



Attempt all questions before checking the answer key. Use the ideal-diode model only where specified. Draw labelled circuits and characteristic curves.

A. Very short answers - 1 mark each

1. What is an energy band gap?
2. Name the majority carriers in an n-type semiconductor.
3. Why is an extrinsic semiconductor electrically neutral?
4. What forms the depletion region of a p-n junction?

5. Does a forward-biased junction have a wider or narrower depletion layer than an unbiased one?

B. Short answers / practice - 2 marks each

6. Distinguish intrinsic and extrinsic semiconductors in terms of carrier sources.
7. Explain how pentavalent doping of silicon produces n-type material.
8. Explain how trivalent doping produces p-type material without making the crystal positively charged overall.
9. Compare the temperature dependence of resistance of a metal and an intrinsic semiconductor.
10. State how the battery must be connected for forward and reverse bias of a p-n diode.
11. Is a p-type semiconductor positively charged overall?
12. Are electrons minority carriers in p-type material?
13. An ideal diode is reverse biased in series with $2\text{ k}\Omega$ and 10 V . Find current.
14. A silicon diode drops 0.7 V in series with $1\text{ k}\Omega$ across 3.7 V . Find current.
15. Why is a depletion layer poor in mobile charge carriers?
16. Does reverse bias generally increase depletion-layer width?
17. State one difference between donor and acceptor impurities.
18. Find full-wave output pulse frequency for a 60 Hz input.
19. Find half-wave output pulse frequency for a 60 Hz input.

20. Explain why rectification produces a unidirectional but varying current.

C. Short answers - 3 marks each

21. Draw qualitative energy-band diagrams for a conductor, semiconductor and insulator. Explain the difference in conductivity.
22. Describe formation of the depletion layer and barrier potential when p-type and n-type regions form a junction.
23. Sketch forward and reverse I-V characteristics of a diode. Explain the small reverse current before breakdown.
24. An ideal forward-biased diode and a $1\text{ k}\Omega$ resistor are in series across 5 V . Find current; repeat with reversed diode polarity. Then find forward current using a 0.7 V silicon-diode drop.
25. Explain why a diode acts as a rectifier and why the output of a rectifier is not automatically steady DC.

D. Long answers - 5 marks each

26. Explain intrinsic conduction and the effect of doping using band diagrams. Compare donor and acceptor levels, majority carriers and minority carriers.
27. Explain a p-n junction under zero bias, forward bias and reverse bias. Discuss barrier potential, depletion width and current in each case.
28. Draw and explain a half-wave rectifier using a diode. Sketch input/output waveforms and state output pulse frequency for a 50 Hz input.
29. Draw a centre-tapped full-wave rectifier and explain diode conduction during both half-cycles. Sketch the output and compare it with half-wave rectification.
30. A centre-tapped transformer provides 12 V peak from either end to the centre. With ideal diodes and a $600\text{ }\Omega$ load in a full-wave rectifier, find peak load current and output pulse frequency for 50 Hz input. Explain which diode conducts in each half-cycle.

ANSWER KEY - Numerical / short answers

- 5) Narrower. 11) No; it remains neutral. 12) Yes. 13) 0 A . 14) 3 mA . 16) Yes. 18) 120 Hz . 19) 60 Hz . 24) 5 mA forward; zero reverse ideally; 4.3 mA with 0.7 V drop. 28) 50 Hz . 30) 20 mA ; 100 Hz .