

1.3 FLOATING POINT NUMBER SYSTEMS

1. Provide the floating point equivalent for each of the following numbers from the floating point number system $F(10, 4, 0, 4)$. Consider both chopping and rounding. Compute the absolute and relative error in each floating point equivalent.
- | | |
|---------------------|--------------|
| (a) π | (b) e |
| (c) $\sqrt{2}$ | (d) $1/7$ |
| (e) $\cos 22^\circ$ | (f) $\ln 10$ |
| (g) ζ^5 | |

In the following table, δ denotes the absolute error and ϵ the relative error.

y	$f(y)$	Chopping error	$f(y)$	Rounding error
π	3.141	$\delta = 5.927 \times 10^{-4}$ $\epsilon = 1.886 \times 10^{-4}$	3.142	$\delta = 4.073 \times 10^{-4}$ $\epsilon = 1.297 \times 10^{-4}$
e	2.718	$\delta = 2.818 \times 10^{-4}$ $\epsilon = 1.037 \times 10^{-4}$	2.718	$\delta = 2.818 \times 10^{-4}$ $\epsilon = 1.037 \times 10^{-4}$
$\sqrt{2}$	1.414	$\delta = 2.136 \times 10^{-4}$ $\epsilon = 1.510 \times 10^{-4}$	1.414	$\delta = 2.136 \times 10^{-4}$ $\epsilon = 1.510 \times 10^{-4}$
$1/7$	0.1428	$\delta = 5.714 \times 10^{-4}$ $\epsilon = 4.000 \times 10^{-4}$	0.1429	$\delta = 4.286 \times 10^{-4}$ $\epsilon = 3.000 \times 10^{-4}$
$\cos 22^\circ$	0.9271	$\delta = 8.385 \times 10^{-5}$ $\epsilon = 9.044 \times 10^{-5}$	0.9272	$\delta = 1.615 \times 10^{-5}$ $\epsilon = 1.741 \times 10^{-5}$
$\ln 10$	2.302	$\delta = 5.851 \times 10^{-4}$ $\epsilon = 2.541 \times 10^{-4}$	2.303	$\delta = 4.149 \times 10^{-4}$ $\epsilon = 1.802 \times 10^{-4}$
ζ^5	2.080	$\delta = 8.382 \times 10^{-5}$ $\epsilon = 4.030 \times 10^{-5}$	2.080	$\delta = 8.382 \times 10^{-5}$ $\epsilon = 4.030 \times 10^{-5}$

2. Prove the bounds on the absolute and relative roundoff error associated with rounding:

$$|f_{\text{round}}(y) - y| \leq \frac{1}{2} \beta^{t-s} \quad \text{and} \quad \frac{|f_{\text{round}}(y) - y|}{|y|} \leq \frac{1}{2} \beta^{t-s}.$$

Consider the floating point system $F(\beta, k, m, M)$ with rounding. Let y be a real number whose expansion is given by

$$y = \pm (0.d_1 d_2 d_3 \dots d_k d_{k+1} \dots)_\beta \times \beta^r$$

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Bradie



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Table of Contents Friendly Introduction To Numerical Analysis Solutions Manual

1. Understanding the eBook Friendly Introduction To Numerical Analysis Solutions Manual
 - The Rise of Digital Reading Friendly Introduction To Numerical Analysis Solutions Manual
 - Advantages of eBooks Over Traditional Books
2. Identifying Friendly Introduction To Numerical Analysis Solutions Manual
 - 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 Friendly Introduction To Numerical Analysis Solutions Manual
 - User-Friendly Interface
4. Exploring eBook Recommendations from Friendly Introduction To Numerical Analysis Solutions Manual
 - Personalized Recommendations
 - Friendly Introduction To Numerical Analysis Solutions Manual User Reviews and Ratings
 - Friendly Introduction To Numerical Analysis Solutions Manual and Bestseller Lists

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 - Friendly Introduction To Numerical Analysis Solutions Manual Budget-Friendly Options
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 - ePub, PDF, MOBI, and More
 - Friendly Introduction To Numerical Analysis Solutions Manual Compatibility with Devices
 - Friendly Introduction To Numerical Analysis Solutions Manual Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Friendly Introduction To Numerical Analysis Solutions Manual
 - Highlighting and Note-Taking Friendly Introduction To Numerical Analysis Solutions Manual
 - Interactive Elements Friendly Introduction To Numerical Analysis Solutions Manual
8. Staying Engaged with Friendly Introduction To Numerical Analysis Solutions Manual
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Friendly Introduction To Numerical Analysis Solutions Manual
9. Balancing eBooks and Physical Books Friendly Introduction To Numerical Analysis Solutions Manual
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Friendly Introduction To Numerical Analysis Solutions Manual
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Friendly Introduction To Numerical Analysis Solutions Manual
 - Setting Reading Goals Friendly Introduction To Numerical Analysis Solutions Manual
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Friendly Introduction To Numerical Analysis Solutions Manual
 - Fact-Checking eBook Content of Friendly Introduction To Numerical Analysis Solutions 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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