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Ch E 674 **Numerical Solutions of Engineering Problems** January 1999

1 Linear Algebra

1. Amundson, N. R., *Mathematical methods in Chemical Engineering* Matrices and their application, Prentice Hall, 1966.
   An excellent introduction linear algebra with examples from Chemical Engineering. The presentation should be easily accessible to an engineering student.

2. Ramakrishna, D. & N. R. Amundson, *Linear operator methods in Chemical Engineering*, Prentice Hall, 1985.
   Presents a rigorous, axiomatic approach to linear systems. Includes linear ordinary and partial differential equations in a unified operator theoretic approach. Examples are drawn mostly from Chemical Engineering applications. But not for casual reading!

3. Wilkinson, J. H., *The algebraic eigenvalue problem*, Clarendon Press, 1965.
   A classical treatise on algebraic eigenvalue problems. Addresses both theoretical and algorithmic issues.

4. Lapidus, L., *Digital Computation for Chemical Engineers*, (Chap .5), McGraw-Hill, 1962.
   A classic numerical methods book for Chemical Engineers, algorithmic approach.

5. Usmani, R. A., *Applied Linear Algebra*, Marcel Dekker, 1987.
   A good introductory book written by a mathematician, but with plenty of simple illustrations (not necessarily Ch E examples!)

6. Wei, J. & C. D. Prater, "The structure and Analysis of Complex Reaction Systems", *Advances in Catalysis*, Chap. 5, Vol. 13, Academic Press, 1962.
   This article is an excellent example of how the concepts from linear algebra (eigenvalues, eigenvectors etc) can be applied fruitfully to study complex (but linear!) reaction systems and how one can design proper experiments to determine rate constants.

7. Keller, H. B., The bordering algorithm and path following near singular points of higher nullity, *SIAM J. Sci. Stat. Comput.*, 573-582, 1983.

8. George, A. & J. W.-H. Liu, *Computer solution of large sparse symmetric positive definite systems of linear equations*, Prentice-Hall.
   The book contains a summary of the authors research on sparse matrix solvers. The software developed based on this work is called SPARSPAK which is available on MTS. This is an outstanding package.

2 Nonlinear algebraic equations

1. Ortega, J. & W. Rheinboldt, *Iterative solution of nonlinear equations in several variables,* AP (1970).
   The most comprehensive work on this topic. For the mathematically inclined!

2. Byrne, G. D. & C. A. Hall, Eds., *Numerical solutions of systems of nonlinear algebraic equations*, AP (1973).
   Contains a collection of review articles dealing with various aspects of solving nonlinear system of algebraic equations — easily accessible.

3. Rabinowitz, P., Ed., *Numerical methods for nonlinear algebraic equations,* Gorden & Breach (1970).
   Another collection of review articles. It also contains a good bibliography on this subject.

4. Baker, C. T. H. & C. Phillips, Eds., *The numerical solution of nonlinear problems*, Clarendon Press (1981).
   Part I of this work contains 6 articles on nonlinear algebraic equations. The article by R. Cook on "nonlinear eigenvalue problems" reviews the status on continuation methods and bifurcation algorithms.

5. Zangwill, W. I. & C. B. Garcia, *Pathways to solutions, fixed points, and equilibria*, Prentice-Hall (1981).
   A text on continuation schemes with a good mix of theory, applications and algorithms.

6. Scales, L. E., *Introduction to non-linear optimization*, Springer-Verlag (1985).
   Of particular interest is chapter 4 where the algorithms (along with the pseudo code) for the nonlinear least squares problem are reviewed.

7. Aggarwal, J. K., *Notes on nonlinear systems*, Van Nostrand Reinhold (1972).
   A good introduction to nonlinear systems — phase plane analysis, stability issues.

8. Cullum, J. & R. A. Willoughby, *Large Scale Eigenvalue Problems*, Noth-Holland (1985).
Proceedings if an IBM workshop. It addresses algorithmic issues for parallel and vector processors.

