Chapter 6

Semiconductors, diodes and applications of diodes

One mark questions (knowledge):

1. What are conductors?
2. What are semiconductors?
3. Define valance band.
4. Define conduction band.
5. Name the majority charge carriers in n-type semiconductor.
6. Name the majority charge carriers in p-type semiconductor.
7. What is forbidden energy gap?
8. What is doping?
9. Name any one acceptor impurity.
10. Name any one donor impurity.
11. What is the value of potential barrier of a silicon diode?
12. Write the symbol of a p-n junction diode.
13. What is the static resistance of a diode?
14. Define dynamic resistance of a junction diode.
15. What is reverse saturation current?
16. Mention the Shockley's equation for diode.
17. What is an ideal diode?
18. What is clipping circuit?
19. What is a clamper?
20. What is rectification?
21. What is a rectifier?
22. What is the function of a filter in rectifier circuit?
23. What is a Zener diode?
24. Write the schematic symbol of a Zener diode.
25. Define Zener breakdown voltage.
26. Mention the main application of Zener diode.
27. What is line regulation?
28. What is load regulation?
29. What is LED?
30. What is a varactor diode?
31. Write the symbol of a varactor diode.
32. What is an infrared LED?
33. Write the symbol of an IR LED.
34. Name any one application of an IR LED.
35. What is a photodiode?
36. Write the symbol of a photodiode.
37. Write any one application of a photodiode.
38. What is a tunnel diode?
39. Write the symbol of a tunnel diode.

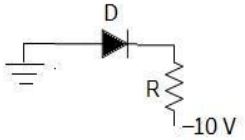
40. What is a Schottky diode?
41. Mention any one application of Schottky diode.
42. Mention any one application of a seven segment display.
43. Expand LCD.
44. Name the IC regulator used to construct +12 V fixed voltage regulator.
45. Name the IC regulator used to construct adjustable positive voltage regulator.

One mark questions (Understanding):

1. How p-n junction is formed?
2. What is meant by depletion region?
3. What do you mean by potential barrier?
4. What is meant by biasing a p-n junction?
5. What is meant by forward biasing?
6. What do you mean by reverse bias?
7. What is the effect of forward bias on the width of a p-n junction?
8. What is the effect of reverse bias on the width of a p-n junction?
9. Is reverse saturation current depends on temperature?
10. What do you mean by junction breakdown?
11. Give the expression for transition capacitance.
12. Write the equivalent circuit of a reverse biased ideal diode.
13. Write the equivalent circuit for second approximation of a diode.
14. Write the equivalent circuit for third approximation of a diode.
15. What is the power rating of a diode?
16. What is the importance of peak inverse voltage?
17. What is the value of ripple factor in half wave rectifier?
18. In what respect Zener diode is different from an ordinary diode.
19. Name the active component used for voltage regulation.
20. Under which bias LED is operated?
21. During which process light is emitted from LED?
22. Under which biasing condition is a varactor diode operated?
23. In what bias condition is a photodiode normally operated?
24. Name any one application of tunnel diode.

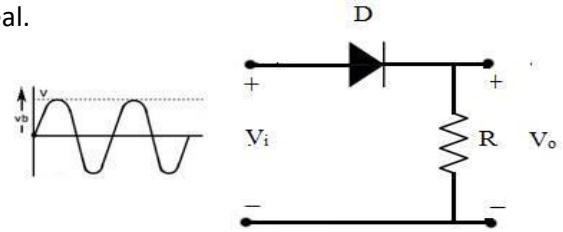
One mark questions (Application):

1. Draw the equivalent circuit of a forward biased ideal diode.
2. In the figure shown, is the diode D forward or reverse biased?

