PHYSICS

BOOKS - CHHAYA PHYSICS (BENGALI ENGLISH)

SEMICONDUCTORS AND ELECTRONICS

Numerical Examples

1. An intrinsic semiconductor has 5×10^{28} atoms and the carrier concentration 1.5×10^{16} .If it is doped by a pentavalent impurity in the ratio $1 : 10^6$, then calculate number density of holes as charge carriers.

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2. A semiconductor har equal electron and hole concentrations of $6 \times 10^{8} \mathrm{m}^{-3}$. On doping with a certain impurity,the electron concentration of the semiconductor increases to $8 \times 10^{12} \mathrm{m}^{-3}$. (i) What type of semiconductor is obtained on doping? (ii) Calculate the new hole concentration of the semiconductor.

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3. A semiconductor has the electron concentration $0.45 \times 10^{12} \mathrm{m}^{-3}$ and the hole concentration $5 \times 10^{20} m^{-3}$. Calculate the conductivity of the material of this semiconductor.

Given, Electron mobility $= 0.135 \mathrm{m}^2 . V^{-1} . s^{-1}$ and hole mobility $= 0.048 \mathrm{m}^2 . V^{-1} . s^{-1}$.

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4. The potential barrier of a p-n junction diode is 0.4 V . If the thickness of the depletion region be , what will be $4.0 \times 10^{-7}$the electric field intensity in this region? An electron from the n-region moves towards

the p-n junction with velocity $6 \times 10^5 \mathrm{m}. s^{-1}$. What will be the velocity of the elec- tron with which it enters the p-region?

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5. In a common- emitter circuit, collector- emitter voltage is fixed at 5V. For base currents 30μA and 40 μ A, the collector currents are 8.2 mA and 9.4 mA respec- tively. Calculate current gain of the circuit.

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6. The collector current in an n-p-n transistor is 10 mA. If 99. 5% of the emitted electrons reach the collector, determine the emitter current, base current and amplification factor of the transistor.

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7. An n-p-n transistor is Kept in common- emitter con-figuation. Amplification factor of the transistor is 100.If the collector current is changed by 1 mA, what will by the corresponding change in the emitter current?

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8. The input resistance of a silicon transistor is 100Ω . Base current is changed by 40μ A which results in a change in collector current by 2 mA. This transistor is used as a common emitter amplifier with a load resistance of 4 k Ω. What is the voltage of the amplifier?

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Section Related Questions

1. What do you mean by a semiconductor ?

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2. Given two examples of each of conductor insulator and semiconductor.

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3. How does the resistance of a semiconductor vary with temperature ?

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4. Explain the electrical conductivity of a semiconductor with the help of band theory.

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5. Distinguish between a metal and an insulator with the help of energy band diagram.

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6. What do you mean by a hole ? How is it produced ?

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7. Write down the difference between conductor semiconductor and insulator.

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8. What are the charge carriers in (i) conductors (ii) insulators and (iii) semiconductors ?

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9. Draw the energy band diagram of an intrinsic semiconductor.

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10. What is meant by doping in semiconductors?

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11. What do you mean by n-type [HS'01] and p-type semiconductors?

Or , What are p-type semiconductors?

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12. Explain how an intrinsic semiconductor can be converted into an n-type semiconductor and a p-type semiconductors. Draw the energy band diagrams of n-type and p-type semicon ductors.

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13. State the difference between n-type and p-type semiconductors.

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14. What do you mean by donor atom and acceptor atom?

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15. State the expression of the electrical conductivity of the material of a semiconductor in terms of the mobilities of electrons and holes.

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16. Write the working principles of n-type and p-type semiconductors.

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17. What is a p-n junction diode?

Or,What is a junction diode?

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18. Explain the working principle of a p-n junction.

Watch Video Solution

19. What do you mean by depletion layer?

Watch Video Solution

20. Draw the characteristic curve of a samiconductor diode.

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21. Draw the circuit diagram of a junction diode acting as a full-wave rectifier.

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22. Why is a silicon diode better than a germanium diode in a rectifier circuit?

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23. Draw the circuit diagram of a forward biased and reverse biased p-n junction diode.

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24. What is rectification ? Explain with diagram how a p-n junction diode acts as a half-wave rectifier.

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25. Draw the circuit diagram of a half -wave rectifier using p-n junction diodes. Draw the input and output voltage form by a schematic graph.

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26. Explain what happens to the depletion layer ,if the junction is forward biased and reverse biased.

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27. What is a Zener diode?

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28. What is the breakdown of a diode?

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29. Draw the characteristic curve of a Zener diode. From this curve, explain the speciality of a Zener diode in respect to a general semiconductor diode.

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30. For what purpose is the Zener diode generally used?

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31. Draw a circuit diagram to illustrate the action of a Zener diode as a voltage regulator.

Draw the current versus voltage characteristics curve of a Zener diode. Indicate the position of Zener voltage in the curve.

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32. What do you mean by the load regulation in a voltage regulator?

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33. What is a light emitting diode (LED)?

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34. Draw the characteristic curve of a LED. Can you recognise any difference from the characteristic curve of an ordinary semiconductor diode?

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35. What is meant by a photodiode ? What are its main practical uses?

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36. Draw the ampere-volt characteristic curve of a photodiode and mention the significance of its salient features.

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37. What is a solar cell? How does a solar diode behave as a battery?

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38. How many kinds of transistor are there? What is the main function of a transistor?

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39. Draw the circuit diagrams of p-n-p and n-p-n transistors.

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40. Show the structures of a p-n-p transistor and an n-p-n transistor with the help of diagrams.

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41. What do you mean by current amlificantion factor?

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42. What do you understand by active region saturation region and cut -off region of a transistor ?

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43. What are the input and output resistance of a transistor in its CE mode?

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44. Draw few output characteristics of a given p-n-p transistor in CE configuration from which β can be obtained and explain how to determine it. (Take different I_B).

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45. What do you understand by the term current gain -β of a transistor ?

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46. Define α and β parameters of a transistor. What is the relation between them?

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47. What do you mean by transistor switch?

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48. Draw the circuit diagram for plotting the characteristics of a transistor in common emitter configuration. What is current magnification?

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49. Draw a circuit diagram of a CE amplifier by using n-p-n transistor and show input and output voltages graphically.

