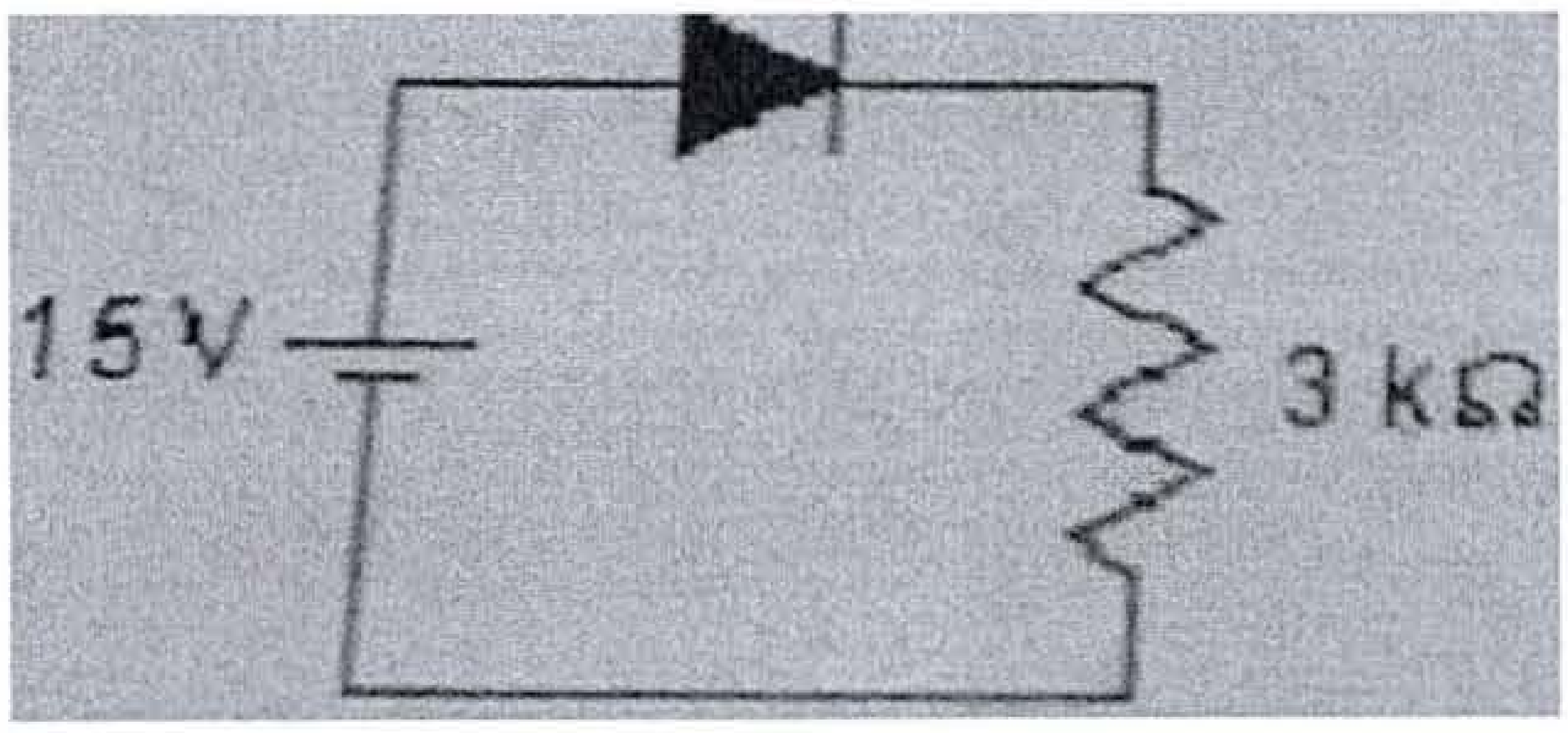
11. Determine the total discharge time for the capacitor in a clamper having C= 0.01μF and R= 500KΩ.
A. 5ms
B. 25ms
C. 2.5ms
D. 50ms

