

Planetary Orbits and Interplanetary Flight:
Basic Calculus and the Missions of Juno, the Voyagers, and Cassini
By: Alexander J. Hahn

I have been an aerospace engineer for 39 years and honestly, it would be hard for me to overstate how valuable I believe this book will be to numerous scientific and engineering disciplines and in particular to the future of aerospace engineering.

Dr. Hahn's book comes at the perfect time to both inspire and educate the newest generation of aerospace engineers and scientists and to help deepen the understanding of current engineers. We are witnessing the commercialization and the democratization of space at an awe inspiring rate. Everything from palm-sized consumer video recording drones, to privately developed launch systems and the recently renewed interest in lunar probes and expeditions, by both governments and private companies, require the drive, the skill, and the knowledge of aerospace engineers to make these dreams a reality.

This book is perfectly crafted to motivate, educate, and prepare the scientists and engineers who wish to reach for the sky and beyond.

This book instills in its readers a genuine appreciation for the fact that although the planets, the stars, and the galaxies may stretch across unimaginably vast distances, the rules that govern their movements can be fully understood by us through the application of calculus. The magnificent elegance of this tool is fully demonstrated by the author's citation of the history of our astronomical understanding and scientific accomplishments, and the mathematical methods applied to achieve them. This comprehensive mathematical textbook uses our awe inspired quest to understand and explore our universe as both the backdrop and the motivation for the learning of calculus. A comprehensive understanding of the subject matter is achieved through a description of the motivation for the development of advanced calculus, a chronicling of its early history and applications, examples of its ability to describe the mechanics of our universe, a discussion of the goals of space pioneers and how using calculus was fundamental to achieving those goals, and a truly fascinating discussion of our accomplishments in interplanetary and deep space explorations that would not have been possible without the application of calculus. The book is richly illustrated and provides hundreds of practice problems with full explanations.

Dr. Hahn's prior book, *Basic Calculus from Archimedes to Newton to its Role in Science* has been an essential text that has been both respected and widely recommended by NASA engineers for more than 20 years because of its unique approach to teaching calculus by first detailing the motivation behind the development of calculus and then fully explaining the step by step history of its development. This thorough explanation of calculus from the ground up leads to a much deeper understanding of its power and potential applications.

In Dr. Hahn's newest text, *Planetary Orbits and Interplanetary Fight: Basic Calculus and the Missions of Juno, the Voyagers, and Cassini* the author again succeeds in fostering an appreciation for the power of calculus by showing how the pioneers in its development used this tool to explain the previously unexplainable. Inspired by their desire to answer the most fundamental questions about the mechanics of our universe, they developed advanced calculus to make precise predictions and then they confirmed its usefulness by verifying that its predictions matched the empirical observations. Chapter by chapter this book takes the reader on a journey through the annals of astronomical science from its inception to the modern day and shows how calculus played a key role in taking humanity from merely looking up into the heavens to exploring them. Dr. Hahn explains each achievement in astronomical science with an enthusiasm that is contagious. The author uses a clever technique of first describing each interesting and extraordinary scientific achievement in a way that leaves the reader inquisitive about how it was accomplished, and then he explains each step in the mathematical process in a clear, methodical, and thorough manner. Each new concept when introduced is reinforced with additional examples and exercises for the reader. Chapter by chapter the book provides a fascinating history of man's accomplishments in space exploration while at the same time it teaches calculus from its origins to its current magnificent applications.

Magnificent is the word that may best describe this phenomenally powerful book. Its elegance lies in its ability to define and explain complex issues from perspectives that awaken the intellect and foster a true appreciation for the power of calculus and its ability to extend our reach of travel to the planets and beyond, and to extend our reach of perception to the ends of the universe.

Dr. Hahn's breadth and depth of knowledge has enabled him to create a text that is both historically interesting and mathematically enriching. With each chapter he clearly and succinctly describes each new topic in a logical manner that allows the reader to build on the previously introduced mathematical ideas to achieve a deeper,

more enriching understanding of mathematical principles and their role in making the space program a successful reality.

This book is ideally suited for applications as a primary text for teaching calculus to all science and engineering majors and I am especially hopeful that it will also be adopted as a text for High School AP Calculus where it may serve as an inspiration to students to consider a career in the rapidly re-expanding aerospace engineering industry. Further, the way in which this book clearly shows that the mechanics of our universe can be described in clearly understandable mathematical formulas, may help to inspire the next generation of astrophysicists.

In Summary, this book takes the reader on a joyful and fascinating journey through the history of astronomical science and space exploration while it seamlessly weaves in the mathematical underpinnings of each accomplishment. Dr. Hahn has a unique talent for making the complex seem to be straight-forward and understandable, and in doing so, he teaches and motivates the reader to do the same. This text truly emboldens its readers to take-on seemingly impossible engineering problems through the artful application of advanced mathematical analysis and computation.

Submitted by Dr. Mario Zoccoli, Aerospace Engineer, NASA and Lockheed Martin