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50. What do you mean by an oscillator ?

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51. Write down Barkhausen Criterion of oscillation.What is the importance of this criterion?

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52. What is feedback in an amplifier circuit?

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53. Derive the relationship between open loop gain and closed loop gain of an amplifier circuit with

reference to feedback ratio.

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54. Given a brief description of LC feedback oscillator. What is the source of its input signal ? What is the frequency of its output signal ?

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55. What is the practical utility of positive feedback and negative feedback?

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Higher Order Thinking Skill Hots Questions

1. When a semiconductor is irradiated by light of definite wavelength its resistance decreases.Exaplain why.

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2. What happens if the amount of reverse bias in a p-n junction diode is gradually increased ?

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3. At absolute zero temperature the conductivities of both the insulators and the semiconductors are zero. At any higher temperature the semiconductor may have some conductivity but for insulator it is zero. Explain why.

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4. You are given two bars of same resistance, one of them is a conductor and the other is a semiconductor. How will you distinguish them experimentally?

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5. Draw the voltage-current charateristics of a p-n junction and compare it with the characteristics of a resistor.

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6. What is the effect of doping on the depletion layer of a p-n junction?

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7. Why does the conductivity of a pure semiconductor increases with rise in temperature ?

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8. In which kind of biasing of a p-n junction the net holes flows the n-region to the p-region ?

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9. Explain why the resistance of a semiconductor decreases with increase in temperature.

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10. In a transistor the base is made very thin. Explain the reason.

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11. Why is a transistor called temperature- sensitive device?

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12. In a transistor the forward bias is always small as compared to the reverse bias. Why?

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13. Explain why the input resistance of a transistor is low while the output resistance is high.

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14. The gain of a common- emitter amplifier is given by $A_v = -g_m R_L$. Does it mean that if we Keep on increasing R_L indefinitely,the gain of the amplifier will also increase indefinitely? Explain your answer.

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15. If the emitter and base of a transistor have same doping concentration, how will the base current and the collector current be affected?

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16. How will you test wheather a transistor is damaged or not?

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17. Under normal use of transistors, the emitter is forwerd biased while the collector is reverse biased.

Can either of these biasing be changed? Explain.

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18. Can two separate p-n junction diodes placed back to back be used to form a p-n-p transistor ?

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Ncert Textbook Questions With Answer Hint

1. In an n-type silicon, which of the following statements is true?

A. electrons are majority carriers and trivalent atoms are the dopants

B. electrons are minority carriers and pentavalent atoms are dopants

C. holes are minority carriers and pentavalent atoms are dopants

D. holes are majority carriers and trivalent atoms are dopants

Answer: C

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2. In an unbiased p-n junction holes diffuse from the p-region to the n-region because

A. free electrons in the n-region attract them

B. they move across the junction by the potential difference

C. hole concentration in p-region is more as compared to n-region

D. all the above

Answer: C

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3. Carbon silicon and germanium have four valence electrons each. These are characterised by valence and conduction bands separated by energy band gap respectively equal to $(E_g)_C$, $(E_g)_{Si}$ and $(E_g)_{Ge}$ which of the following statements is true?

A. $(E_g)_{Si} < (E_g)_{Ge} < (E_g)_C$

B. $(E_g)_C < (E_g)_{Ge} < (E_g)_{Si}$

C. $(E_g)_C > (E_g)_{Si} > (E_g)_{Ge}$

D. $(E_g)_C = (E_g)_{Si} = (E_g)_{Ge}$

Answer: C

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4. In half-wave rectification what is the output frequencey if the input frequency is 50 Hz. What is the output frequency of a full-wave rectifier for the same input frequency?

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5. For a CE -transistor amplifier the audio signal voltage across the collector resistance of 2 $k\Omega$is 2V. Suppose the current amplification factor of the transistor is 100 find the input signal voltage and base current if the base resistance is 1 k Ω.

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6. The amplifiers are connected one after the other in series (cascaded). The first amplifier has a voltage gain of 10 and the second has a voltage gain of 20. If the input signal is 0.01 V, calculate the output ac signal.

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7. A p-n photodiode is fabricated from a semiconductor with band gap of 2.8 eV. Can it detect a wavelength of 6000 nm?

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8. In an intrinsic semiconductor the energy gap E_g is 1.2 eV. Its hole mobility is much smaller than electron mobility and independent of temperature. What is the ratio between conductivity at 600 K and that at 300 K? Assume that the temerature dependence of intrinsic carrier concentration n_i is given by

$n_i = n_0 \exp\left(-\frac{E_g}{2k_B T}\right)$ where n_0 is a constant.

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9. The number of silicon atoms per m^3 is 5×10^{28}. This is doped simultaneously with 5×10^{22} atoms per m^3 of arsenic and 5×10^{20} atoms per m^3 of indium. Calculate the number of electrons and holes . Given

that $n_i = 1.5 \times 10^{16} \mathrm{m}^{-3}$. Is the material n-type or p-type?

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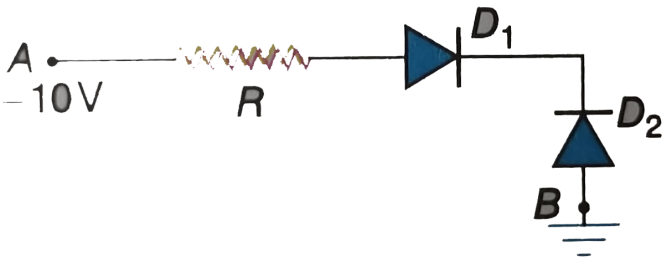
Ncert Exemplar Questions With Answer Hint Single Option Correct

1. In Fig 1.50 assuming the diodes to be ideal



A. D_1 is forward biased and D_2 is reverse biased hence current flows from A to B

B. D_2 is forward biased and D_1 is reverse biased hence no current flows from B to A and vice versa

C. D_1 and D_2 are both forward biased and hence current flows A to B

D. D_1 and D_2 are both reverse biased and hence no current flows from A to B and vice versa

Answer: B

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2. A 220 V ac supply is connected between points A and B [Fig.1.51]. What will be the potential difference V across the capacitor?

