SOLUTIONS MANUAL for CMOS Digital Integrated Circuits Analysis and Design 4th Edition by Kang Full download:

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Exercise Problems

3.1 Consider a MOS system with the following parameters:

$$I_{av} = 1.6 \text{ nm}$$

 $ac = 1.04 \text{ V}$
 $N_A = 2.8 \times 10^{18} \text{ cm}^{-3}$
 $Q_{ov} = 94 \times 10^{10} \text{ C/cm}^2$

a. Determine the threshold voltage V_m under zero bias at room temperature (T = 300 K). Note that _m 3.97_a and _m 11.7_a.

SOLUTION:

First, calculate the Fermi potentials for the p-type substrate and for the n-type polysilicon gate:

(substrate)
$$\frac{kT_{\ln q}}{q} \frac{N_{a}}{N_{a}^{0.026}} = \frac{1.45 \times 10^{10}}{2.8 \times 10^{0.49}} = \frac{1.45 \times 10^{10}}{1.45 \times 10^{10}} = \frac{1.45 \times 1$$

The depletion region charge density at $V_{vir} = 0$ is found as follows:

$$Q_{ss}\sqrt{2 \ q \ N_{s-Sc} \ 2_{p} (substrate)}$$

 $\sqrt{21.610^{cs} \ (2.810^{cs}) 11.7 \ 8.85 \ 10^{cs} \ 2 \ 0.49}$

The oxide-interface charge is:

The gate oxide capacitance per unit area is calculated using the dielectric constant of silicon dioxide and the oxide thickness t_{car}

$$C_{ce} = \frac{3.978.8510^{14} \text{ F/cm}}{I_{ce}} = \frac{3.978.8510^{14} \text{ F/cm}^2}{1.610^7 \text{ cm}} = 2.210^6 \text{ F/cm}^2$$

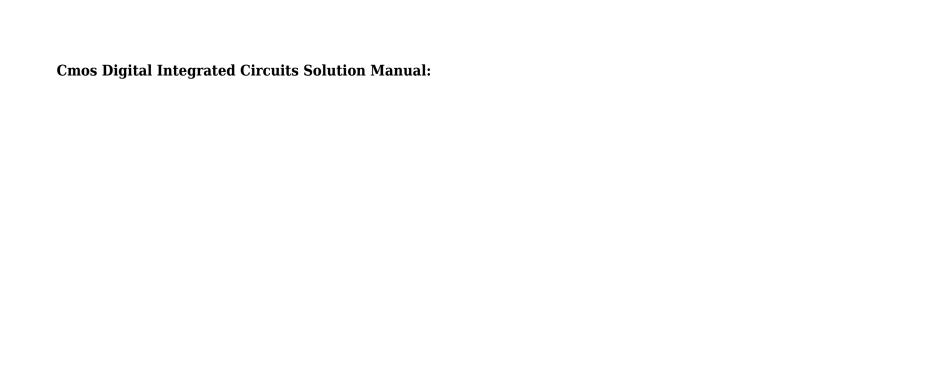
Now, we can combine all components and calculate the threshold voltage.

$$V_{r0-GC} = 2 \frac{Q_{sv}}{r} \frac{Q_{sv}}{C_{ss}} \frac{Q_{sv}}{C_{ss}} \frac{Q_{sv}}{C_{ss}}$$
1.04 (0.98) (0.53) (0.03) 0.44V

 Determine the type (p-type or n-type) and amount of channel implant (N_i/cm²) required to change the threshold voltage to 0.6V

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Roger L. Tokheim



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Table of Contents Cmos Digital Integrated Circuits Solution Manual

- 1. Understanding the eBook Cmos Digital Integrated Circuits Solution Manual
 - The Rise of Digital Reading Cmos Digital Integrated Circuits Solution Manual
 - Advantages of eBooks Over Traditional Books
- 2. Identifying Cmos Digital Integrated Circuits Solution Manual
 - Exploring Different Genres
 - o Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
- 3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Cmos Digital Integrated Circuits Solution Manual
 - User-Friendly Interface
- 4. Exploring eBook Recommendations from Cmos Digital Integrated Circuits Solution Manual
 - Personalized Recommendations
 - Cmos Digital Integrated Circuits Solution Manual User Reviews and Ratings
 - Cmos Digital Integrated Circuits Solution Manual and Bestseller Lists

- 5. Accessing Cmos Digital Integrated Circuits Solution Manual Free and Paid eBooks
 - o Cmos Digital Integrated Circuits Solution Manual Public Domain eBooks
 - Cmos Digital Integrated Circuits Solution Manual eBook Subscription Services
 - Cmos Digital Integrated Circuits Solution Manual Budget-Friendly Options
- 6. Navigating Cmos Digital Integrated Circuits Solution Manual eBook Formats
 - ∘ ePub, PDF, MOBI, and More
 - Cmos Digital Integrated Circuits Solution Manual Compatibility with Devices
 - Cmos Digital Integrated Circuits Solution Manual Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Cmos Digital Integrated Circuits Solution Manual
 - Highlighting and Note-Taking Cmos Digital Integrated Circuits Solution Manual
 - Interactive Elements Cmos Digital Integrated Circuits Solution Manual
- 8. Staying Engaged with Cmos Digital Integrated Circuits Solution Manual
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Cmos Digital Integrated Circuits Solution Manual
- 9. Balancing eBooks and Physical Books Cmos Digital Integrated Circuits Solution Manual
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Cmos Digital Integrated Circuits Solution Manual
- 10. Overcoming Reading Challenges
 - $\circ\,$ Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Cmos Digital Integrated Circuits Solution Manual
 - Setting Reading Goals Cmos Digital Integrated Circuits Solution Manual
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Cmos Digital Integrated Circuits Solution Manual
 - Fact-Checking eBook Content of Cmos Digital Integrated Circuits Solution Manual
 - 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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