12. Which element dictates the maximum level of the source voltage in the circuit



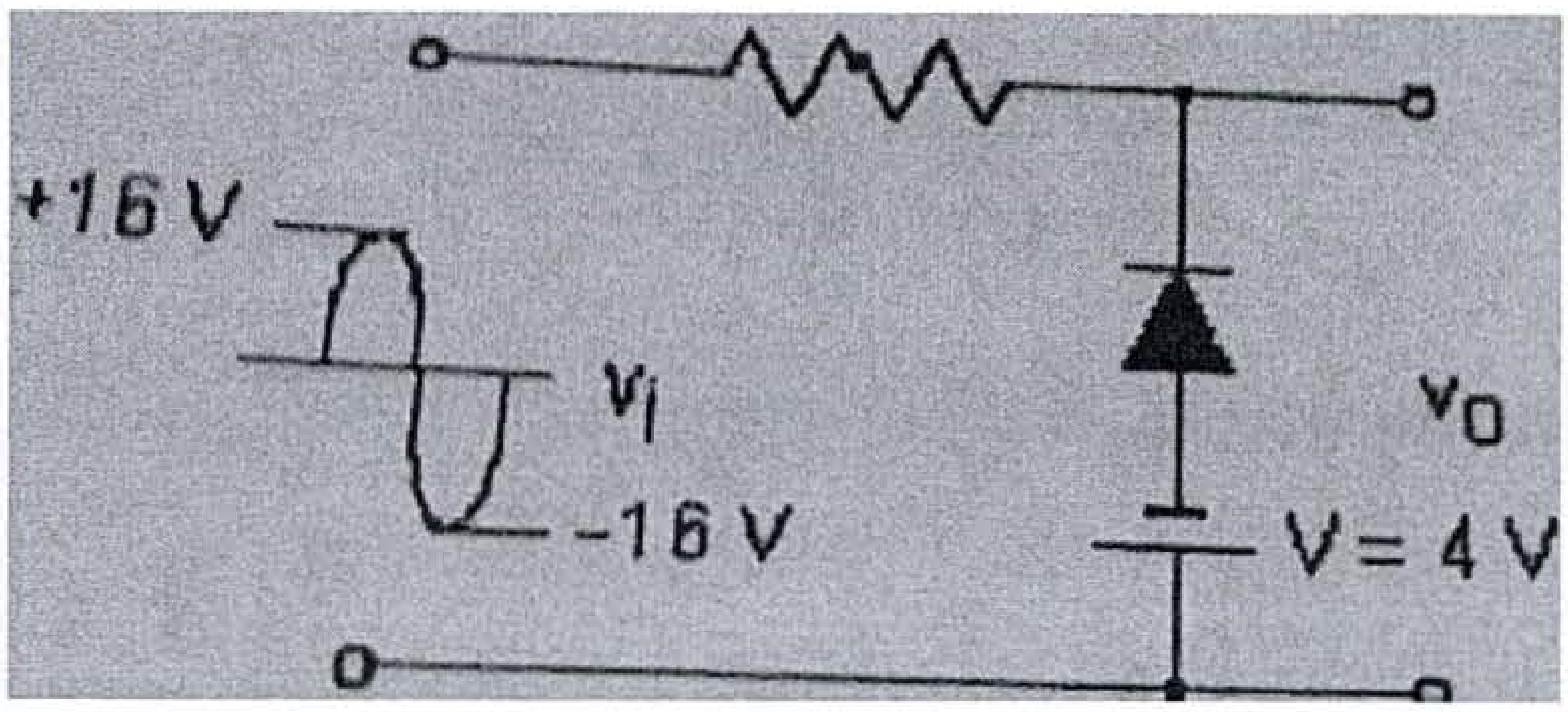
A. V_Z
B. I_{Zmax}
C. I_Z
D. None of the above

13. Determine the current level if E = 15V and R = 3KΩ



A. 0A
B. 4.76mA
C. 5mA
D. 5A

14. Determine the peak for both half cycles of the output waveform



   A. 16V, - 4V
   B. 16V, 4V
   C. -16V, 4V
   D. -16V, -4V
15. A germanium diode is approximated by------------------equivalent for voltages less than 0.3V
   A. A Short circuit
   B. A Series circuit
   C. A Parallel circuit
   D. An open circuit
16. Which of the following is (are) terminals of a transistor?
   A. Emitter
   B. Base
   C. Collector
   D. All of the above
17. A transistor in common emitter mode has
   A. A high input resistance and low output resistance
   B. A medium input resistance and high output resistance
   C. A very low input resistance and a low output resistance
   D. A high input resistance and a high output resistance
18. In a BJT with $\beta = 100$, α equals
   A. 99
   B. 0.99
   C. 1.0
   D. 1.01
19. For a properly biased PNP transistor, let IC = 10 mA, and IE = 10.2 mA, what would be the level of I_B
   A. 0.2A
   B. 200 mA
   C. 200μA
   D. 20.2 mA
20. In the saturation region, the collector-base junction is--------------biased and the base-emitter junction is----------------biased for a transistor.

