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MAT2002 – Applications of Differential and Difference Equations
Experiment 2A, 2B: Matrices

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Problem Solved:

[1] Eigen values and eigen vector (Exp 2A) **(Page 1)**
[2] Diagonalization of matrix by Similarity transformation (Exp 2B) **(Page 4)** $m^{-1}*A*m$; modal matrix (eigen vectors as columns)
[3] Diagonalization of matrix by Orthogonal transformation (Exp 2B) **(Page 7)** $n^{T}*A*n$; normalized modal matrix (eigen vectors)

Experiment 2A

Exercise Problem 1: Eigen values and Eigen vectors

Find the eigenvalues and eigenvectors of the following matrices

$$\begin{bmatrix} 7 & -2 & 2 \\ -2 & 1 & 4 \\ -2 & 4 & 1 \end{bmatrix}$$

Solution:

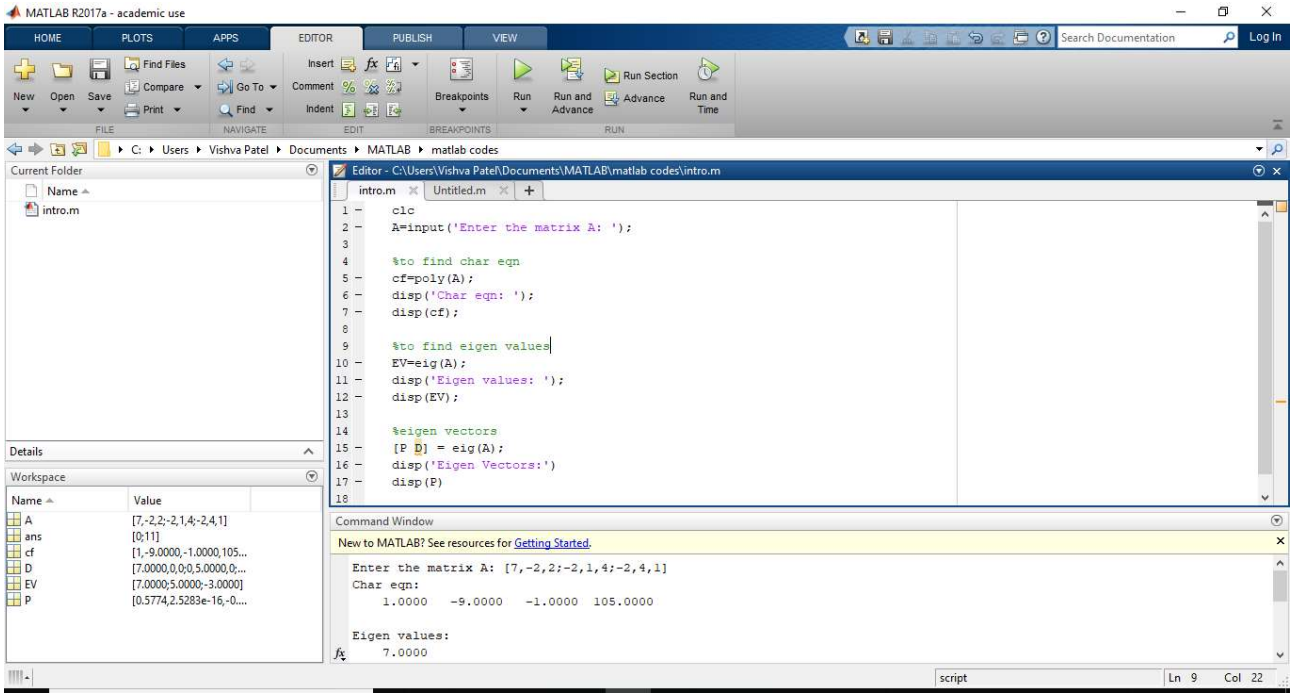
MATLAB Commands Used: (for reference)

Poly(A) – to get char eqn of matrix A
Eig(A) – to get eigen values of matrix A
[P D]
P : P matrix (modal matrix) – is a variable automatically generated by matlab software , once after the execution of eig() function call.
D: diagonal matrix – same as P.

