Mock, M. S.

Analysis of mathematical models of semiconductor devices. (English) Zbl 0532.65081

Boole Press Advances in Numerical Computation Series, 3. Dublin: Boole Press. VIII, 200 p. hbk: $ 89.00; pbk: $ 69.00 (1983).

According to the author, there are two objects to this book, namely to indicate to engineers what numerical methods are available for the solution of problems associated with semiconductor devices and to interest numerical analysts in the problems associated with semiconductor devices which lead to nonlinear partial differential equations. The first chapter is a preliminary one in which the author introduces the equations defining the physics of the problems and indicates the device models which he is to consider. The second and third chapters deal with time independent problems. Conditions are given under which unique solutions may be obtained and it is pointed out that unique solutions may not necessarily exist under certain conditions. Suitable iterative schemes for finding a solution and their convergence are discussed. A full treatment is given of approximating problems obtained by the discretisation of continuous problems, a number of different methods being compared. Of these five involve second order accuracy and one fourth order accuracy. In this connection, it is pointed out that the phenomenon of recombination can give rise to serious mathematical difficulties. The fourth and fifth chapters treat nonstationary systems. It is pointed out that, for these, the dependence of carrier mobilities on electric fields is of considerable importance. Uniqueness theorems are profounded and estimates are obtained which are associated with the asymptotic behaviour of the system. Particular attention is given to the regions where the charge-neutral approximation is valid. A discussion is given of the stability of the discretised analogues of continuous problems, and here again a number of different methods of discretisation are indicated. In the sixth chapter, it is indicated how the principles discussed in the earlier part of the work are applied to a number of devices such as a one dimensional bipolar transistor and a bipolar flip flop circuit. The book is mathematically sophisticated using function spaces of abstruse character and the second goal is more likely to be attained than the first. Much of the work is new and it is a pity that it will only be available in a book with such a extraordinarily high price for 200 pages of typed input (some of which is missing at the bottom of page 104), even in paperback.

Reviewer: Ll.G.Chambers

MSC:

65Z05	Applications to the sciences
78-02	Research exposition (monographs, survey articles) pertaining to optics and electromagnetic theory
65N12	Stability and convergence of numerical methods for boundary value problems involving PDEs
78A55	Technical applications of optics and electromagnetic theory
65N15	Error bounds for boundary value problems involving PDEs
00A06	Mathematics for nonmathematicians (engineering, social sciences, etc.)
65C20	Probabilistic models, generic numerical methods in probability and statistics
35Q99	Partial differential equations of mathematical physics and other areas of application

Keywords:

mathematical models; semiconductor devices; iterative schemes; convergence; nonstationary systems; asymptotic behaviour; stability; a one dimensional bipolar transistor; bipolar flip flop circuit