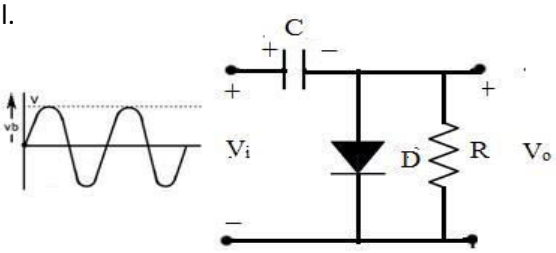


3. In which type of bias, the p-n junction diode resistance is high?

4. Sketch the shape of the output voltage waveform for the circuit shown below assuming the diode to be ideal.



5. Sketch the shape of the output voltage waveform for this circuit shown below assuming the diode to be ideal.



6. Determine average DC voltage of HWR. Given V_m = 9V. Ans: V_{av} = 2.86 V
7. Name any one application of a varactor diode.
8. Draw the equivalent circuit of a Zener diode.
9. Draw the symbol of a Schottky diode.
10. Draw the schematic symbol of LED.

Two marks questions (Knowledge):

1. Classify extrinsic semiconductor.
2. Mention majority and minority charge carriers in n-type semiconductor.
3. Draw the crystalline structure of a p-type semiconductor.
4. Mention the typical values of knee voltage for Ge and Si diodes.
5. Define ideal diode. Draw its V-I characteristics.
6. Mention any two applications of a diode.
7. Mention wave shaping circuits.
8. What is clipping circuit? Mention any one application of clipping circuit.
9. What is clamping circuit? Mention any one application of clamping circuit.
10. Write the circuit of series positive clipper and show the input and output waveforms.
11. Write the circuit of series negative clipper and show the input and output waveforms.
12. Write the circuit of positive clamper and show the input and output waveforms.
13. Write the circuit of negative clamper and show the input and output waveforms.
14. Define ripple factor and give its significance.
15. Write the circuit diagram of a full wave rectifier along with the input and output wave forms.
16. What are the values of rectification efficiency of a full wave rectifier and half wave rectifier?
17. What is Zener break down?
18. What is voltage regulation? Mention the types of voltage regulation.
19. Write any two application of LED.
20. Mention any two applications of LCD.

Two marks questions (Understanding):

1. Explain the phenomenon of diode reverse breakdown.
2. What do you mean by the transition capacitance of a diode?
3. A p-n junction diode is a non linear element. Explain.
4. Distinguish between Ge and Si diode.
5. Explain the second approximation of a semiconductor diode.
6. Explain the third approximation of a semiconductor diode.
7. Distinguish between positive and negative clipper?
8. What is the difference between positive and negative clamper?
9. How many diodes are used in a (i) Centre tapped full wave rectifier and (ii) Bridge rectifier?
10. Distinguish between full wave rectifier and half wave rectifier.
11. Distinguish between series inductor filter and shunt capacitor filter.
12. Explain the need of a voltage regulator circuit in a power supply.

Two marks questions (Application):

1. Draw the lattice structure of silicon.
2. Draw the circuit diagram of a forward biased p-n junction diode.
3. Draw the circuit diagram of a reverse biased p-n junction diode.
4. A silicon diode has a bulk resistance of 1.5 Ω and a forward current of 10 mA. What is the forward voltage drop across the diode? Ans: 0.715 V
5. Draw the VI Characteristics of Zener diode.
6. Draw the circuit diagram of +12 V voltage regulator.
7. Draw the circuit diagram of an adjustable voltage regulator.
8. Draw the diagram of seven segment LED display.

Three marks question (Knowledge):

1. Classify solids based on energy band diagram.
2. Write the properties of semiconductor.
3. Briefly explain n-type semiconductors.
4. Briefly explain p-type semiconductors.
5. Write a note on diode junction capacitance.
6. Write a note on diode specifications.
7. Write a note on diode approximations.
8. Write a note on fixed positive regulator.

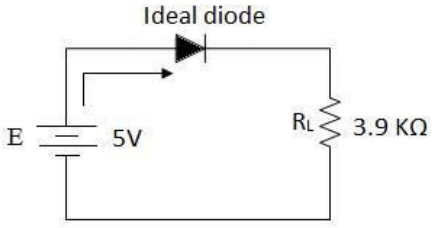
Three marks questions (Understanding):

1. How is the depletion region formed in a p-n junction?
2. Explain the working of a p-n junction when it is forward biased.
3. Explain the action of series positive clipper.
4. Explain the action of series negative clipper.
5. Explain the working of positive clamper.
6. Explain the working of negative clamper.
7. Explain the working of a p-n junction when it is reverse biased.