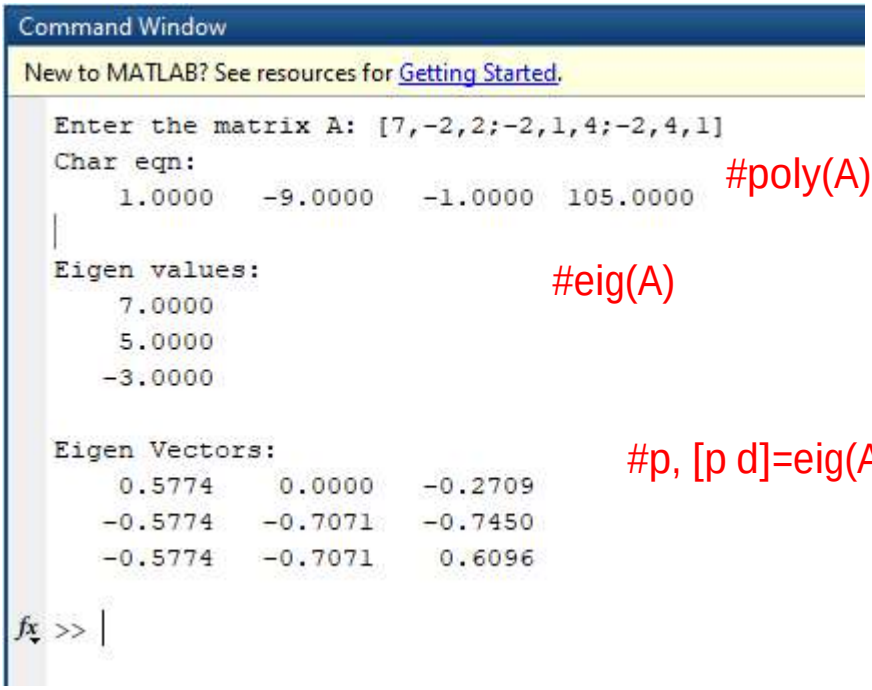
MATLAB Code:

```
clear all
clc
A=input('Enter the matrix A: ');

%to find char eqn
cf=poly(A);
disp('Char eqn: ');
disp(cf);

%to find eigen values
EV=eig(A);
disp('Eigen values: ');
disp(EV);

%eigen vectors
[P D] = eig(A);
disp('Eigen Vectors:')
disp(P)
```

Screenshots of MATLAB work area:



Input/Output:



Enter the matrix A: [7,-2,2;-2,1,4;-2,4,1]

Char eqn:

1.0000 -9.0000 -1.0000 105.0000

Eigen values:

7.0000

5.0000

-3.0000

Eigen Vectors:

0.5774 0.0000 -0.2709

-0.5774 -0.7071 -0.7450

-0.5774 -0.7071 0.6096

Experiment 2B: Diagonalization of matrix

Exercise Problem 2: Similarity transformation

m^{-1} a m, here m=modal matrix is denoted by P

. Diagonalize $A = \begin{bmatrix} 1 & 6 & 1 \\ 1 & 2 & 0 \\ 0 & 0 & 3 \end{bmatrix}$ by similarity transformation

Solution:

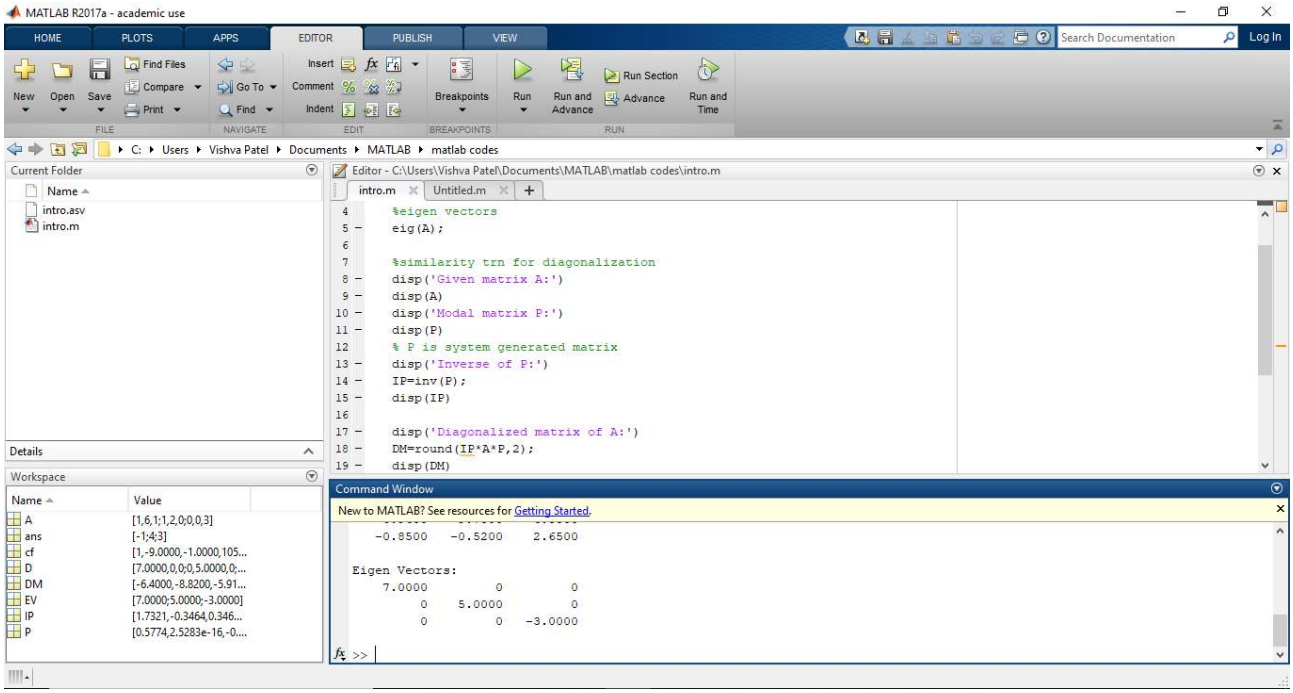
MATLAB Commands Used:

Eig(A) – to get eigen values of matrix A
Inv(A) – to get inverse of matrix A
Round(value, digit after floating point) – to round off the floating value
P : P matrix (modal matrix) – is a variable automatically generated by matlab software , once after the execution of eig() function call.
D: diagonal matrix – same as P.

