

## ***Numerical instructions in Matlab (M), Octave (O) or both ones***

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## 1. Nonlinear Equations and polynomials

|   |          |                                                                                                                                                                         |
|---|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| O | company  | Compute the companion matrix corresponding to polynomial coefficient vector                                                                                             |
| B | conv     | Convolve two vectors.                                                                                                                                                   |
| B | deconv   | Deconvolve two vectors                                                                                                                                                  |
| B | conv2    | Returns 2D convolution                                                                                                                                                  |
| B | convn    | Returns 2D convolution                                                                                                                                                  |
| B | fzero    | Find a zero point of a univariate function. Using interval method with options defined by optimset (f.e. "FunValCheck", "OutputFcn", "TolX", "MaxIter", "MaxFunEvals".) |
| B | optimset | Define options for fzero, fsolve, ...                                                                                                                                   |
| B | polyval  | Evaluate a polynomial                                                                                                                                                   |
| O | polygcd  | Find greatest common divisor of two polynomials                                                                                                                         |
| B | polyvalm | Evaluate a polynomial in the matrix sense                                                                                                                               |
| B | residue  | Compute the partial fraction expansion for the quotient of the polynomials                                                                                              |
| B | roots    | Find all zeros of polynomial equations                                                                                                                                  |

## 2. Linear Algebra

|   |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| B | cond                   | Condition number with respect to inversion                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| B | condeig                | Condition number with respect to eigenvalues                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| B | condest                | 1-norm condition number estimate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| B | det                    | Matrix determinant                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| B | expm                   | Matrix exponential                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| M | funm                   | Evaluate general matrix function                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| M | gallery                | Get a specialized matrix (binomial, Cauchy, chebspec, chebvand, chow, circul, clement, compare, condex, cyclo, dorr, dramadah, fiedler, forsythe, frank, gearmat, gcdmat, grcar, hanowa, house, integerdata, invhess, invol, ipjfact, jordbloc, kahan, kms, krylov, lauchli, lehmer, leslie, lesp, lotkin, minij, moler, Neumann, normaldata, orthog, parter, pei, poisson, prolate, randcolu, randcorr, randhess, randjorth, rando, randsvd, redheff, Riemann, ris, sampling, smoke, toeppd, tridiag, triw, uniformdata, wathen, wilk,) |
| O | housh                  | Compute Householder reflection vector                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| B | inv                    | Inverse of matrix                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| B | kron                   | Form the kronecker product of two matrices                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| O | krylov                 | Construct an orthogonal basis $u$ of block Krylov subspace                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| B | logm                   | Matrix logarithm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| M | mldivide \, mrdivide / | Left or right matrix division                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| M | norm                   | Vector and matrix norms                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| M | normest                | 2-norm estimate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| M | null                   | Null space                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| M | orth                   | Range space of matrix                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| M | paugment               | Form least squares augmented systems                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| M | pinv                   | Moore-Penrose pseudoinverse of matrix                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| M | prank                  | Structural rank                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| M | rank                   | Rank of matrix                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| M | rcond                  | Matrix reciprocal condition number estimate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| M | rref                   | Reduced row echelon form                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

|   |                       |                             |
|---|-----------------------|-----------------------------|
| B | <code>sqrtm</code>    | Matrix square root          |
| B | <code>subspace</code> | Angle between two subspaces |
| M | <code>trace</code>    | Sum of diagonal elements    |

