

Civan, Faruk; Sliepcevic, C. M.

Differential quadrature for multi-dimensional problems. (English) Zbl 0557.65084
J. Math. Anal. Appl. 101, 423-443 (1984).

This paper uses a technique developed by R. E. Bellman and his coworkers and applies a generalisation of this technique to the solution of time dependent and time independent partial differential equations involving multiple space dimensions. This technique involves an approximation of the form $(\partial^m / \partial x^m) f(x_i) \simeq \sum_{j=1}^N W_{ij} f(x_j)$ where the data points x_i are given and the weights are chosen so that the result is exact when $f(x) = x^k$, $k = 0, \dots, (N - 1)$. For the time independent case the theory leads to a set of linear algebraic equations for the values of the solution at the grid points. The time dependent case leads to a similar set of linear first order differential equations in time. Examples and numerical computations are given using convection-diffusion equations.

Reviewer: [B.Burrows](#)

MSC:

- [65Z05](#) Applications to the sciences
- [65N35](#) Spectral, collocation and related methods for boundary value problems involving PDEs
- [35K60](#) Nonlinear initial, boundary and initial-boundary value problems for linear parabolic equations
- [92D40](#) Ecology

Cited in **33** Documents

Keywords:

differential quadrature; convection-diffusion equation; steady-state dispersion of inert, neutrally buoyant pollutants; unbounded atmosphere

Full Text: [DOI](#)

References:

- [1] Apostol, R.T.; Charlton, J.A., Solution of a two-dimensional diffusion-convection equation describing the mass transfer of a neutrally buoyant tracer, (), 323-332
- [2] Bellman, R.E., (), Chap. 16
- [3] Bellman, R.E.; Casti, J., Differential quadrature and long-term integration, *J. math. anal. appl.*, 34, 235-238, (1971) · [Zbl 0236.65020](#)
- [4] Bellman, R.E.; Kashef, B.G.; Casti, J., Differential quadrature: A technique for the rapid solution of nonlinear partial differential equations, *J. comput. phys.*, 10, 40-52, (1972) · [Zbl 0247.65061](#)
- [5] Bellman, R.E.; Kashef, B.G., Solution of the partial differential equation of the hodgkins—huxley model using differential quadrature, *Math. biosci.*, 19, 1-8, (1974) · [Zbl 0273.65088](#)
- [6] Bellman, R.E.; Roth, R.S., System identification with partial informauon, *J. math. anal. appl.*, 68, 321-333, (1979)
- [7] Bellman, R.E.; Roth, R.S., A scanning technique for systems identification, *J. math. anal. appl.*, 71, 403-411, (1979) · [Zbl 0419.93023](#)
- [8] Civan, F., Solution of transport phenomena type models by the method of differential quadratures, ()
- [9] Civan, F.; Sliepcevic, C.M., Application of differential quadrature to transport processes, *J. math. anal. appl.*, 93, 1, 206-221, (1983) · [Zbl 0538.65084](#)
- [10] Civan, F.; Sliepcevic, C.M., Solution of the Poisson equation by differential quadrature, *Internat. J. numer. methods engrg.*, 19, 711-724, (1983) · [Zbl 0512.65078](#)
- [11] Fehlberg, E., Low-order classical Runge-Kutta formulas with stepsize control and their application to some heat transfer problems, *Nasa tr r-315*, (July 1969)
- [12] Forsythe, G.E.; Moler, C.B., Computer solution of linear algebraic systems, (1967), Prentice-Hall Englewood Cliffs, N.J, Sect. 17 · [Zbl 0154.40401](#)
- [13] Guymon, G.L., A finite element solution of the one-dimensional diffusion-convection equation, *Water resour. J.*, 6, 1, 204-210, (1970)

- [14] Hamming, R.W., Numerical methods for scientists and engineers, (1973), McGraw Hill New York · [Zbl 0262.65001](#)
- [15] Mingle, J.O., Computational considerations in nonlinear diffusion, Internal. J. numer. methods engrg., 7, 103-116, (1973) · [Zbl 0263.65102](#)
- [16] Mingle, J.O., The method of differential quadrature for transient nonlinear diffusion, J. math. anal. appl., 60, 559-569, (1977) · [Zbl 0372.65049](#)
- [17] Pepper, D.W.; Baker, A.J., A high-order accurate numerical algorithm for three-dimensional transport prediction, Comput. fluids., 8, 371-390, (1980) · [Zbl 0438.76068](#)
- [18] Seinfeld, J.H., Air pollution, (), 295-296, Table 6.3
- [19] Wassyng, A., Solving $\text{Ax} = \text{b}$: A method with reduced storage requirements, SIAM J. numer. anal., 19, 1, (1982) · [Zbl 0478.65013](#)

This reference list is based on information provided by the publisher or from digital mathematics libraries. Its items are heuristically matched to zbMATH identifiers and may contain data conversion errors. It attempts to reflect the references listed in the original paper as accurately as possible without claiming the completeness or perfect precision of the matching.