Unit 22 · Semiconductor Devices

WORKSHEET

Full marks 33

Name _____ Class _____ Roll no. _____ Date _____ Marks _____ / 33

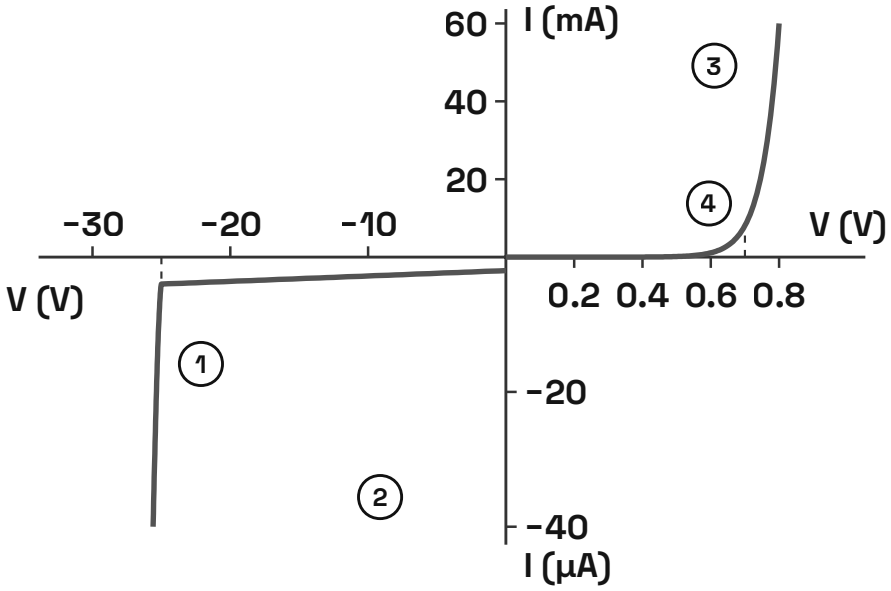
1 Key words [3]

Match each term in Column A with its meaning in Column B. One item in Column B is not needed. Each pair carries 0.5 mark.

Column A		Column B
1. depletion layer	☐	**a.** a circuit that turns a.c. into d.c.
2. barrier potential	☐	**b.** a heavily doped diode made to work in reverse breakdown
3. forward bias	☐	**c.** a gate from which every other gate can be built
4. Zener diode	☐	**d.** a diode that makes a current when light falls on its junction
5. rectifier	☐	**e.** the p.d. across the depletion layer, about 0.7 V for silicon
6. universal gate	☐	**f.** the region at a p–n junction with no free carriers, only fixed ions
		g. the p side joined to the positive terminal, so the layer thins

2 Label the graph [2]

The graph is the I–V characteristic of a silicon diode. Write the label that belongs in place of 1 to 4. Each carries 0.5 mark.



1. _____ **2.** _____

3. _____ **4.** _____

3 Multiple choice [5]

Choose the correct option for each of the following questions.

i. A bridge rectifier is fed from 50 Hz mains. The number of humps in its output each second is: [1]

a. 25 **b.** 50

c. 100 **d.** 200

ii. A silicon diode (0.7 V) and a 1.0 kΩ resistor are joined in series, forward biased, to a 5.0 V battery. The current is about: [1]

a. 5.0 mA **b.** 4.3 mA

c. 5.7 mA **d.** almost zero

iii. The output of a NOR gate is 1 when: [1]

a. both inputs are 1 **b.** either input is 1

c. both inputs are 0 **d.** the inputs are different

iv. When a p–n junction is reverse biased, its depletion layer: [1]

a. becomes wider and the barrier higher **b.** becomes thinner

c. disappears **d.** fills with majority carriers

v. The output of a two-input NAND gate is fed into a NOT gate. Together they act as: [1]

a. an OR gate **b.** an AND gate

c. a NOR gate **d.** a NAND gate

4 Short answers [6]

Write short answers to the following questions.

a. Why does a silicon diode in forward bias carry almost no current until about 0.7 V is across it? [2]

b. Why is a large capacitor joined across the load of a rectifier? [2]

c. Why is a Zener diode joined reverse biased across the load in a voltage regulator? [2]

5 Long answer [4]

Write a long answer to the following question.

With a labelled circuit diagram, explain how a bridge rectifier of four diodes turns a.c. into d.c. Sketch the input and output voltages.

6 Numerical problems [10]

Solve the following problems. Show your working.

a. In a Zener regulator, a 5.1 V Zener diode is joined across a 1.0 kΩ load, with a 230 Ω resistor in series with a 12 V supply. Find i. the current through the resistor, ii. the load current, iii. the Zener current, and iv. the Zener current if the supply rises to 15 V. [4]

Answer:

b. A silicon diode (0.7 V) is joined in series with a 470 Ω resistor to a 6.0 V battery, forward biased. Find the current and the power in the resistor. What happens when the battery is turned round? [3]

Answer:

c. A step-down transformer with a turns ratio of 20 : 1 is joined to the 230 V (rms) mains, and its secondary feeds a bridge rectifier. Taking the diodes as ideal, find the rms and the peak voltage of the secondary, and the frequency of the humps in the rectifier's output. **[3]**

Answer: _____

7 Think **[3]**

Dipesh wants a car's warning buzzer to sound (Y = 1) when the key is in (C = 1) and either the driver's door (A = 1) or the passenger's door (B = 1) is open. Write the Boolean expression, the gates he needs, and the rows of the truth table that give Y = 1.

8 Activity: A diode's forward characteristic (not marked)

Join a silicon diode, forward biased, in series with a 1 kΩ resistor and a milliammeter, and a voltmeter across the diode. Use a rheostat as a potential divider to set the voltage across the diode, from 0 upwards.

V across the diode (V)	0.2	0.4	0.5	0.6	0.65	0.7
I (mA)						

Plot I against V. Where is the knee? Does the diode obey Ohm's law?