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A. 220 V

B. 110 V

C. 0 V

D. 222 $\sqrt{2}$ V

Answer: D

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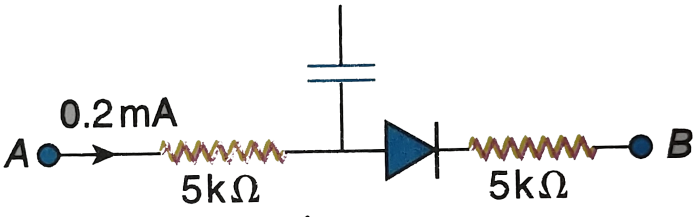
3. In the circuit shown in Fig 1.52, if the diode forward voltage drop is 0.3 V the voltage difference between A and B is



A. 1.3 V

B. 2.3 V

C. 0

D. 0.5 V

Answer: B

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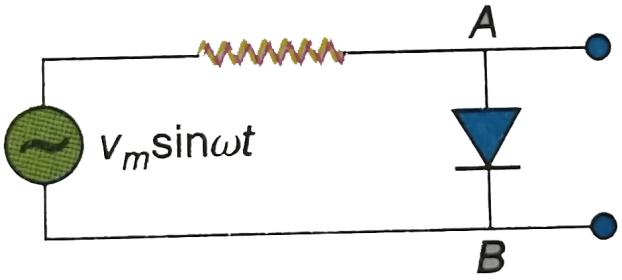
4. The output of the given circuit in Fig 1.53.



A. would be zero

B. would be like a half-wave rectifier with positive cycles in output

C. would be like a half-wave rectifier with negative cycles in output

D. would be like that of a full-wave rectifier

Answer: C

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5. The breakdown in a reverse biased p-n junction is more likely to occur due to the

A. large velocity of the minoriy charge carriers if the doping concentration is small

B. large velocity of the minority carriers if the doping concentration is large

C. strong electric field in a depletion region if the doping concentration is small

D. strong electric field in the depletion region if the doping concentration is large

Answer: A::D

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6. In an n-p-n transistor circuit, the collector current is 10 mA. If 95% of the electrons emitted reach the collector, which of the following statements are true?

A. the emitter current will be 8 maA

B. the emitter current will be 10.53 mA

C. the base curent will be 0.53 mA

D. the base current will be 2mA

Answer: B::C

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Ncert Exemplar Questions With Answer Hint Multiple Options Correct

1. Consider an n-p-n transistor with its base -emitter junction forward biased and collector -base junction reverse biased. Which of the following statements are true ?

A. electrons cross over over from emitter to collector

B. holes move from base to collector

C. electrons move from emitter to base

D. electrons from emitter move out of base without going to the collector

Answer: A::C

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Exercise Multiple Choice Questions

1. If potential difference is applied the value of electric current

A. becomes infinite for an insulator kept at 0 K

B. becomes zero for a semiconductor kept 0 K

C. becomes finite for a metal kept at 0 K

D. becomes infinite in a forward biased p-n junction diode kept at 300 K

Answer: B

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2. Two pieces of copper and germanium are cooled from room temperature to 77 K. As a result

A. resitance of both the pieces will increase

B. resistance of both the pieces will decrease

C. resistance of copper will decrease but that of germanium will increase

D. resistance of copper will increase but that of germanium will decrease

Answer: C

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3. For in intrinsic semiconductor the energy gap of forbidden zone is approximately

A. 0.01 eV

B. 0.1 eV

C. 1 eV

D. 10 eV

Answer: C

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4. In a semiconducting material the mobilities of electrons and holes are μ_e and μ_h respectively. Which of the following is true ?

A. $\mu_e > \mu_h$

B. $\mu_e < \mu_h$

C. $\mu_e = \mu_h$

D. $\mu_e < 0, \mu_h > 0$

Answer: A

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5. In some substance charge can flow at ordinary temperature but not at very low temeratures. These are called

A. conductors

B. insulators

C. semiconductors

D. dielectrics

Answer: C

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6. If a small amount of antimony is added to germanium crystal

A. it becomes a p-type semiconductor

B. the antimony becomes an acceptor atom

C. there will be more free electrons than holes in the semiconductor

D. its resistance is increased

Answer: C

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7. Pure Si at 500 K has equal number of electron (n_e) and hole (n_h) concentrations of $1.5 \times 10^{16}\mathrm{m}^{-3}$. Doping by indium increases n_h to $4.5 \times 10^{22}\mathrm{m}^{-3}$. The doped semiconductor is of

A. p-type having electron concentration $n_e = 5 \times 10^{9}\mathrm{m}^{-3}$

B. n-type having electron concentration $n_e = 5 \times 10^{22}\mathrm{m}^{-3}$

C. p-type having electron concentration $n_e = 2.5 \times 10^{10}\mathrm{m}^{-3}$

D. n-type having electron concentration

$$n_e = 2.5 \times 10^{23} \mathrm{m}^{-3}$$

Answer: A

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8. If a p-n junction diode is not connected in a circuit then

A. potential is same everywhere

B. potential of p-end is more than n-end

C. an electric field acts from the n-end to p-end at the junction

D. an electric field acts from the p-end to n-end at the junction

Answer: C

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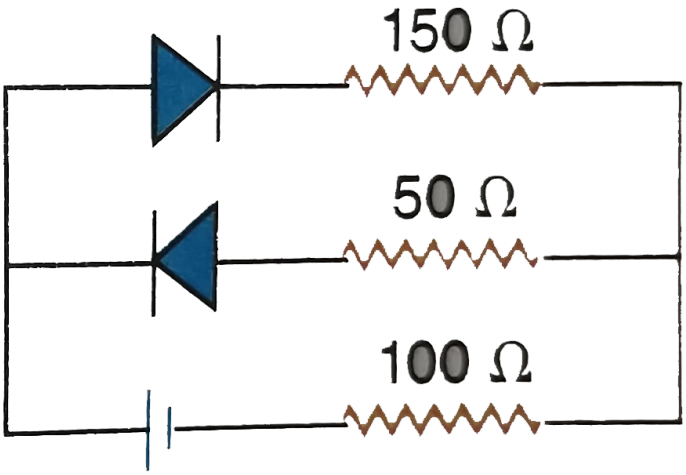
9. In the circuit shown in Fig 1.54 the forward bias resistances of both the diodes are 50 Ω and reverse bias resistances are infinite. If the battery voltage be 6V , the current throught 100 Ω resistance in the unit

A is



A. zero

B. 0.02

C. 0.03

D. 0.036

Answer: B

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10. When a p-n diode is reverse biased then

A. no current flows

B. the depletion region is increased

C. the depletion region is reduced the height of the potential barrier is reduced.

D.