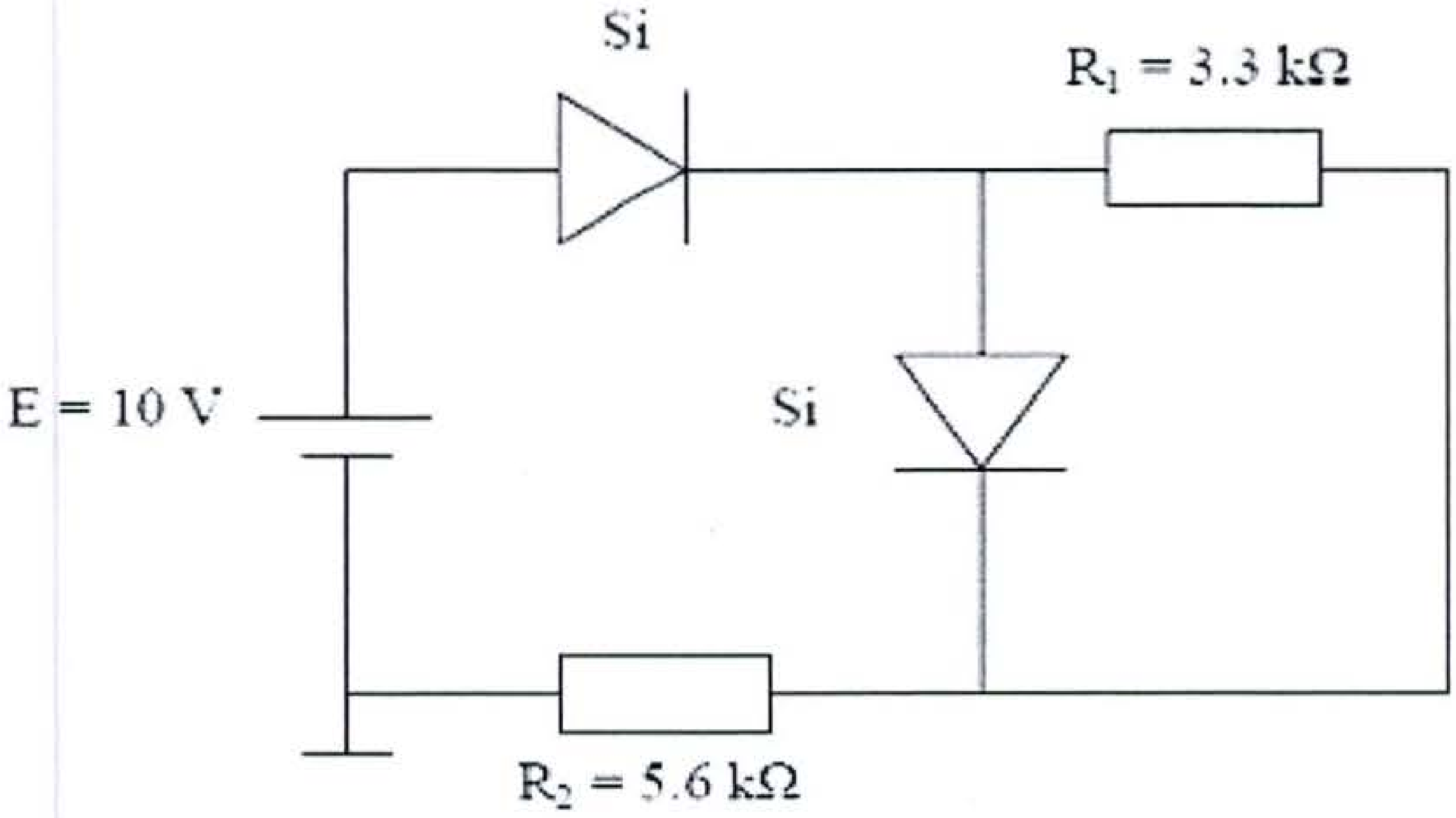
A. Reverse, forward
B. Forward, reverse
C. Reverse, reverse
D. Forward, forward

