## Conclusion

When many operating points of an ETM must be found, the decoding algorithms given earlier are recommended. Most, if not all, of these are represented by various methods scattered in the existing literature of turbomachines but here they are gathered together and put in a computationally efficient form. The coefficients in the section describing method 3 are identical or equivalent to quantities which also occur in the literature, but for the purpose of decoding they have been put in the simplest form. This shows that their origin is strongly based on combinatorial features of the relationships governing the ETM in addition to the well known relationships which ultimately derive from Newton's laws.

For the 3-terminal elements, although the fluid mechanics is no more complicated than for the ETM, the combinatorial relationships *are* more complicated.

Since there is no universal way of characterisation, the total number of characterisations was investigated and shown to be 108, or 216 if the dependent variables are treated as distinct. Despite this diversity, only two classes of characterisation need to be distinguished and so, by using coefficients analogous to those for the ETM, a comprehensive set of decoding algorithms could be specified as given in Table 2.

## References


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# BOOK REVIEW

## Numerical Properties and Methodologies in Heat Transfer

Ed. T. M. Shih

This handsome volume is the first Proceedings publication in the series in 'Computational Methods in Mechanics and Thermal Sciences', with W. J. Minkowycz and E. M. Sparrow as series editors. It is the final 'reviewed and revised' form of the papers for the US Second National Symposium on Numerical Methods in Heat Transfer, held in Mayland in September 1981. The book comprises thirty-two papers including six invited reviews.

In numerical heat transfer one may now discern two parallel trends: the development of alternative methods and application to increasingly complex problems. This publication is particularly rich in the first aspect, this being evident not just in the fine review papers and specific method studies. The final paper on one-dimensional enclosed flames, for example, gives a thorough comparison of no less than nine, mainly finite-difference, methods for that problem.

The review papers are authoritative and satisfying. They are also readable for those with some prior knowledge of the subject. The introductory trio survey respectively finite-difference methods for parabolic equations, variational principles, and a finite-difference/finite element comparison. They form a well-chosen and well-balanced overview of alternative methods. The other reviews cover singular perturbation problems, multi-phase flow phenomena and radiation.

Applications include free convection in enclosures, external flows, two-phase flows, radiation, and fires and combustion. Here, perhaps, the book is not so strong since the number of papers is rather limited in a given topic. In this and other respects the philosophy and impact of the book are complementary to those of the proceedings of the biennial numerical methods conferences originating from University College, Swansea, U.K.

The title, then, fairly reflects the emphasis of the book. The cost, $69.50, is not unreasonable for a quality production containing much material. It forms a source book for knowledge of available methods for different heat transfer situations. Here, perhaps, an (obvious) proviso should be made. While the study of method is essential, it is of necessity done for the simpler problem, and the desired application introduces variables which themselves can affect the numerical properties of the method. However, the very number of alternatives possibly contains the necessary warning: in leaving the familiar solved problem for the complex unknown, the choice of method must be made with care. D. Brian Spalding's comment in a specific context surely has some generality: 'Proceed cautiously; you are on your own'. I feel this book is a good reflection both of the current potential of numerical methods in heat transfer, and of the effort needed in their application.

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