Answer: B

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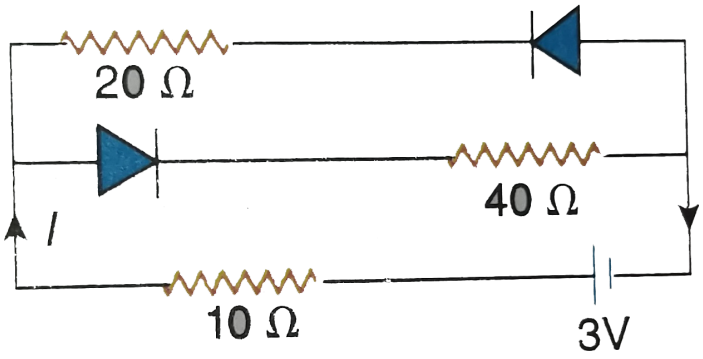
11. The current through the given circuit of Fig .1.56.



A. $\frac{3}{40}$ A

B. $\frac{1}{10}$ A

C. $\frac{3}{50}$ A

D. $\frac{3}{10}$ A

Answer: C

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12. The impurity atoms that should be added to germenium to make it n-type semiconductor is

A. iodine

B. indium

C. arsenic

D. aluminimum

Answer: C

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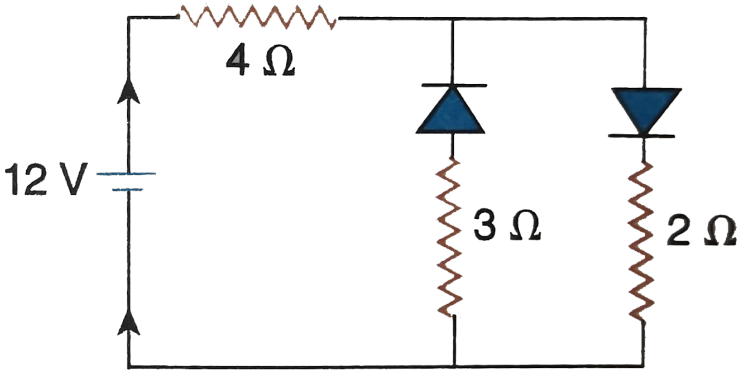
13. The circuit has two oppositely connected ideal diodes in parallel. What is the current in the circuit ?



A. 1.33 A

B. 1.71 A

C. 2.00 A

D. 2.31 A

Answer: C

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14. When a p-n junction is reverse biased then

A. no current flows

B. the depletion layer is increased

C. the depletion layer is decreased

D. hight of potential barriers is reduced

Answer: B

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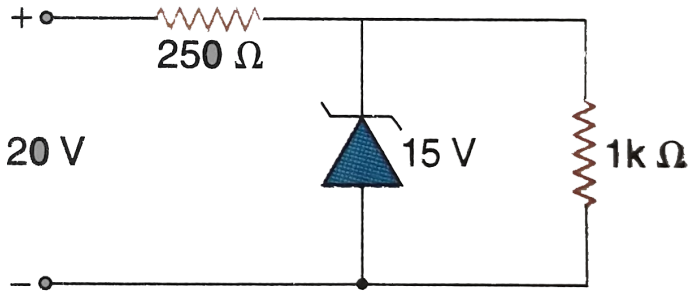
15. A Zener diode having breakdown voltage equal to 15V,is used in a voltage regulator circuit shown in Fig 1.58. The current through the diode is



A. 5 mA

B. 10 mA

C. 15 mA

D. 20 mA

Answer: A

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16. If the rate of doping in the emitter base and colletor of a transistor be $D_e, D_b \text{and} D_c$ respectively then

A. $D_e = D_b = D_c$

B. $D_e < D_b = D_c$

C. $D_e > D_b > D_c$

D. $D_e > D_c > D_b$

Answer: D

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17. In the active region of a transistor the biasisng at the emitter-base junction and collector - base junction are respectively

A. forward , forward

B. forward ,reverse

C. reverse, forward

D. reverse , reverse

Answer: B

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18. A transistor is used as

A. a rectifier

B. an amplifier

C. an oscillator

D. a source of electrons and holes

Answer: B

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19. In an n-p-n transistor circuit collector current is 10 mA. If 90% of electrons from the emitter enter into

the collector then,

A. emitter current =11.11 mA

B. emitter current =9mA

C. base current =2.1 mA

D. base current =0.9 mA

Answer: A

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20. For a transistor if $\frac{\Delta I_C}{\Delta I_E} = 0.96$ then the current gain β is

A. 6

B. 12

C. 24

D. 48

Answer: C

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21. A transistor is operated in common-emitter configuration at $V_C = 2\text{V}$ such that a change in the base current from 100 μ A to 300 μ A produces in the

collector current from 10 mA to 20 mA. The current gain is

A. 50

B. 75

C. 100

D. 25

Answer: A

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Exercise Semiconductor Diode

1. A rectifier converts

A. mechanical energy into electrical energy

B. light energy into electrical energy

C. ac to dc

D. dc to ac

Answer: C

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Exercise Osillator

1. If open loop gain and feedback ratio of a positive feedback oscillator are A are r respectively then closed loop gain A_f is

A. 1

B. $<$ A

C. $<$ Ar

D. infinity

Answer: D

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Very Short Answer Type Questions Semiconductor

1. What type of impurity is required to prepare an n-type semiconductor ?

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2. What type of impurity is required to prepare a p-type semiconductor ?

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3. What kind of semiconductor will be produced if it is doped with a donor element?

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4. What is the effective electric charge of a hole?

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5. The total number of negative charge carriers in an intrinsic semiconductor is n. What is the total number of positive charge carriers in this semiconductor ?

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6. What change in the energy band gap of a pure semiconductor is occurs due to increase of temperature ?

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7. What change in the energy band gap of a semiconductor occurs due to increase of doping ?

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8. At which temperature is a semiconductor completely transformed into an insultor ?