8. Explain the working of LED.
9. Explain common anode type of seven segment display.
10. Compare LED display with LCD display.

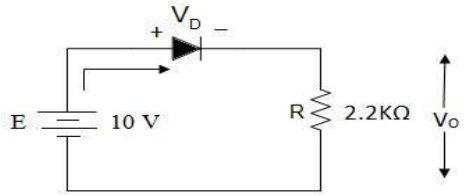
Three marks questions (Application):

1. A silicon diode dissipates 2.5 W for a forward current of 1.5 A. Determine the forward voltage drop across the diode and its bulk resistance. Ans: $V_F = 1.66$ V, $R_B = 0.64\ \Omega$
2. Calculate the load voltage and load current for the circuit shown.



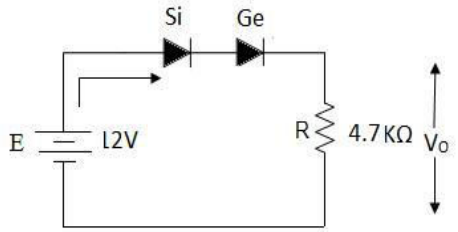
Ans: $V_L = 5$ V, $I_L = 1.28$ mA

3. A silicon diode is used in the circuit shown in figure. Determine V_D, V_R and I_D.



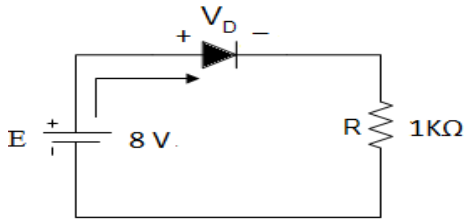
Ans: $V_D = 0.7$ V, $V_R = 9.3$ V and $I_R = 4.22$ mA

4. For the series diode configuration shown in figure, determine the current I_D and V_R.



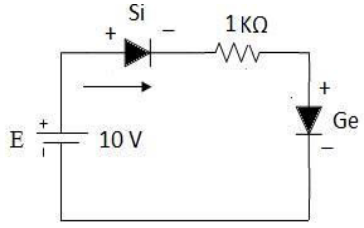
Ans: $V_R = 11$ V, $I_R = 2.34$ mA

5. Find the value of an applied voltage for Si diode having bulk resistance 25 Ω and a forward current of 2 mA. Ans: 0.75 V
6. A germanium diode is used in the circuit shown in figure. Determine V_D, V_R and I_D.



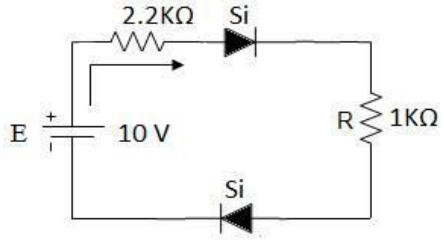
Ans: $V_D = 0.3$ V, $V_R = 7.7$ V, $I_D = 7.7$ mA

7. Determine the current through 1 KΩ resistor.



Ans: 9 mA

8. For the series diode configuration as shown in figure, determine the value of current through the circuit.



Ans: 2.60 mA

9. In a power supply the DC output voltage drops from 65 V with no load to 60 V at full load. Calculate the percentage voltage regulation Ans: 7.69%
10. Ideal diodes are used in constructing a centre tapped full wave rectifier circuit. An ac 200 V, 50 Hz applied across a transformer. If N_p= 500 turns, $N_{s1} = N_{s2}$ = 150 turns and R_L = 1 kΩ, Calculate rms values and DC values of the current and voltage.