### 3. Linear Equations

|   |                                                                                                      |                                                                 |
|---|------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| B | <code>chol</code>                                                                                    | Cholesky factorization                                          |
| M | <code>cholinc</code>                                                                                 | Sparse incomplete Cholesky and Cholesky-Infinity factorizations |
| O | <code>cholinv</code>                                                                                 | Compute the inverse matrix using the Cholesky factorization     |
| O | <code>chol2inv</code>                                                                                | Compute the inverse matrix from the Cholesky factorization      |
| O | <code>cholinsert</code> , <code>choldelete</code> , <code>cholshift</code> , <code>cholupdate</code> |                                                                 |
| M | <code>ilu</code>                                                                                     | Sparse incomplete LU factorization                              |
| B | <code>inv</code>                                                                                     | Matrix inverse                                                  |
| M | <code>ldl</code>                                                                                     | Block LDL' factorization for Hermitian indefinite matrices      |
| M | <code>linsolve</code>                                                                                | Solve linear system of equations                                |
| M | <code>lsqcov</code>                                                                                  | Least-squares solution in presence of known covariance          |
| M | <code>lsqnonneg</code>                                                                               | Solve nonnegative least-squares constraints problem             |
| M | <code>lu</code>                                                                                      | LU matrix factorization                                         |
| M | <code>luinc</code>                                                                                   | Sparse incomplete LU factorization                              |
| B | <code>qr</code>                                                                                      | Orthogonal-triangular decomposition                             |
| O | <code>qrupdate</code> , <code>qrinsert</code> , <code>qrdelete</code>                                |                                                                 |
| O | <code>qz</code>                                                                                      | QZ generalized eigenvalue problem                               |
| O | <code>qzhess</code>                                                                                  | Hessenberg triangular decomposition                             |
| M | <code>rcond</code>                                                                                   | Matrix reciprocal condition number estimate                     |
| B | <code>schur</code>                                                                                   | Schur decomposition                                             |
| O | <code>syl</code>                                                                                     | Solve the Sylvester equation                                    |

### 4. Linear Equations (Iterative Methods)

|   |                        |                                                                                                                           |
|---|------------------------|---------------------------------------------------------------------------------------------------------------------------|
| M | <code>bicg</code>      | Biconjugate gradients method                                                                                              |
| B | <code>bicgstab</code>  | Solve a linear system with positive definite real matrix by mean of iterative method                                      |
| M | <code>bicgstabl</code> | Biconjugate gradients stabilized (l) method                                                                               |
| M | <code>bgs</code>       | Conjugate gradients squared method                                                                                        |
| M | <code>bmres</code>     | Generalized minimum residual method (with restarts)                                                                       |
| B | <code>cgs</code>       | Solve a linear system with positive definite real matrix by mean of iterative method (conjugate gradients squared method) |
| M | <code>lsq</code>       | rLSQR method                                                                                                              |
| M | <code>minres</code>    | Minimum residual method                                                                                                   |
| M | <code>pcg</code>       | Preconditioned conjugate gradients method                                                                                 |
| M | <code>qmr</code>       | Quasi-minimal residual method                                                                                             |
| M | <code>symmlq</code>    | Symmetric LQ method                                                                                                       |
| M | <code>tfqmr</code>     | Transpose-free quasi-minimal residual method                                                                              |

## 5. Nonlinear systems

B    fsolve        Solve a system of nonlinear equations

## 6. Eigenvalues and Singular Values

B    balance        Diagonal scaling to improve eigenvalue accuracy  
M    cdf2rdf        Convert complex diagonal form to real block diagonal form  
M    condeig        Condition number with respect to eigenvalues  
M    eig            Eigenvalues and eigenvectors  
M    eigs            Largest eigenvalues and eigenvectors of matrix  
M    gsvd           Generalized singular value decomposition  
B    hess            Hessenberg form of matrix  
M    ordeig        Eigenvalues of quasitriangular matrices  
M    ordqz        Reorder eigenvalues in QZ factorization  
M    ordschur       Reorder eigenvalues in Schur factorization  
M    poly           Polynomial with specified roots  
M    polyeig        Polynomial eigenvalue problem  
M    rsf2csf        Convert real Schur form to complex Schur form  
M    schur          Schur decomposition  
M    sqrtm        Matrix square root  
M    ss2tf        Convert state-space filter parameters to transfer function form  
M    svd            Singular value decomposition  
M    svds          Find singular values and vectors