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9. What kind of semiconductor will be produced if a silicon crystal is doped with arsenic?

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Very Short Answer Type Questions Semiconductor Diode

1. If full-wave rectifier draws an input from a 50 Hz mains what will be the ripple frequency of the output?

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2. What will be the change in the thickness of depletion region if a p-n junction is forward biased ?

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3. In which condition does a semiconductor diode bahave like an open switch?

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4. What kind of biasing is required to use a Zener diode as a voltage regulator ?

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5. What type of biasing gives a semiconductor diode very high resistance?

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6. Mention the practical importance of a Zener diode in the laboratory.

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7. Under what condition does a p-n junction diode work as an open switch ?

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Very Short Answer Type Questions Transistor

1. How many effective regions are found in the CE mode of a transistor ?

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2. In which region of the output characteristics is a transistor generally used ?

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3. What is the majority charge carrier in a p-n-p transistor ?

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4. What is the majority charge carrier in a n-p-n transistor ?

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5. What is the relation among emitter current (I_E) collector current (I_C) and base current (I_B) for a transistor ?

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6. How will you recognise from a transistor circuit whether the transistor is n-p-n or p-n-p ?

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7. Calculate the change in collector current due to the change of 10 μ A in base current of a transistor having β=150.

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Very Short Answer Type Questions Oscillator

1. What is the product of open loop gain and feedback ratio of the amplifier in a feedback oscillator.

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2. What is the natural frequency of an LC oscillator?

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Short Answer Type Questions I

1. How will you identify a conductor and a semiconductor from two given rods of same resistance ?

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2. What change in energy band gap of a semiconductor due to doping of of pentavalent element?

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3. What is the effect of doping on electric conductivity of a semiconductor ?

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4. How is sample of an n-type semiconductor electrically neutral though it has an excess of negative charge carriers?

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5. Explain the law of mass action $\left(np = n_i^2\right)$.

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6. Draw V-I characteristic curve of a p-n junction and compare it with the characteristic of a resistance.

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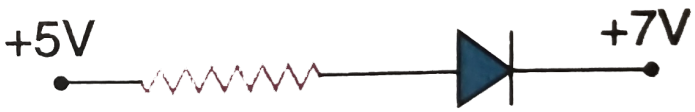
7. What type of biasing has been given to the diode of Fig 1.60?



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8. When breakdown voltage of a Zener diode is around 6 V, then the value of this voltage does not depend upon temperature -Explain.

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9. What is the relation between the energy band gap of an LED and maximum possible wavelength of emitted light from it ?

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10. In case of solar diode what is the significance of voltampere relation of characteristic curve in fourth quadrant ?

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11. Why is the base of a transistor lightly doped ?

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12. In which region will a transistor act if both emitter - base and collector-base junctions are reverse biased?

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13. In which region will a transistor act if both emitter - base and collector-base junctions are forward biased?

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14. Without any any input signal a feedback oscillator gives output signal. Explain how the conservation of energy is not violated.

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15. What is the significance of Barkhausen criterion?

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16. Open loop gain of an amplifier is A. If a feedback oscillator is made by this amplifier then what feedback ratio is to be taken?

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Short Answer Type Questions Ii

1. The current in the forward bias is known to be more (-mA) than the current in the reverse bias (-μa). What

is the reason then to operate in the photodiode in reverse bias ?

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2. Explain why the p-n junction contact potential cannot be measured by a voltmeter across the diode terminals.

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3. Why two diodes connected back to back cannot behave as a transistor?

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4. Why is the base region of transistor usually made thin?

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5. Explain why Si and Ge are not used in LED.

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Problem Set I Semiconductor

1. A semiconductor has the electron concentration of $8 \times 10^{13} \mathrm{cm}^{-3}$ and hole concentration $4 \times 10^{12} \mathrm{cm}^{-3}$. Is this semiconductor n-type or p-type ? Also calculate resistivity of its material.

Given : Electron mobility =24000$\mathrm{cm}^2 . \mathrm{V}^{-1} . s^{-1}$. and hole mobility =200 $\mathrm{cm}^2 . \mathrm{V}^{-1} . s^{-1}$

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2. Pure silicon at 300 K has same electron and hole concentrations of $1.5 \times 10^{16} \mathrm{m}^{-3}$. Doping by indium the concentration of holes increases to

$4.5 \times 10^{22} \mathrm{m}^{-3}$. Calculate electron concentration in doped silicon.

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3. A semiconductor has the electron concentration of $4 \times 10^{12} \mathrm{cm}^{-3}$ and the hole concentration of $7 \times 10^{13} \mathrm{cm}^{-3}$. Is this semiconductor n-type or p-type ?

Also calculate conductivity of its material.

Given : Electron mobility =22000 $\mathrm{cm}^2 . \mathrm{V}^{-1} . s^{-1}$ and hole mobility =150 $\mathrm{cm}^2 . \mathrm{V}^{-1} . s^{-1}$

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4. Calculate the conductivity of a semiconductor having electron concentration $5 \times 10^{12} \mathrm{cm}^{-3}$ and hole concentration $8 \times 10^{13} \mathrm{cm}^{-3}$

$\left[\mu_e = 2.3 \mathrm{V}^{-1}.s^{-1}.\mathrm{m}^2 \quad \text{and} \quad \mu_h = 0.1 \mathrm{V}^{-1}.s^{-1}.\mathrm{m}^2\right]$

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5. The energy of a photon of light $(\lambda = 590 \mathrm{nm})$ equals the band gap of a semiconducting material.Find the minimum energy required to create a hole-electron pair.

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Problem Set I

1. If an unregulated voltage of 10 V is regulated by a Zener diode of rating 4.7 V-1W calculate minimum resistance to be connected to the circuit for safe current.

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2. A transistor has β=100 and $I_B = 20\mu$ A. Find the emitter current.

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3. Current gain of a common-emitter transistor amplifier is 50. If the emitter current is 6.6 mA , calculate collector current and base current.

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4. In CE circuit if base of the transistor is increased from 100 μA to 150 μ A, then collector current increases to 10 mA from 5 mA. Calculate current gain β of the transistor.

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5. In LC circuit of a feedback oscillator , L =36 mH.If the oscillator is used as an alternating source of different frequencies in the range 100 Hz to 1000 Hz ,then find the range in which the capacitance of C should be kept.