Ans: V_{rms} = 60 V, I_{rms} = 0.06 A, V_{dc} = 54.04 V, I_{dc} = 0.054 A

Five marks questions (Application):

1. A half wave rectifier uses a diode with a forward resistance of 50 Ω. If the input ac voltage is 200V rms and the load resistance is of 1 kΩ, determine
   (i) I_m (ii) I_{dc} (iii) I_{rms} (iv) Ripple factor (v) Rectification efficiency

   Ans: I_m = 0.269 A, I_{dc} = 0.085 A, I_{rms} = 0.134A, ϒ = 1.21, η = 38.32 %
2. The load resistance of a full wave rectifier is 500 Ω and the transformer secondary voltage is 80sinωt. Assume the diodes to be an ideal, determine the following: (i) rms values of voltage and current (ii) average values of voltage and current (iii) efficiency of rectifier and (iv) ripple factor.

   Ans: V_{rms} = 56.57 V, I_{rms} = 0.113 A, V_{dc} = 50.92 V, I_{dc} = 0.102 A, η = 81.2%, ϒ = 0.48
3. A single phase full wave rectifier uses two diodes with the internal resistance of each being 120 Ω. The transformer rms secondary voltage from the centre to each end of secondary is 30 V and load resistance is 200 Ω. Determine (i) rms value of voltage and current and (ii) average value of voltage and current (iii) ripple factor and (iv) efficiency of rectifier.

   Ans: V_{rms} = 30 V, I_{rms} = 0.141 A, V_{dc} = 27.03 V, I_{dc} = 0.135 A, ϒ = 0.48, η = 80.66 %
4. A 230 V, 50 Hz AC voltage is applied to the primary of 5:1 step down transformer, which is used in bridge rectifier, having a load resistance of 100 Ω. Assuming the diodes to be an ideal, determine the following:
   (i) DC output current (ii) DC output voltage (iii) DC power delivered to the load and (iv) PIV of each diode.

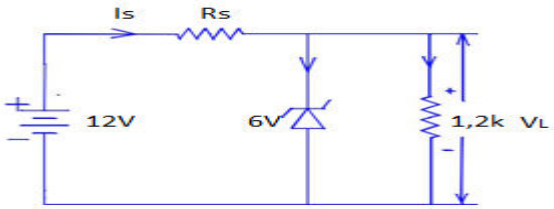
   Ans: I_{dc} =0.41 A, V_{dc} = 41.4 V, P_{dc} = 16.8 W, PIV = 130.1 V
5. A centre tapped transformer has a 230 V primary winding and a secondary winding rated at 15 V-0-15 V and is used in a full wave rectifier circuit with a load of 120 Ω. What is the dc output voltage, dc load current and the PIV rating required for diodes?

   Ans: V_{dc} =13.5 V, I_{dc} = 0.11 A, PIV = 42.43 V
6. For the Zener diode voltage regulator with V_S = 20 V, R_S = 100 Ω, V_Z = 12 V, R_L = 680 Ω, determine
   a. Load voltage
   b. Voltage drop across series resistance R_s
   c. Current through the Zener diode

Ans: $V_L = V_Z = 12$ V, $V_{RS} = 8$ V, $I_Z = 62.35$ mA

7. Calculate the load current and Zener diode current if $V_Z = 6$ V. Given $V_S = 25$ V, $R_S = 1.5$ kΩ and $R_L = 2$ kΩ. Ans: $I_L = 3$ mA, $I_Z = 9.6$ mA
8. In the circuit shown in fig. find the value of series resistance R_S, if Zener current is 10 mA.

Ans: Rs = 400 Ω



Five marks questions (Knowledge):

1. Classify solids based on energy band diagram.
2. Draw and explain the V-I characteristics of a p-n junction diode.
3. Explain the working of full wave centre tapped rectifier.
4. Explain the working of half-wave rectifier.
5. Explain the operation of bridge rectifier.
6. Explain the negative voltage rectifier.
7. Explain the working of a series inductor filter.
8. Explain the working of a shunt capacitor filter.

Five marks questions (Understanding):

1. How do you draw the forward and reverse characteristics of a semiconductor diode.
2. Explain the characteristics of a Zener diode.
3. Discuss the working of a Zener diode as a voltage regulator.
4. Explain the regulated +12 V DC power supply.
5. Describe the regulated -12 V power supply.

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