SECTION B

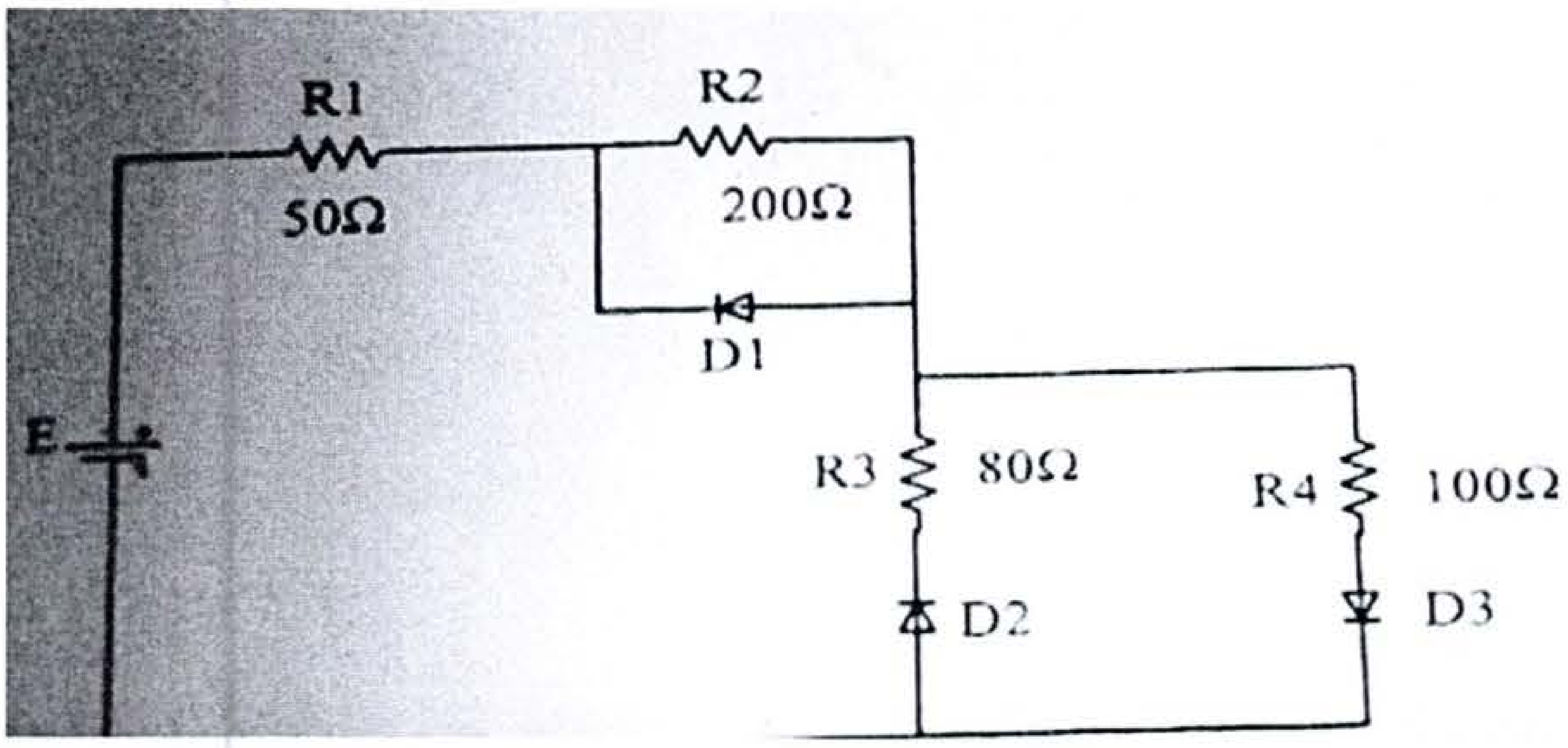
B111 With reference to BJT transistor operating regions, complete the following table with relevant information [4]

Bias mode	Emitter Junction (EJ)	Collector Junction (CJ)
Cutoff		
Saturation		
Inverse		
Normal Active		

B112 Determine the current through and the voltage across each component for the circuit below [3]