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Problem Set Ii Semiconductor

1. An LED is constructed from a p-n junction based on a certain Ga-As-P semiconducting material whose

energy is 1.9 eV. What is the wavelength of the emitted light?

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Hots Numerical Problems

1. The base current of a transistor is 105 μ A and collector current is 2.05 mA.

Determine the values of β, I_E and α.

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2. The base current of a transistor is 105 μ A and collector current is 2.05 mA.

A change of 27 μA in the base current produces a change of 0.65 mA in the collector current. Find β_{ac}.

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3. Following current readings are obtained in a transistor circuit : I_E=2 mA and I_B =20 μ A. Compute the values of I_C and α.

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Entrance Corner Assertion Reason Type

1. Direction : These question have statement I and statement II. Of the four choices given below choose the one that best describes the two statements.

Statement I: The depletion of thermal layer is also generated at the junction of a p-n junction diode without any applied biasing.

Statement II. The diffusion of thermal electrons and holes takes place from one region to another.

A. Statement I is true statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true statement II is false.

D. Statement I is false statement II is true.

Answer: B

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2. Statement I: The holes are created in the valence band only if the electrons from the valence band transit to the conduction band.

Statement II: Due to applied electric field the hole in a semiconductor gains velocity which is less than that of a free electron.

A. Statement I is true statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true statement II is false.

D. Statement I is false statement II is true.

Answer: B

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3. Statement I: In p-type semiconductor the drift velocity of charge carrier holes is higher than of electrons.

Statement -II : In p-type semiconductor majority charge carriers are holes.

A. Statement I is true statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true statement II is false.

D. Statement I is false statement II is true.

Answer: D

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4. Statement I : In CE mode of a transistor if the input signal is applied at base then the output signal is obtained at collector.

Statement II : In a transistor most of the emitter current is transformed into the collector current.

A. Statement I is true statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true statement II is false.

D. Statement I is false statement II is true.

Answer: B

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5. Statement I : The frequency of the output signal from a feedback oscillator depends on its feedback ratio.

Statement II : A feedback oscillator circuit is made in such a way that the closed loop gain of the amplifier reaches to an infinite value.

A. Statement I is true statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true statement II is true, statement II is not a correct explanation for

statement I.

C. Statement I is true statement II is false.

D. Statement I is false statement II is true.

Answer: D

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6. Statement I: In spite of increasing in doping level the conductivity of the semiconductor does not change.

Statement II : By increasing in doping level the conductivity the concentration of one type of charge carriers (electrons or holes) is increased and at the

same time concentration of other charge carrier decreases.

A. Statement I is true statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true statement II is false.

D. Statement I is false statement II is true.

Answer: D

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7. Statement I : If the frequency of light below a certain minimum value is made incident on a photodiode , then no current will flow through it.

Statement II : If the energy of incident photon is less than a minimum value then in a photodiode there is no possibility of recombination of electron-hole pairs.

A. Statement I is true statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true statement II is true, statement II is not a correct explanation for

statement I.

C. Statement I is true statement II is false.

D. Statement I is false statement II is true.

Answer: C

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Entrance Corner Multiple Correct Answers Type

1. Depletion region of p-n junction completely vanishes if

A. a suitable forward bias is appled

B. a suitable reverse bias is applied

C. a light of suitable frequency is made incident from outside

D. Zener effect takes place

Answer: A::C::D

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2. If a pentavalent element is doped in an intrinsic semiconductor then

A. a p-type semiconductor is formed

B. effective energy gap of the forbidden zone decreases

C. the energy states of free electrons in the pentavalent element come nearer to the conduction band

D. the energy states of free in the pentavalent element come down near the valence band

Answer: B::C

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3. If a p-n junction is reverse biased then

A. a potential barrier is created at the junction

B. the effective resistance reaches an infinite value

C. a small current is obtained due to diffusion of majority carrier electrons and holes

D. In spite of increasing the reverse bias the reverse current remains almost unchanged

Answer: A::B::D

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4. In case of a transistor

A. the emitter region is heavily doped

B. in CE configuration if the base-emitter and the collector-emitter both junction are forward biased then the transistor acts in saturation region

C. to use as an amplifier it is operated in active region

D. to use as a switch it is operated in between saturation region and cut off region

Answer: A::B::C::D

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5. In case of a Zener diode,

A. to use as a voltage regulator it is kept in reverse bias.

B. power consumption in reverse bias is higher than that of an ordinary semiconductor diode

C. in forward bias it behaves as an ordinary semiconductor diode is

D. If Zener voltage is applied in reverse bias then a high potential barrier is created at its junction

Answer: A::B::C

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6. In a feedback oscillator,

A. effective amplification of the amplifier used in this oscillator is infinity

B. the output ac singnal frequency is only determined by the feedback ration

C. the output ac signal frequency is controlled by a tank circuit in the feedback device

D. the output ac singnal is obtained without any externally applied input

Answer: A::C::D

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7. In an n-type semiconductor if n and p are the concentration of electrons and holes respectively and n_i is the concentration of electron-hole pairs in a pure semiconductor then

A. n=p

B. n $>$ p

C. n $<$ p

D. np=n_i^2

Answer: B::D

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Entrance Corner Integer Answer Type

1. For an n-type doping in a pure semiconductor the concentration of charge carrier electrons increases 5 times. Find hole concentration as percentage of the electron concentration.

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2. An extrinsic semiconductor has the concentration of holes as charge carriers $5 \times 10^{20} \mathrm{m}^{-3}$. The electron concentration is negligible as compared to hole concentration . If mobility of holes is 0.05 $\mathrm{m}^2 . \mathrm{V}^{-1} . s^{-1}$ then find the conductivity (in mho. m^{-1}) of the semiconductor ?

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3. The maximum output voltage of an unregulted voltage source is 10V. A Zener diode of rating 1 W is connected in reverse bias with this voltage source through a resistance R. The Zener diode will be burnt

if R is less than 24 Ω. Find the maximum value of Zener voltage (in volt) of the diode.

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4. In a transistor the value of β =200. In CE configuration it is kept in a stable dc bias. Now if an input signal is applied then output signal will vary in the range of 5.6 mA to 6.4 mA. Find the amplitude of the input signal (in μ A).

