Journal and Proceedings, Royal Society of New South Wales, Vol. 115, pp. 101-102, 1982
ISSN 0035-9173/82/0204 — 02 $4.00/1

Abstracts of Theses

Title: Multi-dimensional Neutron Diffusion

Author: J.M. Barry

Abstract:

The numerical solution of time dependent neutron diffusion approximation to the transport equation is of vital interest to those concerned with reactor design and safety. The growth of modern computing power has increased the scale with which computations may be undertaken. To exploit these electronic advances fully, however, it is necessary to review existing numerical approaches and substitute more efficient techniques wherever appropriate.

This work first summarises an approach typical of the conventional method of solution. It subsequently concentrates on the heart of the method, namely the solution of very large sparse systems of linear equations. A new numerical approach for their solution is formulated. This essentially seeks a splitting for the iteration matrix which makes the iterative process more implicit. The role that 'experimental mathematics' and computer graphics played in its evolution is discussed. The method has three other possible applications. Two of these are pursued here. Of these secondary applications, the acceleration of convergence in energy has tremendous potential for thermal reactor studies.

Various aspects concerning the behaviour of the new iterative approach are observed. The method is tested extensively on a number of reactor configurations which demonstrate several aspects of design and modelling techniques. The implicit approach is contrasted and compared with relaxation and conjugate gradient methods. Considerable attention is devoted to the efficient implementation of the three iterative schemes on computers with virtual memory.

Traditionally, a secondary acceleration of the iterative technique is achieved with a variational approach. Several modern variations of this, with linear approximating functions instead of constant rescaling factors are considered. The scheme requires the solution of a reduced system of linear equations. Matrix properties of the reduced system are considered, and methods of their solution discussed.

Justification for the secondary acceleration is analysed with a Fourier approach. The applicability of each scheme to the three basic iterative methods is considered by analysing the reduction of frequency components of error in the solution estimate. Predictions from theory are then compared with results on several reactor geometries, with and without the secondary acceleration.

Type of Thesis: Thesis for the Degree of Doctor of Philosophy at the University of Wollongong, Wollongong, N.S.W.

Present Address of Author: Australian Atomic Energy Commission,
Research Establishment,
Private Mail Bag,
Sutherland, N.S.W. 2232.