Continuum Analysis of Biological Systems

Conserved Quantities, Fluxes and Forces

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This book addresses the analysis, in the continuum regime, of biological systems at various scales, from the cell to the industrial. It presents fundamental conservation principles (mass, charge, momentum and energy), and relevant fluxes that result from appropriate driving forces useful for the analysis, design and operation of biological systems. It includes the concept of charge conservation, an important principle for biological systems that is not explicitly covered in any other book of this kind. The book is divided into five units on mass conservation, charge conservation, momentum conservation, energy conservation, and multiple conservations applied together. Fluxes resulting from primary driving forces are covered prior to fluxes resulting under the simultaneous action of more than one driving force. The mass conservation aspects, which are easy to grasp intuitively, are presented first, followed by the momentum conservation aspects that require a certain capacity for abstract understanding.

It is designed to provide to the reader a better understanding of the relevant principles, and to facilitate their application in situations that require out-of-the-box thinking for the analysis and design of biological systems. The reader would need a background in engineering mathematics, usually covered in the first three semesters of any engineering curriculum (calculus, differential equations, linear algebra, etc.). An important feature of this book is that the complete mathematical steps are presented so that the reader is able to follow the text with ease. Those who may not have a natural flair for mathematics – typically, a considerable fraction in an undergraduate engineering class – need not spend a long time in understanding the mathematical parts of the text.

Key Features

- Enables self-study by the reader.
- Includes worked out numerical examples in most sub-sections for better understanding of the underlying concepts.
- Presents all the conservation principles of interest in biological systems.
- Promotes an intuitive understanding of the subject by students.
- Demonstrates the efficacy of the principles in tackling many practical issues related to the design and operation, apart from an analysis of biological systems.

G.K. Suraishkumar is Professor at the Department of Biotechnology, Indian Institute of Technology (IIT) Madras, Chennai, India. He obtained his Ph.D. from Drexel University, Philadelphia, USA and his B.Tech. in Chemical Engineering from IIT Madras. He has extensive experience of teaching Biological Engineering to undergraduate and postgraduate students at IIT Bombay, where he spent over a decade as a faculty member in the Department of Chemical Engineering, and later at IIT Madras. His mainstream research area is reactive species – currently, the relevance of reactive species in bio-fuels and in nanoparticle toxicity. He has published research papers in highly reputed international journals. He is passionate about improving student learning and has published papers in reputed international journals on the methods that he had developed for the same. He has contributed significantly in different administrative roles. Notably, he played pivotal roles in the set-up of the Departments of Biotechnology, as the first formal Department Head first at IIT Madras and later, at IIT Hyderabad. He was one of the main architects of the first postgraduate programme in Clinical Engineering in India, which is a multi-Institute programme. He has also contributed on National level committees in relevant areas. He is an inventor of three patents, has guided many Ph.D. and Masters theses work, and has led many sponsored research projects.

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