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5. The emitter of an n-p-n transistor emits 1.25×10^{10} electrons per micro-second (μs). Find the emitter current in mA. (Given : electronic charge, e= 1.6×10^{-19} coulomb).

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Examination Archive With Solutions Wbchse

1. What are the majority carriers in a p-type semiconductor?

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2. What type of semiconductor is produced if germanium crystal is doped with arsenic?

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3. Draw the circuit diagram of a full-wave rectifier using p-n junction diode and explain its operation. To which factor is the pulsating nature of the output due?

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4. The impurity atom when added to germanium makes it an n-type semiconductor is

A. boron

B. indium

C. arsenic

D. aluminimum

Answer:

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5. Draw the I-V characteristics of a light emitting diode (LED) and explain its working principle.

Watch Video Solution

6. Draw the output characteristics of an n-p-n transistor in common emitter configuration for five base currents. What is an oscillator?

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7. What is Zener diode? Draw its voltage vs current characteristics in the reverse bias and indicate the

breakwon voltage on the characteristics. Mention one important use of this diode.

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8. What will happen if the amount of reverse biasing in a p-n junction diode is gradually increased?

A. thickness of depletion region will increase

B. flow of current due to majority carriers will increase

C. thickness of depletion region will decrease

D. flow of current due to majority carriers will decrease

Answer: C

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9. What is a p-n junction diode ? Draw the circuit diagram of a full-wave rectifier using p-n junction diodes. Show the input and output voltage waveforms by a schematic graph.

Watch Video Solution

10. What is a photodiode ? Draw the I-V characteristic curve of a photodiode. Mention one use of photodiode.

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11. Draw the V-I characteristic curve for forward and reverse bias of a p-n junction diode. (Graph sheet is not required)

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12. State one difference between n-type and p-type semiconductors.

Watch Video Solution

13. In a transistor emitter-base junction is always forward biased while the collector-base junction is reverse biased. Why ?

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14. For a transistor if β =100 ,then α will be

A. 0.99

B. 1.01

C. 100

D. 0.01

Answer: A

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15. The lengths radii and specific resistance of two conducting wires are each in the ratio of 1:3. If the resistance of the thinner wire is 10 Ω then the resistance of the other wire will be

A. 49 Ω

B. 20 Ω

C. 10 Ω

D. 5 Ω

Answer: C

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16. Explain with diagram the action of p-n diode as a full wave rectifier.

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17. Draw the output characteristic curves of a n-p-n transistor in a CE configuration and find the output resistance from it.

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18. Explain with circuit diagram the action of a transistor as a switch.

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19. In normal transistor operation

A. emitter -base junction and collector-base junction are both in reverse bias

B. emitter -base junction is in forward bias and collector -base junction is in reverse bias

C. emitter-base junction and collector-base junction both are in forward bias

D. emitter-base junction is in reverse bias and collector -base junction is in forward bias

Answer: B

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20. (i) What is Zener diode?

(ii) Explain with circuit diagram how a Zener diode regulates voltage across a load resistance.

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21. Why does a photodiode function in reverse bias?

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Examination Archive With Solutions Wbjee

1. In a transistor output characteristic commonly used in common-emitter configuration the base current I_B

the collector current I_C and the collector -emitter voltage V_{CE} have values of the following orders of the magnitude in the active region

A. I_B and I_C are both in μA and V_{CE} in V

B. I_B is in μA I_C in mA and V_{CE} in mV

C. I_B is in mA, I_C in μ A and V_{CE} in mV

D. I_B is in mA I_C is in mA and V_{CE} in mV

Answer: B

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2. In the circuit shown assume the diode to be ideal. When V_i increases from 2 V to 6 V the changes in the current is (in mA)

A. zero

B. 20

C. $\frac{80}{3}$

D. 40

Answer:

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3. If the band gap between valence band and conduction band in a material is 5.0 eV, then the material is

A. semiconductor

B. good conductor

C. superconductor

D. insulator

Answer: D

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4. Assume that each diode shown in Fig 1.70 has a forward bias resistance of 50 Ω and an infinite reverse bias resistance . The current through the resistance 150 Ω is

A. 0.66 A

B. 0.05 A

C. zero

D. 0.04

Answer: D

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5. In case of a bipolar transistor β =45. The potential drop across the collector resistance of 1 kΩ is 5 V. The base current is approximately

A. 222 μ A

B. 55 μ A

C. 111μ A

D. 45 μ A

Answer: C

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6. A zener diode having breakdown voltage 5.6 V is connected in reverse bias with a battery of emf 10 V and a resistance of 100Ω in series . The current flowing through the zener is.

A. 88 mA

B. 0.88 mA

C. 4.4 mA

D. 44 mA

Answer: D

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7. When a semiconductor device is connected in series with a battery and a resistance a current is found to flow in the circuit. If however the polarity of the battery is reversed practically no current flows in the circuit. The device may be

A. a p-type semiconductor

B. a n-type semiconductor

C. an intrinsic semiconductor

D. a p-n junction

Answer: D

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8. What will be the current flowing through the 6 k Ω resistor in the circuit shown where the breakdown voltage of the Zener is 6 V?

A. $\frac{2}{3}$ mA

B. 1 mA

C. 10 mA

D. $\frac{3}{2}$ mA

Answer: A

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Examination Archive With Solutions Jee Main

1. The forward biased diode connection is

A. 

B. 

C. 

D. 

Answer: A

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2. For a common emitter configuration if α and β have their usual meanings the incorrect relationship between α and β is

A. $\frac{1}{\alpha} = \frac{1}{\beta} + 1$

B. $\alpha = \frac{\beta}{1-\beta}$

C. $\alpha = \frac{\beta}{1+\beta}$

D. $\alpha = \frac{\beta^2}{1+\beta^2}$

Answer: C

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3. In a common-emitter amplifier circuit using an n-p-n transistor the phase differene between the input and the output voltages will be

A. 45°

B. 90°

C. 135°

D. 180°

Answer: D

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4. The reading of the ammeter for a silicon diode in the given circuit is

A. 11.5 mA

B. 13.5 mA

C. 0

D. 15 mA

Answer: A

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Examination Archive With Solutions Aipmt

1. The barrier potential of a p-n junction depends on (i) type of semiconductor material (ii) amount of doping and (iii) temperatur e. Which one of the following is correct?