B113 Calculate the current through and the voltage across each in the circuit if the supply voltage is 12V. [5]



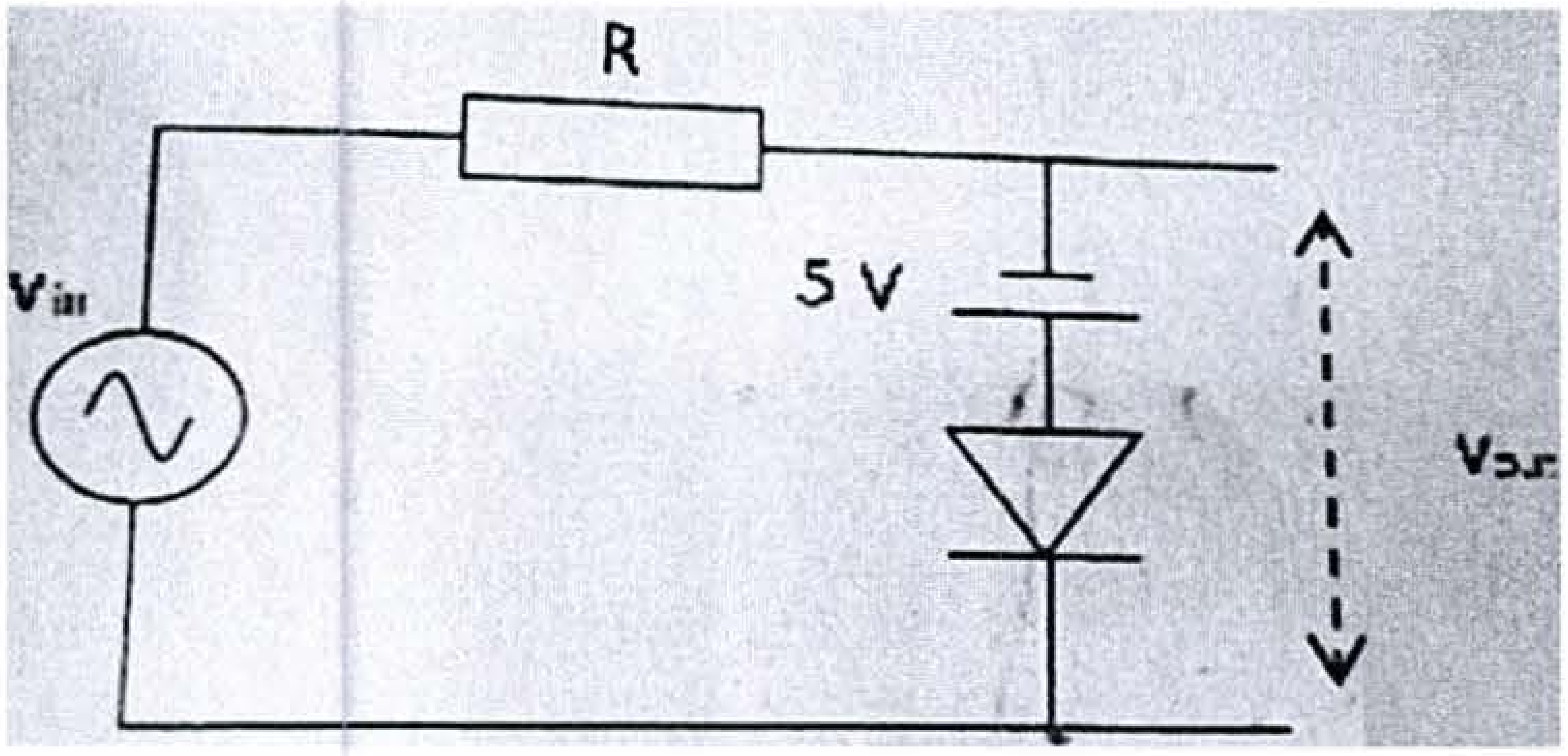
B114 Given a Si diode with a reverse current (I_R) of 35nA at 25°C, calculate its reverse current at 100°C. [4]

B115 Draw and explain the V-I characteristics of the following in both forward and reverse mode:

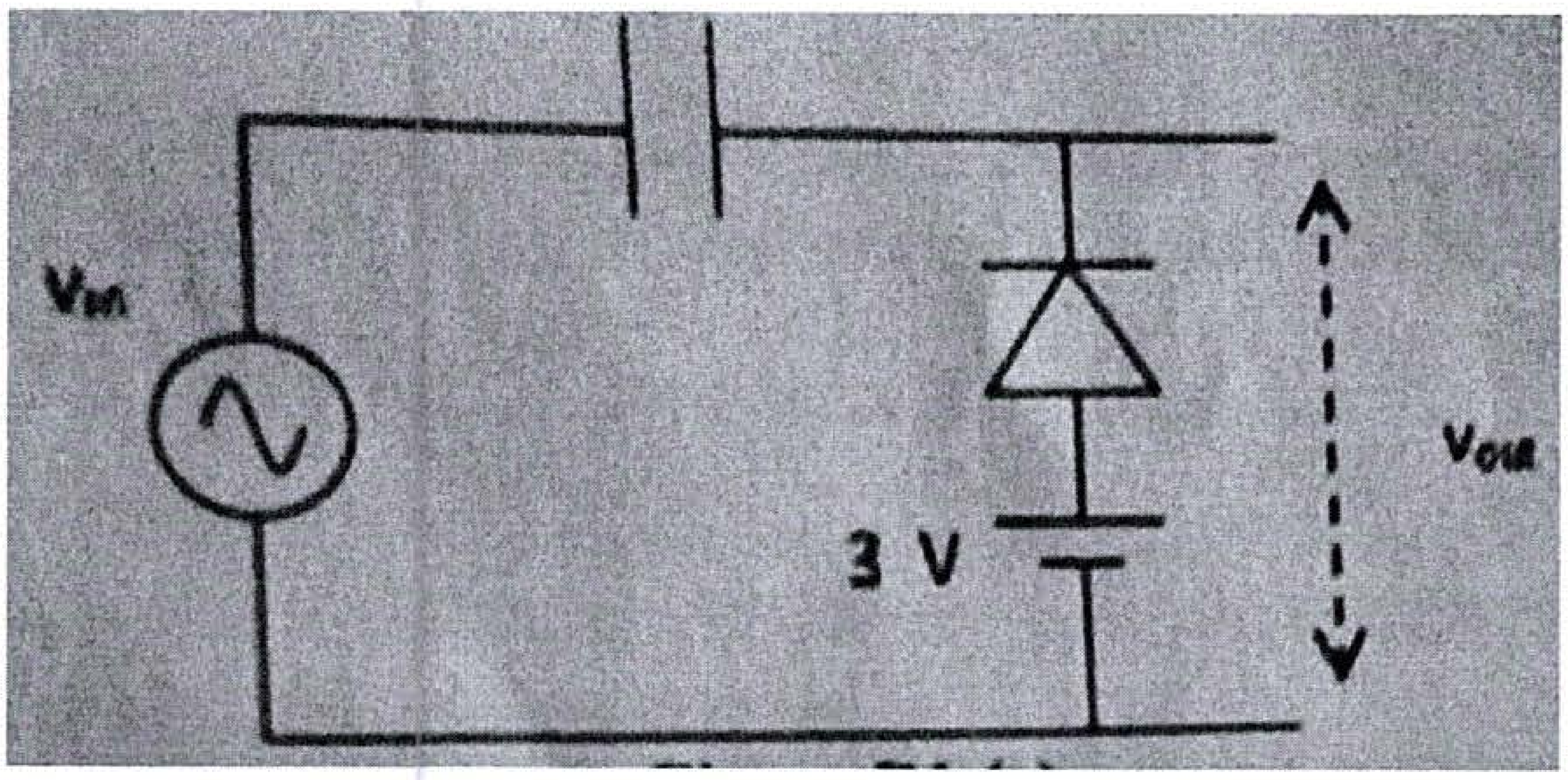
a. Rectifier diode [2]

b. Zener diode [2]

B211 For the circuit below, assume the input voltage is a sine wave voltage with amplitude of 12V. Sketch the output waveform [5]



B212 For the circuit below, assume the input voltage is a sine wave voltage with amplitude of 12V. Sketch the output waveform [5]

