



Tensor Calculus for Physics: A Concise Guide

By Dwight E. Neuenschwander

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Understanding tensors is essential for any physics student dealing with phenomena where causes and effects have different directions. A horizontal electric field producing vertical polarization in dielectrics; an unbalanced car wheel wobbling in the vertical plane while spinning about a horizontal axis; an electrostatic field on Earth observed to be a magnetic field by orbiting astronauts?these are some situations where physicists employ tensors. But the true beauty of tensors lies in this fact: When coordinates are transformed from one system to another, tensors change according to the same rules as the coordinates. Tensors, therefore, allow for the convenience of coordinates while also transcending them. This makes tensors the gold standard for expressing physical relationships in physics and geometry.

Undergraduate physics majors are typically introduced to tensors in special-case applications. For example, in a classical mechanics course, they meet the "inertia tensor," and in electricity and magnetism, they encounter the "polarization tensor." However, this piecemeal approach can set students up for misconceptions when they have to learn about tensors in more advanced physics and mathematics studies (e.g., while enrolled in a graduate-level general relativity course or when studying non-Euclidean geometries in a higher mathematics class).

Dwight E. Neuenschwander's *Tensor Calculus for Physics* is a bottom-up approach that emphasizes motivations before providing definitions. Using a clear, step-by-step approach, the book strives to embed the logic of tensors in contexts that demonstrate why that logic is worth pursuing. It is an ideal companion for courses such as mathematical methods of physics, classical mechanics, electricity and magnetism, and relativity.

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Editorial Review

Review

Dr. Neuenschwander has written the book I wish I could have read when I was learning mathematical physics. It is colloquial yet authoritative, with many treasures lurking within the chapters. The book brings a breath-taking cohesion to the varied ideas about vectors and tensors that are typically spread across the undergraduate's school terms haphazardly. It is the book I'll want to have nearby next time I teach special or general relativity, or upper-level electromagnetism or rotational dynamics, as much for the historical tidbits and definitive examples, as for its asides about vocabulary and conventions and for its bibliography.

(Gary White, Editor, The Physics Teacher, American Association of Physics Teachers)

This book is well written and has sufficient rigor to allow students to use it for independent study.

(*Choice*)

An introductory *Tensor Calculus for Physics* book is a most welcome addition... Professor Neuenschwander's book fills the gap in robust fashion.

(*American Journal of Physics*)

About the Author

Dwight E. Neuenschwander is a professor of physics at Southern Nazarene University. He is a columnist for the *Observer*, the magazine of the Society for Physics Students, and the author of *Emmy Noether's Wonderful Theorem*, also published by Johns Hopkins, and *How to Involve Undergraduates in Research: A Field Guide for Faculty*.

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