## 7. Interpolation

### 1) One-dimensional Interpolation

B    interp1        1-D data interpolation (table lookup)  
B    interp1q      Quick 1-D linear interpolation  
B    interp2        2-D data interpolation (table lookup)  
B    interp3        3-D data interpolation (table lookup)  
B    interpft       1-D interpolation using FFT method  
B    mkpp          Make piecewise polynomial  
O    lookup        Identify the points of the original data that are closest to the current point of interest  
B    pchip        Piecewise Cubic Hermite Interpolating Polynomial (PCHIP)  
B    ppval        Evaluate piecewise polynomial  
B    spline        Cubic spline data interpolation  
B    Unmkpp       Piecewise polynomial details

### 2) Multi-dimensional Interpolation

O    bicubic        2-D bicubic interpolation  
M    griddata      Data gridding

|   |           |                                                              |
|---|-----------|--------------------------------------------------------------|
| M | griddata3 | Data gridding and hypersurface fitting for 3-D data          |
| M | griddatan | Data gridding and hypersurface fitting (dimension $\geq 2$ ) |
| M | intern    | N-D data interpolation (table lookup)                        |
| B | meshgrid  | Generate X and Y arrays for 3-D plots                        |
| B | ndgrid    | Generate arrays for N-D functions and interpolation          |

### 3) Scattered Data

|   |                    |                                                 |
|---|--------------------|-------------------------------------------------|
| M | dsearch            | Search Delaunay triangulation for nearest point |
| M | dsearchn           | N-D nearest point search                        |
| M | padecoef           | Padé approximation of time delays               |
| M | TriScatteredInterp | Interpolate scattered data                      |
| M | TriScatteredInterp | Interpolate scattered data                      |
| M | Tsearch            | Search for enclosing Delaunay triangle          |
| M | Tsearchn           | N-D closest simplex search                      |

### Delaunay Triangulation and Tessellation

|   |                               |                                                               |
|---|-------------------------------|---------------------------------------------------------------|
| M | baryToCart (TriRep)           | Converts point coordinates from barycentric to Cartesian      |
| M | cartToBary (TriRep)           | Convert point coordinates from cartesian to barycentric       |
| M | circumcenters (TriRep)        | Circumcenters of specified simplices                          |
| M | Delaunay                      | Delaunay triangulation                                        |
| M | delaunay3                     | 3-D Delaunay tessellation                                     |
| M | delaunayn                     | N-D Delaunay tessellation                                     |
| M | DelaunayTri                   | Delaunay triangulation in 2-D and 3-D                         |
| M | DelaunayTriConstruct          | Delaunay triangulation                                        |
| M | edgeAttachments (TriRep)      | Simplices attached to specified edges                         |
| M | edges (TriRep)                | Triangulation edges                                           |
| M | faceNormals (TriRep)          | Unit normals to specified triangles                           |
| M | featureEdges (TriRep)         | Sharp edges of surface triangulation                          |
| M | freeBoundary (TriRep)         | Facets referenced by only one simplex                         |
| M | incenters (TriRep)            | Incenters of specified simplices                              |
| M | inOutStatus (DelaunayTri)     | Status of triangles in 2-D constrained Delaunay triangulation |
| M | isEdge (TriRep)               | Test if vertices are joined by edge                           |
| M | nearestNeighbor (DelaunayTri) | Point closest to specified location                           |
| M | neighbors (TriRep)            | Simplex neighbor information                                  |
| M | pointLocation (DelaunayTri)   | Simplex containing specified location                         |
| M | size (TriRep)                 | Size of triangulation matrix                                  |
| M | tetramesh                     | Tetrahedron mesh plot                                         |
| M | trimesh                       | Triangular mesh plot                                          |
| M | TriRep                        | Triangulation representation                                  |
| M | TriRep                        | Triangulation representation                                  |
| M | Trisurf                       | Triangular surface plot                                       |
| M | Vertex                        | Attachments (TriRep)                                          |
| M |                               | Return simplices attached to specified vertices               |

## Convex Hull

|   |            |                                    |
|---|------------|------------------------------------|
| M | convexHull | (DelaunayTri) Convex hull          |
| M | convhull   | Convex hull                        |
| M | convhulln  | N-D convex hull                    |
| M | patch      | Create one or more filled polygons |
| M | trisurf    | Triangular surface plot            |