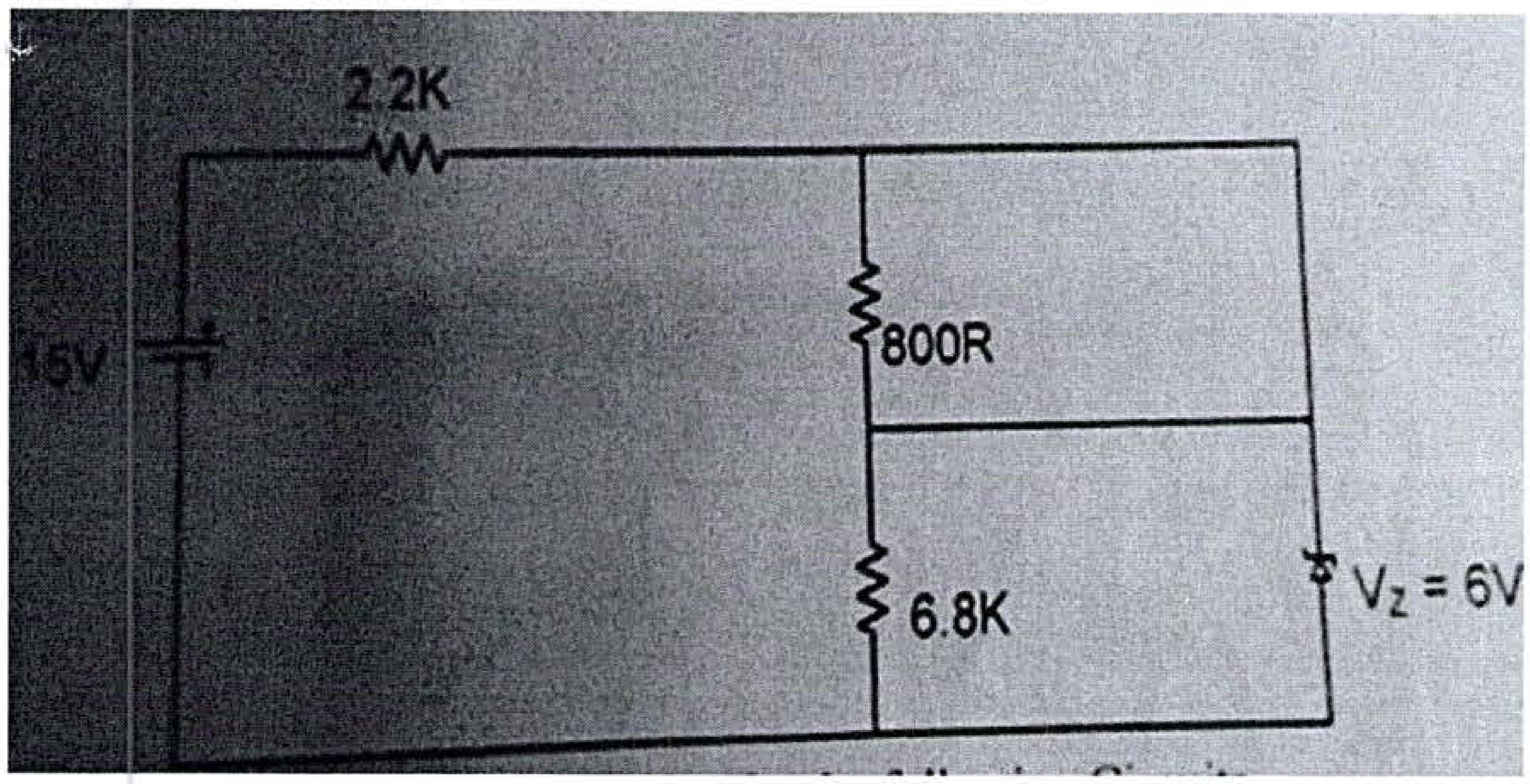


B213 Describe the formation of an intrinsic semiconductor and draw a diagram of the resultant structure after an external energy has been applied. [6]