A. (i) and (ii) only

B. (ii) only

C. (ii) and (iii) only

D. (i),(ii) and (iii)

Answer: D

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2. If in a p-n junction a square input signal of 10 V is applied as shown then the output across R_L will be

A. 

B. 

C. 

D. 

Answer: D

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Examination Archive With Solutions Neet

1. Consider the junction diode as ideal. The value of current flowing through AB is

A. 10^{-2} A

B. 10^{-1} A

C. 10^{-3}A

D. 0

Answer: A

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2. A n-p-n transistor is connected to common emitter configuration in a given amplifier. A load resistance of 800 Ω is connected in the collector circuit and the voltage drop across it is 0.8 V. If the current amplification factor is 0.96 and the input resistance of the circuit is 192 Ω the voltage gain and the power gain of the amplifier will respectively be

A. 3.69,3.84

B. 4,4

C. 4,3.69

D. 4,3.84

Answer: D

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3. Two sides of a semiconductor germanuim crystal A and B are doped with arsenic and indium respectively. They are connected to a battery as shown in figure.

 The correct graph between current and voltage for the arrangement is

A. 

B. 

C. 

D. 

Answer: A

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4. A common-emitter amplifier circuit is shown in the figure below. For the transistor used in the circuit the current amplification factor , β_{dc} =100. Other parameters are mentioned in the figure.

We that

A. $V_{BE} = +18.2V, V_{BC} = -3.45$ V and amplifier is working

B. $V_{BE} = +18.5V, V_{BC} = +2.85$ V and amplifier is not working

C. $V_{BE} = +20.7V, V_{BC} = +3.75$V and amplifier is not working

D. $V_{BE} = +21.5V, V_{BC} = -2.75$ V and amplifier is working

Answer: C

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5. In the circuit shown in the figure the input voltage V_i is 20 V , V_{BE} =0 and V_{CE}=0. The values of I_B, I_C and

β are given by

A. $I_B = 20\mu A, I_C = 5\text{mA}, \beta$=250

B. $I_B = 25\mu A, I_C = 5\text{mA}, \beta$=200

C. $I_B = 40\mu A, I_C = 5\text{mA}, \beta$=250

D. $I_B = 40\mu A, I_C = 5\text{mA}, \beta$=125

Answer: D

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6. In a p-n junction diode change in temperature due to heating

A. does not affect resistance of p-n junction

B. affects only forward resistance

C. affects only reverse resistance

D. affects the overall V-I characteristic of p-n junction

Answer: D

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Cbse Scanner

1. (a) Describe briefly with the help of a diagram the role of the two important processes involved in the formation of a p-n junction.

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2. Name the device which is used as a voltage regulator. Draw the necessary circuit diagram and explain its working.

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3. Explain briefly the principle on which a transistor-amplifier works as an oscillator. Draw the necessary circuit diagram and explain its working.

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4. Draw V-I characteristics of p-n junction diode. Answer the following questions giving reasons:

Why is the current under reverse bias almost independent of the applied potential up to a critical voltage?

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5. Draw V-I characteristics of p-n junction diode. Answer the following questions giving reasons:

Why does the reverse current show a sudden increase at the critical voltage?

Name any semiconductor device which operates under the reverse bias in the breakdown region.

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6. Draw typical output characteristics of an n-p-n transistor in CE configuration. Show how these characteristics can be used to determine output resistance.

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7. Draw a circuit diagram of n-p-n transistor amplifier in CE configuration. Under what condition does the transistor act as an amplifier.

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8. Explain with the help of a circuit diagram the working of a p-n junction diode as a half -wave rectifier.

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9. Write any two distinguishing features between conductors semiconductors and insulators on the basis of energy band diagrams.

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10. Explain with the help of suitable diagram the two important processes that occur during the formation of p-n junction. Hence define the terms : depletion region and barrier potential.

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11. How is a light emitting diode fabricated ? Briefly state is working. Write any two important advantages of LEDs over the conventional incandescent low power lamps.

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12. Distinguish between a conductor and a semiconductor on the basis of energy band diagram.

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13. Name the important processes that occur during the formation of a p-n junction.

Watch Video Solution

14. Draw the circuit diagram of a full wave rectifier along with the input and output waveforms. Briefly explain how the output voltage/ current is unidirectional.

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15. Write the two processes that take place in the formation of a p-n junction. Explain with the help of a diagram, the formation of depletion region and barrier potential in a p-n junction.

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16. In the following diagram, is the junction diode forward biased or reverse biased?

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17. Draw the circuit diagram of a fuII wave rectifier and state how it works.

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18. A Zener diode is fabricated by heavily doping both p and n-sides of the junction. Explain why? Briefly explain the use of Zener diode as a dc voltage regulator with the help of a circuit diagram.

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19. In the following diagram which bulb out of B_1 and B_2 will glow and why ?

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20. Draw a diagram of an illuminated p-n junction solar cell.

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21. Explain briefly the three processes due to which generation of emf takes place in solar cell.

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22. In the following diagram 'S' is a semiconductor. Would you increase or decrease the value of R to keep the reading of the ammeter A constant when S is heated ? Give reason for your answer.

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23. Draw the circuit diagram of a photodiode and explain its working.Draw its I-V characteristics.

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24. Name the junction diode whose I-V charateristics are drawn below

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25. For a CE -transistor amplifier the audio signal voltage across the collector resistance of 2 $k\Omega$is 2V. Given the current amplification factor of the transistor is 100 find the input signal voltage and base current if the base resistance is 1 k Ω.

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26. Write the functions of the three segments of a transistor.

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27. Draw the circuit diagram for studying the characteristics of a transistor in common emitter configuration. Explain briefly and show how input and output characteristics are drawn.

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28. Draw the circuit diagram of an n-p-n transistor amplifier in common emitter configuration.

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29. Derive an expression for voltage gain of the amplifier and hence show that the output voltage is in opposite phase with the input voltage.

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30. A student wants to use tow p-n junction diode to convert alternating current into direct current. Draw

the labelled circuit diagram she would use and explain how it works.

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31. Draw the typical input and output characteristics of an n-p-n transistor in CE configuration. Show how these characteristics can be used to determine (a) the input resistance (r_i) and (b) current amplification factor (β).

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