## Voronoi Diagrams

|   |          |                                      |
|---|----------|--------------------------------------|
| M | Patch    | Create one or more filled polygons   |
| M | Voronoi  | Voronoi diagram                      |
| M | Voronoi  | Diagram (DelaunayTri)Voronoi diagram |
| M | Voronoin | N-D Voronoi diagram                  |

## M Domain Generation

|   |          |                                                     |
|---|----------|-----------------------------------------------------|
| M | meshgrid | Generate X and Y arrays for 3-D plots               |
| M | ndgrid   | Generate arrays for N-D functions and interpolation |

## M Cartesian Coordinate System Conversion

|   |          |                                                         |
|---|----------|---------------------------------------------------------|
| M | cart2pol | Transform Cartesian coordinates to polar or cylindrical |
| M | cart2sph | Transform Cartesian coordinates to spherical            |
| M | pol2cart | Transform polar or cylindrical coordinates to Cartesian |
| M | sph2cart | Transform spherical coordinates to Cartesian            |

## 8. Interpolation and Regression

|   |             |                                                                              |
|---|-------------|------------------------------------------------------------------------------|
| B | interp1     | 1-D data interpolation (table lookup)                                        |
| B | interp2     | 2-D data interpolation (table lookup)                                        |
| B | interp3     | 3-D data interpolation (table lookup)                                        |
| B | interpft    | Fourier interpolation                                                        |
| B | intern      | N-D data interpolation (table lookup)                                        |
| B | polyfit     | Polynomial curve fitting                                                     |
| B | polyval     | Polynomial evaluation                                                        |
| B | spline      | Cubic spline interpolation                                                   |
| M | lsqcurvefit | Solve nonlinear curve-fitting (data-fitting) problems in least-squares sense |
| M | lsqlin      | Solve constrained linear least-squares problems                              |
| M | lsqnonlin   | Solve nonlinear least-squares (nonlinear data-fitting) problems              |
| M | lsqnonneg   | Solve nonnegative least-squares constraint problem                           |

## 9. Fourier Transforms

|   |          |                                                   |
|---|----------|---------------------------------------------------|
| B | abs      | Absolute value and complex magnitude              |
| B | angle    | Phase angle                                       |
| M | cplxpair | Sort complex numbers into complex conjugate pairs |

|   |            |                                                                        |
|---|------------|------------------------------------------------------------------------|
| O | detrend    | Removes the best polynomial minimum squares fit and leaves the “noise” |
| B | fft        | Discrete Fourier transform                                             |
| B | fft2       | 2-D discrete Fourier transform                                         |
| B | fftn       | N-D discrete Fourier transform                                         |
| O | fftfilt    | Filter a signal using FFT                                              |
| M | fftshift   | Shift zero-frequency component to center of spectrum                   |
| B | fftw       | Interface to FFTW library run-time algorithm tuning control            |
| B | filter     | Filter a signal using FFT                                              |
| O | filter2    | Filter a 2D signal using FFT                                           |
| O | freqz      | Return the complexfrequency                                            |
| O | freqz_plot | Plot the pass band, stop band and phase response                       |
| B | ifft       | Inverse discrete Fourier transform                                     |
| B | ifft2      | 2-D inverse discrete Fourier transform                                 |
| B | ifftn      | N-D inverse discrete Fourier transform                                 |
| M | ifftshift  | Inverse FFT shift                                                      |
| M | nextpow2   | Next higher power of 2                                                 |
| B | unwrap     | Correct phase angles to produce smoother phase plot                    |

