Unit 22 · Semiconductor Devices

HARDER PRACTICE QUESTIONS

Full marks 32

Write your answers on separate paper. Show your working. Take the voltage across a conducting silicon diode as 0.7 V.

1 Spot the error [3]

Find the mistake in the working and correct it.

Puja wrote the truth table of a two-input NOR gate:

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

2 Read the data [4]

Bishnu measured the current through a silicon diode at several forward voltages.

V (V)	0.2	0.4	0.6	0.65	0.7	0.75
I (mA)	0	0.01	1	4	12	30

i. Roughly where is the knee?
ii. Find V/I at 0.6 V and at 0.75 V.
iii. Why can't a diode be described by one value of resistance?
iv. What would a 2 V battery joined straight across this diode do? Why?

3 Predict, then explain [3]

Write your prediction first, then explain it.

A half-wave rectifier gives humps above the axis across its load. Predict what you see if i. the diode is turned round, ii. a large capacitor is then joined across the load. Then explain.

4 Show that [3]

Using truth tables, show that a NAND gate with its two inputs joined is a NOT gate, and that three such gates can make an OR gate (A and B each through a NAND-NOT, into a NAND).

5 A real setting [3]

A phone charger has, in order, a step-down transformer, a bridge rectifier, a filter capacitor and a 5 V regulator. Its transformer gives 9.0 V rms. Say what each block does, and find the peak voltage the capacitor charges to (take the diodes as ideal).

6 Which explanation fits? [2]

The reverse current of a diode hardly changes when the reverse voltage is raised from 2 V to 10 V. Anil says the diode must be damaged. Suman says all the minority carriers are already being swept across. Who is right? Why?

7 Correct the misconceptions [3]

The paragraph has three mistakes. Write each mistake and correct it.

> Rekha wrote: “An n-type semiconductor is negatively charged because it has extra electrons. In forward bias the depletion layer becomes wider. A rectifier’s output, without a capacitor, is steady d.c.”

8 Work backwards [3]

A logic circuit with inputs A and B gives Y = 1 only when A = 1 and B = 0. Write its Boolean expression and draw it with basic gates. A NOT gate is then added at its output: write the new truth table.

9 Design it [4]

Sangita needs a steady 6.2 V for a load that takes 20 mA, from a 12 V supply, using a 6.2 V Zener diode. She wants 10 mA to flow through the Zener as well.

i. What series resistor should she use?
ii. What power does the resistor take?
iii. Show that regulation fails if the supply falls to 8.0 V.

10 What if? [2]

What if a reverse-biased diode is warmed? Say what happens to its reverse current, and why.

11 Make your own [2]

Write a Zener regulator problem whose answer is “the Zener current is 15 mA”. Solve it to show it works.