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Library: MATHLIB
Submitter :
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Fast Partial Differential Equation Solver

ELPAHY uses fast Fourier transform techniques for the solution, over a rectangular domain, of the following elliptic, parabolic or hyperbolic part differential equation:

$$\frac{d^2\phi(x,y)}{dx^2} + c_1\frac{d^2\phi(x,y)}{dy^2} + c_2\frac{d\phi(x,y)}{dy} + c_3\phi(x,y) \; = \; \rho(x,y)$$

where $\phi(x,y)$ is the unknown function, $\rho(x,y)$ the known source term, and c_1, c_2, c_3 given coefficients. A large variety of boundary conditions can be specified on the sides of the rectangle.

Structure:

SUBROUTINE subprogram
User Entry Names: ELPAHY
Internal Entry Names: NEWRO, ELANAL, ESOLVE, SYNT, MFT
External References: RFT (D700)
COMMON Block Names and Lengths: /FW1/ 774, /FW2/ 100

Usage:

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CALL ELPAHY(F,NX,NY,DX,DY,C,IBX,BWEST,BEAST,JBY,BSOUTH,BNORTH)
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F (REAL) Two-dimensional array, dimensioned (NX,NY) in the calling program. On input it contains the source term $\rho(x,y)$ and on return it contains the unknown function $\phi(x,y)$.

NX (INTEGER) Number of divisions along X. NX must be of the form $2^n + 1$.

NY (INTEGER) Number of divisions along Y.

DX (REAL) Mesh spacing along X.

DY (REAL) Mesh spacing along Y.

C (REAL) One-dimensional array of dimension 3, containing the coefficients c_1, c_2, c_3.

IBX (INTEGER) Controls the type of boundary conditions on the left (BWEST) and right (BEAST) sides of the rectangular domain:
IBX = 1 : Imposed periodicity along x; BWEST, BEAST not given.
IBX = 2 : Given derivative on either vertical side.
IBX = 3 : Given value on either vertical side.
IBX = 4 : Given value on the left side, given derivative on the right side.

BWEST (REAL) One-dimensional array of size NY containing values or derivatives for the left side; the interpretation depends on IBX.

BEAST (REAL) One-dimensional array of size NY containing values or derivatives for the right side; the interpretation depends on IBX.

JBY (INTEGER) Controls the type of boundary conditions on the lower (BSOUTH) und upper (BNORTH) sides of the rectangular domain:

Elliptic equation ($c_1 > 0$):
JBY = 1 : Given value on both lower and upper sides.
JBY = 2 : Given derivative on both lower and upper sides.
JBY = 3 : Given value on lower side, given derivative on upper side.
JBY = 4 : Given derivative on lower side, given value on upper side.

Parabolic equation ($c_1 = 0$):
Specify BSOUTH array only. (If y=time, BSOUTH are initial values and the future BNORTH cannot be specified).
JBY = 1 : Given value on lower side.
JBY = 2 : Given derivative on lower side.

Hyperbolic equation ($c_1 < 0$):
The BSOUTH array specifies the value, the BNORTH array the derivative.
JBY = 1.

BSOUTH (REAL) One-dimensional array of size NX containing values or derivatives for the lower side; the interpretation depends on JBY.

BNORTH (REAL) One-dimensional array of size NX containing values or derivatives for the upper side; the interpretation depends on JBY.

Notes:

If NX > 65, specify COMMON /FWORK/ of length 6*NX and COMMON /FW1/ of length 6*NX in the calling program. If NY > 50, specify COMMON /FW2/ of length 2*NY. In either case, make sure your program is loaded before ELPAHY (D302) (this is automatic unless you recompile D302 in the same job).

References:

1. R.C. Le Bail, Use of fast Fourier transforms for solving partial differential equations in physics, J. Comput. Phys. **9** (1972) 440–465

A copy of Ref. 1 is available.

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