## 10. Time Series

|   |                        |                                                                                                                 |
|---|------------------------|-----------------------------------------------------------------------------------------------------------------|
| M | ar                     | Noniterative, least-squares method to estimate linear, discrete-time single-output AR models.                   |
| M | armax                  | Iterative prediction-error method to estimate linear, single-output ARMAX models.                               |
| M | arx                    | Noniterative, least-squares method for estimating single-output and multiple-output linear AR models.           |
| M | ivar                   | Noniterative, instrumental variable method for estimating single-output AR models                               |
| O | arch_fit               | Fit an ARCH regression model to the time series $y$ using the scoring algorithm in Engle's original ARCH paper. |
| O | arch_rnd               | Simulate an ARCH sequence.                                                                                      |
| O | arch_test              | Perform a Lagrange Multiplier (LM) test of the null hypothesis of no conditional heteroscedascity.              |
| O | arma_rnd               | Simulate an ARMA sequence.                                                                                      |
| O | autocor                | Return the autocorrelations                                                                                     |
| O | autocov                | Return the autocovariances                                                                                      |
| O | autoreg_matrix         | Generate a regressir matrix to be used in autoregression                                                        |
| O | bartlett               | Return the filter coefficients of a Bartlett (triangular) window                                                |
| O | blackman               | Return the filter coefficients of a Blackman window                                                             |
| O | diffpara ( $x, a, b$ ) | Return the estimator $d$ for the differencing parameter of an integrated time series.                           |
| O | durbinlevinson         | Perform one step of the Durbin-Levinson algorithm.                                                              |
| O | fftshift               | Perform a shift of the vector                                                                                   |
| M | lfftshift              | Undo the action of the fftshift function                                                                        |
| O | fractdiff              | Compute the fractional differences                                                                              |
| O | hamming                | Return the filter coefficients of a Hamming window                                                              |
| O | hanning                | Return the filter coefficients of a Hanning window                                                              |
| O | hurst                  | Estimate the Hurst parameter                                                                                    |

- O periodogram For a data matrix  $x$  from a sample of size  $n$ , return the periodogram
- O rectangle\_lw Rectangular lag window. Subfunction used for spectral density estimation.
- O rectangle\_sw Rectangular spectral window. Subfunction used for spectral density estimation.
- O sinetone Return a sinetone of frequency  $freq$  with length of  $sec$  seconds at sampling rate  $rate$  and with amplitude  $ampl$ .
- O sinewave Return an  $m$ -element vector with  $i$ -th element
- M spectral\_adf Return the spectral density estimator given a vector of autocovariances  $c$ , window name  $win$ , and bandwidth,  $b$
- O spectral\_xdf Return the spectral density estimator given a data vector  $x$ , window name  $win$ , and bandwidth,
- O spencer Return Spencer's 15 point moving average
- O stft Compute the short-time Fourier transform of the vector  $x$  with  $num\_coef$  coefficients by applying a window of  $win\_size$  data points and an increment of  $inc$  points
- O synthesis Compute a signal from its short-time Fourier transform  $y$  and a 3-element vector  $c$  specifying window size, increment, and window type
- O yulewalker Fit an AR (p)-model with Yule-Walker estimates

## 11. Derivatives and Integrals

- M cumtrapz Cumulative trapezoidal numerical integration
- M del2 Discrete Laplacian
- M diff Differences and approximate derivatives
- M gradient Numerical gradient
- B polyder Polynomial derivative
- B polyint Integrate polynomial analytically
- O polyreduce Reduces a polynomial coefficient vector to a minimum number of terms by stripping off any leading zeros

## 12. Numerical Integration (Quadrature)

- B dblquad Numerically evaluate double integral over rectangle
- O colloc Compute derivative and integral weight matrices for orthogonal collocation
- B quad Numerically evaluate integral, adaptive Simpson quadrature
- B quad2d Numerically evaluate double integral over planar region
- B quadgk Numerically evaluate integral, adaptive Gauss-Kronrod quadrature
- B quadl Numerically evaluate integral, adaptive Lobatto quadrature
- B quadv Vectorized quadrature
- B trapz Numerical integration using the trapezoidal method
- B triplequad Numerically evaluate triple integral