9. Dennis, J. E. Jr. & J. J. Moré, Quasi-Newton methods, motivation and theory, *SIAM Review*, **19**, pp443-459 (1977).

3 On discretizing the Navier-Stokes Equations

1. Roache, P. J., *Computational fluid mehcanics*, Hermosa publishers, 1972.
an early classic in this area. It deals primarily with finite difference methods

2. Holt, M., *Numerical methods in fluid mechanics*, Springer Verlag, 1977.

3. Chow, C.-Y., *An introduction to computational fluid mechanics*, John Wiley & Sons, 1979.

4. Patankar, S. V. *Numerical heat transfer and fluid flow,* Hemisphere, 1980.
the clearest exposition of Patankar's own contribution

5. Peyret, R. & T. D. Taylor, *Computational methods for fluid flow*, Springer-Verlag, 1983.

6. Anderson, D. A., J. C. Tannehill & R. H. Pletcher, *Computational fluid mechanics and heat transfer*, Hemishpere, 1984.

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9. Chawla, T. C. (Ed.), *Annual Review of Numerical Fluid Mechanics and Heat Transfer*, Hemisphere (1987).

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11. Baker, A. J., *Finite element computational fluid mechanics*, Hemisphere, 1983.

12. Girault, V. & P.-A. Raviart, *Finite element methods for Navier-Stokes equations*, Springer-Verlag, 1986.

13. Schechter, R. S., *The Variational Method in Engineering*, McGraw-Hill (1967)

14. Gottlieb, D. & S. A. Orszag, *Numerical analysis of spectral methods: Theory and applications*, SIAM, 1983.

15. Canuto, C, *et al.* ., *Spectral Methods in Fluid Dynamics*, Springer-Verlag (1988).

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17. Crochet, M. J., A. R. Davies and K. Walters, *Numerical simulation of non-Newtonian flow*, Elsevier, 1984.

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19. Mitchell, A. R., *Computational methods in partial differential equations*, John Wiley & Sons, 1969.

20. Rice, J. R. and R. F. Boisvert, *Solving Elliptic Problems using* **ELLPACK**, Springer-Verlag (1984)

21. Birkhoff, G. & R. Lynch, *Numerical solution of elliptic problems*, SIAM, 1984.

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23. Aris, R. & N. R. Amundson, *Mathematical methods in Chemical Engineering*, Vol. 2, Prentice Hall, 1973.

24. Lapidus, L. & G. F. Pinder, *Numerical solution of partial differential equations in science and engineering*, John Wiley & Sons, 1982.

25. Finlayson, B. A., *Nonlinear analysis in chemical engineering*, McGraw Hill 1980.

26. Kubicek, M. & V. Hlavacek, *Numerical solutions of nonlinear boundary value problems with applications*, Prentice Hall, 1983.

4 Hydrodynamic Stability & Bifurcation Theory

1. Gleick, J., *Chaos: making a new science*, Viking, New York, NY, USA. (1987).
a popular description of developments in this area.

2. Hilger, B., *Nonlinear phenomena and chaos*, (1986).

3. Milonni, P. W., *Chaos in laser-matter interactions*, World Scientific, Singapore, (1987).

4. Moon, F. C., *Chaotic vibrations: an introduction for applied scientists and engineers* Wiley, New York, (1987).

5. Golubitsky, M. and D. G. Schaeffer, *Singularities and groups in Bifurcation theory*, Springer-Verlag (1985).
a sincere attempt by mathematicians to get the point across to applied scientists and engineers (or mathematically less sophisticated!?).

6. Bhattacharjee, J. K., *Convection and chaos in fluids*, World Scientific, Singapore, (1987).
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- an excellent introduction to the theory with illustrations.

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5 Continuation methods

1. Garcia, C. B. & W. I. Zangwill, *Pathways to solutions, fixed points and equilibria*, Prentice Hall, 1981.

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