

Chapter 1

Exercise Solutions

EX1.1

$$n_i = BT^{3/2} \exp\left(\frac{-E_g}{2kT}\right)$$

$$\text{GaAs: } n_i = (2.1 \times 10^{19})(300)^{3/2} \exp\left(\frac{-1.4}{2(86 \times 10^{-6})(300)}\right) \approx \underline{n_i = 1.8 \times 10^6 \text{ cm}^{-3}}$$

$$\text{Ge: } n_i = (1.66 \times 10^{15})(300)^{3/2} \exp\left(\frac{-0.66}{2(86 \times 10^{-6})(300)}\right) \approx \underline{n_i = 2.40 \times 10^{11} \text{ cm}^{-3}}$$

EX1.2

$$\text{(a) (i) } n_p = N_A = 2 \times 10^{14} \text{ cm}^{-3}$$

$$p_p = \frac{n_i^2}{n_p} = \frac{(1.5 \times 10^{10})^2}{2 \times 10^{14}} = 1.125 \times 10^5 \text{ cm}^{-3}$$

$$\text{(ii) } p_p = N_A = 10^{15} \text{ cm}^{-3}$$

$$n_p = \frac{n_i^2}{p_p} = \frac{(1.5 \times 10^{10})^2}{10^{15}} = 2.25 \times 10^5 \text{ cm}^{-3}$$

$$\text{(b) (i) } n_p = N_A = 2 \times 10^{14} \text{ cm}^{-3}$$

$$p_p = \frac{n_i^2}{n_p} = \frac{(1.8 \times 10^6)^2}{2 \times 10^{14}} = 1.62 \times 10^{-4} \text{ cm}^{-3}$$

$$\text{(ii) } p_p = N_A = 10^{15} \text{ cm}^{-3}$$

$$n_p = \frac{n_i^2}{p_p} = \frac{(1.8 \times 10^6)^2}{10^{15}} = 3.24 \times 10^{-3} \text{ cm}^{-3}$$

EX1.3

(a) For n-type,

$$\rho = \frac{1}{e\mu_n N_D} = \frac{1}{(1.6 \times 10^{-19})(6800)(2 \times 10^{15})} = 0.046 \text{ ohm-cm}$$

$$\text{(b) } J = \frac{1}{\rho} E \Rightarrow E = \rho J = (0.046)(1.75) = 3.04 \text{ V/cm}$$

EX1.4

Diffusion current density due to holes:

$$J_p = -eD_p \frac{dp}{dx}$$

$$= -eD_p (10^{16}) \left(\frac{-1}{L_p} \right) \exp\left(\frac{-x}{L_p}\right)$$

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Donald A. Neamen



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Table of Contents Microelectronics Solution Manual 4th Neamen

1. Understanding the eBook Microelectronics Solution Manual 4th Neamen
 - The Rise of Digital Reading Microelectronics Solution Manual 4th Neamen
 - Advantages of eBooks Over Traditional Books
2. Identifying Microelectronics Solution Manual 4th Neamen
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Microelectronics Solution Manual 4th Neamen
 - User-Friendly Interface
4. Exploring eBook Recommendations from Microelectronics Solution Manual 4th Neamen
 - Personalized Recommendations
 - Microelectronics Solution Manual 4th Neamen User Reviews and Ratings
 - Microelectronics Solution Manual 4th Neamen and Bestseller Lists
5. Accessing Microelectronics Solution Manual 4th Neamen Free and Paid eBooks
 - Microelectronics Solution Manual 4th Neamen Public Domain eBooks
 - Microelectronics Solution Manual 4th Neamen eBook Subscription Services
 - Microelectronics Solution Manual 4th Neamen Budget-Friendly Options
6. Navigating Microelectronics Solution Manual 4th Neamen eBook Formats

- ePub, PDF, MOBI, and More
- Microelectronics Solution Manual 4th Neamen Compatibility with Devices
- Microelectronics Solution Manual 4th Neamen Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Microelectronics Solution Manual 4th Neamen
 - Highlighting and Note-Taking Microelectronics Solution Manual 4th Neamen
 - Interactive Elements Microelectronics Solution Manual 4th Neamen
- 8. Staying Engaged with Microelectronics Solution Manual 4th Neamen
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Microelectronics Solution Manual 4th Neamen
- 9. Balancing eBooks and Physical Books Microelectronics Solution Manual 4th Neamen
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Microelectronics Solution Manual 4th Neamen
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Microelectronics Solution Manual 4th Neamen
 - Setting Reading Goals Microelectronics Solution Manual 4th Neamen
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Microelectronics Solution Manual 4th Neamen
 - Fact-Checking eBook Content of Microelectronics Solution Manual 4th Neamen
 - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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