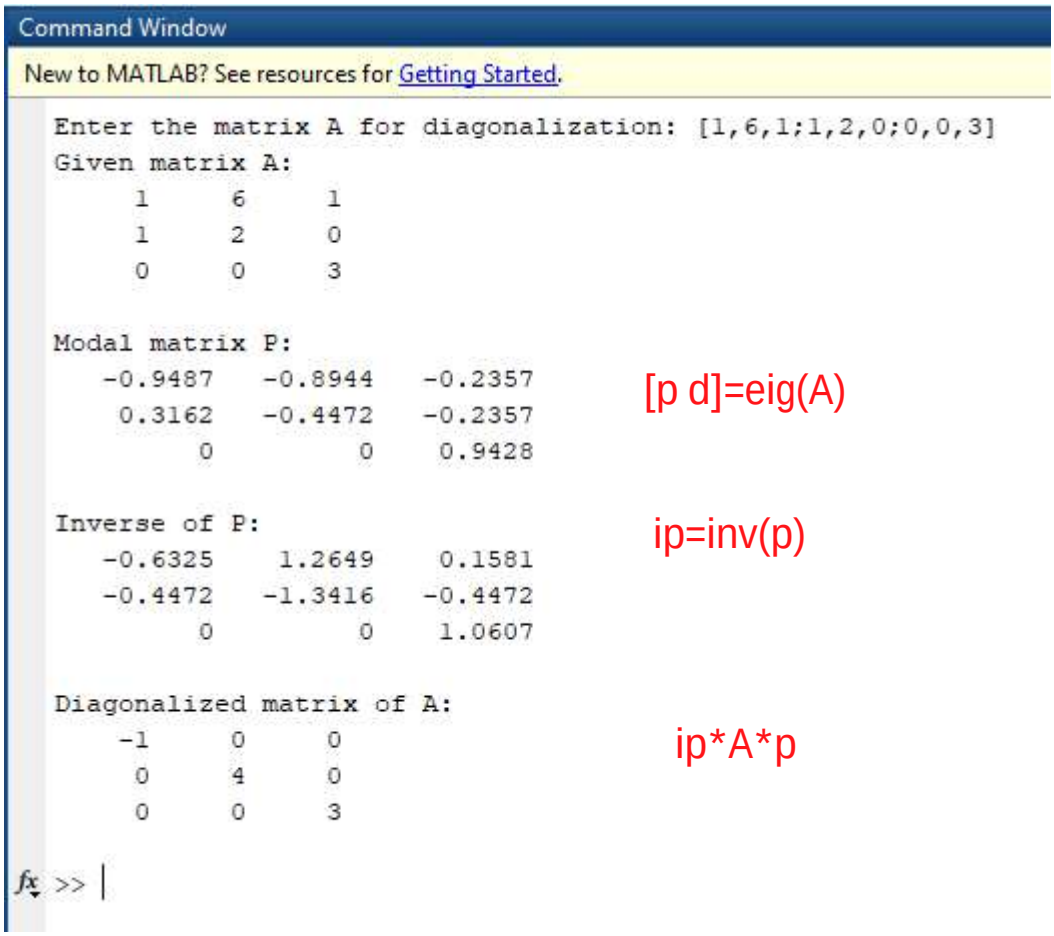
MATLAB Code:

```
clear all
clc
A=input('Enter the matrix A for diagonalization: ');

%eigen vectors
[P D]=eig(A);

%similarity trn for diagonalization
disp('Given matrix A:')
disp(A)
disp('Modal matrix P:')
disp(P)
% P is system generated matrix
disp('Inverse of P:')
IP=inv(P);
disp(IP)

disp('Diagonalized matrix of A:')
DM=round(IP*A*P,2);
disp(DM)
```

Screenshots of MATLAB work area:



Input/Output:



[p d]=eig(A)

ip=inv(p)

ip*A*p

Enter the matrix A for diagonalization: [1,6,1;1,2,0;0,0,3]

Given matrix A:

1	6	1
1	2	0
0	0	3

Modal matrix P:

-0.9487	-0.8944	-0.2357
0.3162	-0.4472	-0.2357
0	0	0.9428

Inverse of P:

-0.6325	1.2649	0.1581
-0.4472	-1.3416	-0.4472
0	0	1.0607

Diagonalized matrix of A:

-1	0	0
0	4	0
0	0	3

Exercise Problem 3: Orthogonal transformation

n^T*A*n; n=normalized modal matrix

Transform the quadratic form $3x_1^2 + 5x_2^2 + 3x_3^2 - 2x_2x_3 + 2x_3x_1 - 2x_1x_2$ to canonical form and specify the matrix of transformation.

Solution:

Here, from given quadratic equation, matrix A,

$$A=\begin{bmatrix} 3 & -1 & 1 \\ -1 & 5 & -1 \\ 1 & -1 & 3 \end{bmatrix}$$

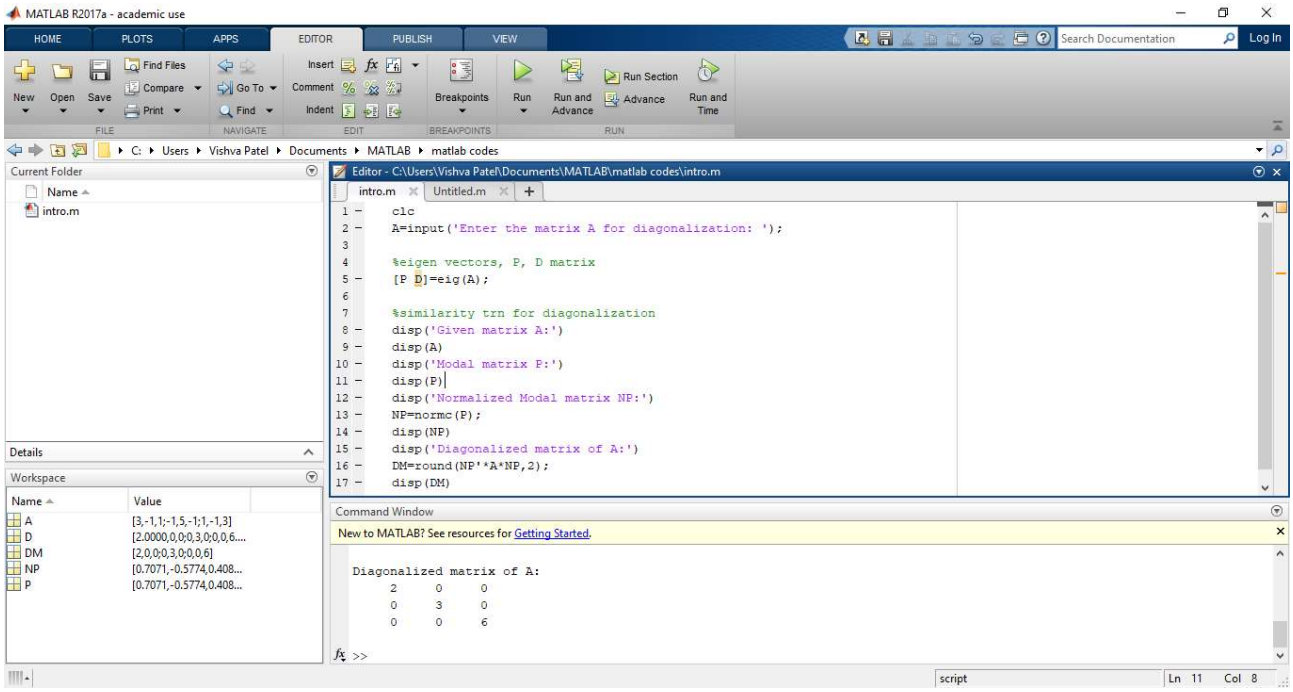
MATLAB Commands Used:

Poly(A) – to get char eqn of matrix A
Eig(A) – to get eigen values of matrix A
[P D] – P is modal matrix and D is diagonalized matrix
Normc(P) – to get normalized modal matrix P
A' – denotes transpose of matrix A

MATLAB Code:

```
clear all
clc
A=input('Enter the matrix A for diagonalization: ');

%eigen vectors, P, D matrix
[P D]=eig(A);

%similarity trn for diagonalization
disp('Given matrix A:')
disp(A)
disp('Modal matrix P:')
disp(P)
disp('Normalized Modal matrix NP:')
NP=normc(P);
disp(NP)
disp('Diagonalized matrix of A:')
DM=round(NP'*A*NP,2);
disp(DM)
```

Screenshots of MATLAB work area:



Input/Output:

Command Window

New to MATLAB? See resources for Getting Started.

```
Enter the matrix A for diagonalization: [3,-1,1;-1,5,-1;1,-1,3]
Given matrix A:
     3    -1     1
    -1     5    -1
     1    -1     3

Modal matrix P:
    0.7071   -0.5774    0.4082
   -0.0000   -0.5774   -0.8165
   -0.7071   -0.5774    0.4082

Normalized Modal matrix NP:
    0.7071   -0.5774    0.4082
   -0.0000   -0.5774   -0.8165
   -0.7071   -0.5774    0.4082

Diagonalized matrix of A:
     2     0     0
     0     3     0
     0     0     6
```

p; [p d]=eig(A)

np; np=normc(p)

d; d=np'*A*np

Enter the matrix A for diagonalization: [3,-1,1;-1,5,-1;1,-1,3]

Given matrix A:

3 -1 1

-1 5 -1

1 -1 3

Modal matrix P:

0.7071 -0.5774 0.4082

-0.0000 -0.5774 -0.8165

-0.7071 -0.5774 0.4082

Normalized Modal matrix NP:

0.7071 -0.5774 0.4082

-0.0000 -0.5774 -0.8165

-0.7071 -0.5774 0.4082

Diagonalized matrix of A:

2 0 0

0 3 0

0 0 6

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