**Code:**

% MP 4 by Nicholas Fong on 2-16-17 for CSCI 166

y1 = [1, 4, 0, 4, 4, 0, 4, -6]; % y1 = x^7 + 4x^6 + 4x^4 + 4x^3 + 4x - 6

y2 = [1, -5, 2, 22, -31, -5, 28, -12]; % y2 = x^7 - 5x^6 + 2x^5 + 22x^4 - 31x^3 - 5x^2 + 28x - 12

companion1 = compan(y1); % get the companion matrices

companion2 = compan(y2);

eigenvalues1 = eig(companion1); % get the eigenvalues of the companion matrices

eigenvalues2 = eig(companion2); % which are the roots of the polynomials

% output the results

fprintf("y1 = x^7 + 4x^6 + 4x^4 + 4x^3 + 4x - 6\nIts companion matrix is\n");

disp(companion1);

fprintf("The eigenvalues of the companion matrix, or the roots of y1, are\n");

display(eigenvalues1); % display seems to be the same as disp except it adds a newline at the end

fprintf("y2 = x^7 - 5x^6 + 2x^5 + 22x^4 - 31x^3 - 5x^2 + 28x - 12\nIts companion matrix is\n");

disp(companion2);

fprintf("The eigenvalues of the companion matrix, or the roots of y2, are\n");

display(eigenvalues2);

**Output:**

>> mp4

y1 = x^7 + 4x^6 + 4x^4 + 4x^3 + 4x - 6

Its companion matrix is

-4 -0 -4 -4 -0 -4 6

1 0 0 0 0 0 0

0 1 0 0 0 0 0

0 0 1 0 0 0 0

0 0 0 1 0 0 0

0 0 0 0 1 0 0

0 0 0 0 0 1 0

The eigenvalues of the companion matrix, or the roots of y1, are

-4.17052 + 0.00000i

-1.22235 + 0.00000i

-0.27235 + 1.01462i

-0.27235 - 1.01462i

0.61123 + 1.05721i

0.61123 - 1.05721i

0.71512 + 0.00000i

y2 = x^7 - 5x^6 + 2x^5 + 22x^4 - 31x^3 - 5x^2 + 28x - 12

Its companion matrix is

5 -2 -22 31 5 -28 12

1 0 0 0 0 0 0

0 1 0 0 0 0 0

0 0 1 0 0 0 0

0 0 0 1 0 0 0

0 0 0 0 1 0 0

0 0 0 0 0 1 0

The eigenvalues of the companion matrix, or the roots of y2, are

-2.00000 + 0.00000i

3.00000 + 0.00000i

-1.00000 + 0.00000i

2.00000 + 0.00000i

1.00001 + 0.00001i

1.00001 - 0.00001i

0.99999 + 0.00000i

**rg.f:**

subroutine rg(nm,n,a,wr,wi,matz,z,iv1,fv1,ierr)

c

integer n,nm,is1,is2,ierr,matz

double precision a(nm,n),wr(n),wi(n),z(nm,n),fv1(n)

integer iv1(n)

c

c this subroutine calls the recommended sequence of

c subroutines from the eigensystem subroutine package (eispack)

c to find the eigenvalues and eigenvectors (if desired)

c of a real general matrix.

c

c on input

c

c nm must be set to the row dimension of the two-dimensional

c array parameters as declared in the calling program

c dimension statement.

c

c n is the order of the matrix a.

c

c a contains the real general matrix.

c

c matz is an integer variable set equal to zero if

c only eigenvalues are desired. otherwise it is set to

c any non-zero integer for both eigenvalues and eigenvectors.

c

c on output

c

c wr and wi contain the real and imaginary parts,

c respectively, of the eigenvalues. complex conjugate

c pairs of eigenvalues appear consecutively with the

c eigenvalue having the positive imaginary part first.

c

c z contains the real and imaginary parts of the eigenvectors

c if matz is not zero. if the j-th eigenvalue is real, the

c j-th column of z contains its eigenvector. if the j-th

c eigenvalue is complex with positive imaginary part, the

c j-th and (j+1)-th columns of z contain the real and

c imaginary parts of its eigenvector. the conjugate of this

c vector is the eigenvector for the conjugate eigenvalue.

c

c ierr is an integer output variable set equal to an error

c completion code described in the documentation for hqr

c and hqr2. the normal completion code is zero.

c

c iv1 and fv1 are temporary storage arrays.

c

c questions and comments should be directed to burton s. garbow,

c mathematics and computer science div, argonne national laboratory

c

c this version dated august 1983.

c

c ------------------------------------------------------------------

c

if (n .le. nm) go to 10

ierr = 10 \* n

go to 50

c

10 call balanc(nm,n,a,is1,is2,fv1)

call elmhes(nm,n,is1,is2,a,iv1)

if (matz .ne. 0) go to 20

c .......... find eigenvalues only ..........

call hqr(nm,n,is1,is2,a,wr,wi,ierr)

go to 50

c .......... find both eigenvalues and eigenvectors ..........

20 call eltran(nm,n,is1,is2,a,iv1,z)

call hqr2(nm,n,is1,is2,a,wr,wi,z,ierr)

if (ierr .ne. 0) go to 50

call balbak(nm,n,is1,is2,fv1,n,z)

50 return

end