# Introduction to Computational Physics for Undergraduates

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**Omair Zubairi**
*Wentworth Institute of Technology*

**Fridolin Weber**
*San Diego State University and University of California at San Diego*

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# Preface

This introductory textbook on computational physics intended for undergraduates at the sophomore or junior level who have taken the introductory freshman series of physics courses to include: introductory classical mechanics, electricity and magnetism, and modern physics. A good understanding of multivariable calculus and linear algebra is highly encouraged. This text provides an introduction to programming languages such as FORTRAN 90/95 and covers numerical techniques such as differentiation, integration, root finding, and data fitting. The textbook also entails the use of the Linux/Unix operating system, text editors, and python for plotting data.

This textbook will allow the reader to become a proficient user of the Linux/Unix operating system. The reader will able to write, compile, and debug computer code in the FORTRAN programming language. The reader will also be able to apply computational techniques such as iterative processes, logical conditions, and memory allocation in addition to applying numerical methods to solve problems involving differentiation, integration, matrix theory, and root finding. The reader will able to use the contents of this text and apply them to a variety of science and engineering applications.

# Acknowledgments

F Weber thanks the National Science Foundation (USA) for supporting his efforts to create opportunities for undergrad students to take part in a range of research and learning activities. O Zubairi acknowledges Wentworth Institute of Technology's EPIC mini grant program which has supported his endeavors to create computational resources for student advancement in research in and out of the classroom.

# Author biographies

## Omair Zubairi

Omair Zubairi received his BSc and MSc in Physics from San Diego State University. He obtained his PhD in Computational Science from Claremont Graduate University and San Diego State University where he primarily worked on compact star physics. Omair is currently an Assistant Professor of Physics at Wentworth Institute of Technology. His other research interests include general relativity, numerical astrophysics and computational methods and techniques.

Omair is a dedicated educator in physics and computational science. He has taught students from all backgrounds in many areas of physics from the introductory sequence to upper division courses where he incorporates numerical methods and computational techniques into each course. 'By allowing students to see and apply numerical simulations to various topics covered in lectures, they are able to gain invaluable insight into the problem at hand.'

## Fridolin Weber

Fridolin Weber is a Distinguished Professor of Physics at San Diego State University and a Research Scientist at the University of California at San Diego. He is interested in nuclear and particle processes that occur in extreme astrophysical systems such as neutron stars and supernovae. Other interests include the application of quantum many-body theory to nuclear matter and dense quark matter, relativistic astrophysics, and Einstein's theory of general relativity. Dr Weber has a PhD in theoretical nuclear physics and a PhD in theoretical astrophysics, both from the Ludwig Maximilian University of Munich, Germany. He has published two books, is the author or co-author of almost 200 publications, and has given around 300 talks at conferences and physics schools.