## 13. Optimization

- M bintprog Solve binary integer programming problems
- M fgoalattain Solve multiobjective goal attainment problems
- M fminbnd Find minimum of single-variable function on fixed interval



|   |            |                                                                                                                  |
|---|------------|------------------------------------------------------------------------------------------------------------------|
| M | fminbnd    | Find minimum of single-variable function on fixed interval                                                       |
| M | fmincon    | Find minimum of constrained nonlinear multivariable function                                                     |
| M | fminimax   | Solve minimax constraint problem                                                                                 |
| M | fminsearch | Find minimum of unconstrained multivariable function using derivative-free method                                |
| M | fminsearch | Find minimum of unconstrained multivariable function using derivative-free method                                |
| M | fminunc    | Find minimum of unconstrained multivariable function                                                             |
| M | fseminf    | Find minimum of semi-infinitely constrained multivariable nonlinear function                                     |
| O | glpk       | Solve Linear Programming problem                                                                                 |
| O | gls        | Solve generalized least squares minimization with anisotropic noise                                              |
| O | gp         | Solve Quadratic Programming problem                                                                              |
| M | ktrlink    | Find minimum of constrained or unconstrained nonlinear multivariable function using KNITRO third-party libraries |
| M | linprog    | Solve Linear Programming problem                                                                                 |
| M | linprog    | Solve linear programming problems                                                                                |
| B | lsqnonneg  | Solve nonnegative least-squares constraints problem                                                              |
| O | ols        | Solve ordinary least squares minimization with isotropic noise                                                   |
| B | optimget   | Optimization options values                                                                                      |
| B | optimset   | Create or edit optimization options structure                                                                    |
| M | quadprog   | Solve Quadratic Programming problem                                                                              |
| M | quadprog   | Solve quadratic programming problems                                                                             |
| O | sqp        | Solve general nonlinear minimization using a successive quadratic programming solver                             |

## 14. Ordinary Differential Equations

|   |                                                       |                                                                                                                     |
|---|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| O | daspk                                                 | Solve differential-algebraic equation using Petzold's solver                                                        |
| O | dassl                                                 | Solve differential-algebraic equation using Petzold's solver with with constraints (stopping conditions)            |
| O | dasrt                                                 | Solve differential-algebraic equation using Petzold's solver with with functional stopping criteria (root solving). |
| M | decic                                                 | Compute consistent initial conditions for ode15                                                                     |
| M | ldeval                                                | Evaluate solution of differential equation problem                                                                  |
| O | lsode                                                 | solve ODEs using Hindmarsh's solver                                                                                 |
| M | ode15i                                                | Solve fully implicit differential equations, variable order method                                                  |
| M | ode23, ode45, ode113, ode15s, ode23s, ode23t, ode23tb | Solve initial value problems for ordinary differential equations                                                    |
| M | odefile                                               | Define differential equation problem for ordinary differential equation solvers                                     |
| M | odeget                                                | Ordinary differential equation options parameters                                                                   |
| M | odeset                                                | Create or alter options structure for ordinary differential equation solvers                                        |
| M | odextend                                              | Extend solution of initial value problem for ordinary differential equation                                         |

## 15. Delay Differential Equations

|   |        |                                                                        |
|---|--------|------------------------------------------------------------------------|
| M | dde23  | Solve delay differential equations (DDEs) with constant delays         |
| M | ddeget | Extract properties from delay differential equations options structure |
| M | ddesd  | Solve delay differential equations (DDEs) with general delay           |

|   |                         |                                                                   |
|---|-------------------------|-------------------------------------------------------------------|
| M | sddeset                 | Create or alter delay differential equations options structure    |
| M | deval                   | Evaluate solution of differential equation problem                |
| M | Boundary Value Problems |                                                                   |
| M | bvp4c                   | Solve boundary value problems for ordinary differential equations |
| M | bvp5c                   | Solve boundary value problems for ordinary differential equations |
| M | bvpget                  | Extract properties from options structure created with bvpset     |
| M | bvpinit                 | Form initial guess for bvp4c                                      |
| M | bvpset                  | Create or alter options structure of boundary value problem       |
| M | bvpextend               | Form guess structure for extending boundary value solutions       |
| M | deval                   | Evaluate solution of differential equation problem                |

## 16. Partial Differential Equations

|   |        |                                                                          |
|---|--------|--------------------------------------------------------------------------|
| M | pdepe  | Solve initial-boundary value problems for parabolic-elliptic PDEs in 1-D |
| M | pdeval | Evaluate numerical solution of PDE using output of pdepe                 |