B214 Describe how the following currents are produced in semiconductor materials

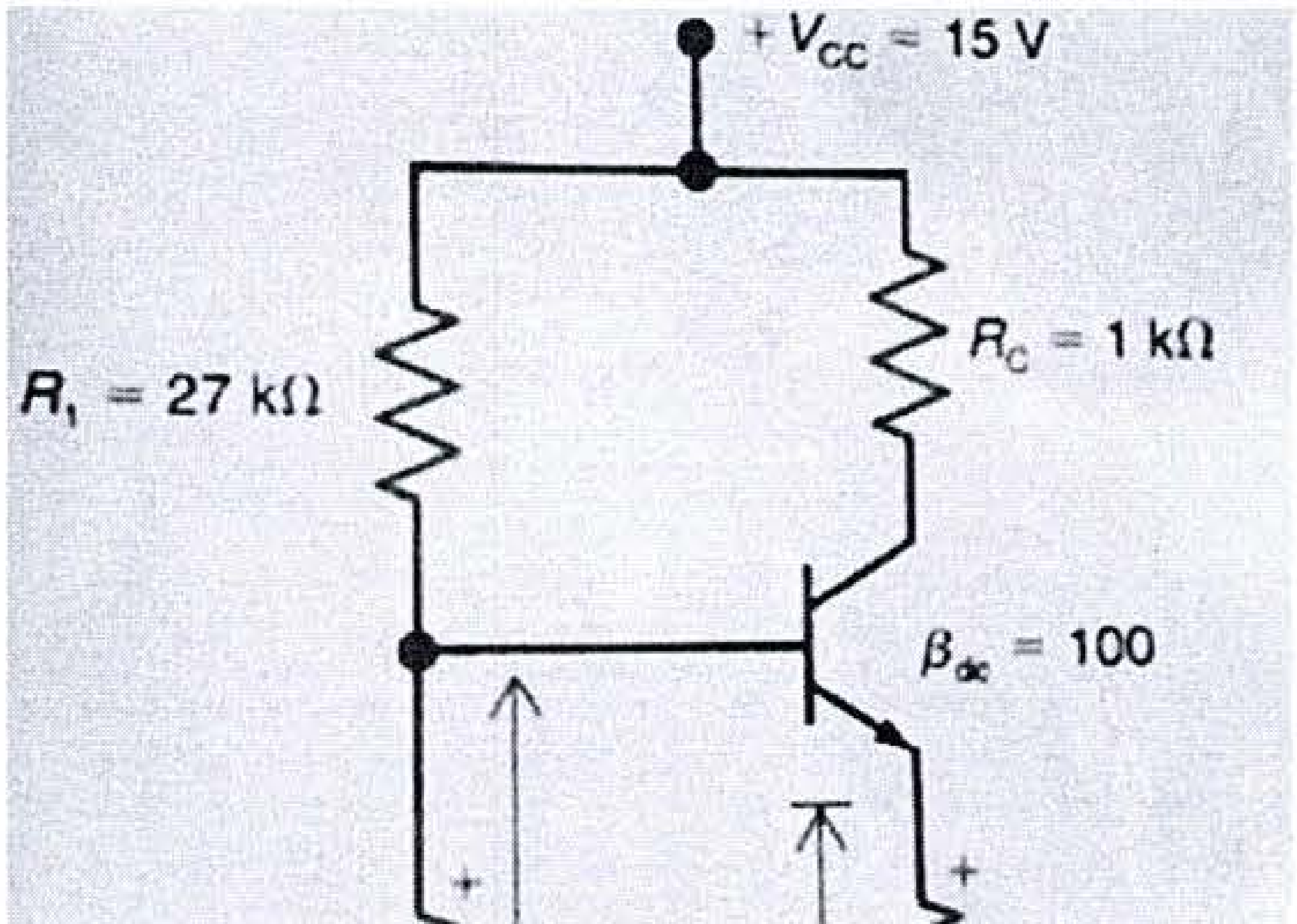
a. Diffusion current [2]
b. Drift current [2]

B311 Calculate the current through each resistor and zener diode [4]



B312 Draw the block diagram of a power supply and explain each block [6]

B313 For the circuit below, determine the values of V_B, V_E, I_E, I_C, V_C and V_{CE}. Hence construct a dc load line showing the values of $I_{C\,(SAT)}$. $V_{CE\,(OFF)}$, I_{CQ} and V_{CEQ}. [10]



B411 Define a rectifier [1]

B412 Draw a full wave bridge rectifier circuit, explain its operation and draw its output waveform. [9]

B413 For the circuit shown below assume that $R_{B1} = 67k\Omega$, $R_{B2} = 32k\Omega$, $R_E = 2.2k\Omega$, $V_{CC} = 20V$, $V_{BE} = 0.7V$ and $\beta = 150$. Calculate I_B, I_E, I_C, V_B, V_E, V_{CE}, V_{CB} and V_C. [10]