```
%%Math 240 Matlab Project 4
% Fall 2020
%
% Section [0342]
%
% Author: [May Kyaw]
% Problem 1
```

(a)

```
clear
clc
close all
format rat
E=[1,0,0,0;0,1,0,0;0,0,1,0;0,0,0,1]
B=[1,1,2,4;0,2,-1,-1;0,0,3,0;0,0,0,1];
C=[1,2,0,0;3,1,3,3;0,0,-1,0;1,0,4,0];
P=B
Q=C
```

```
E =

     1     0     0     0
     0     1     0     0
     0     0     1     0
     0     0     0     1


P =

     1     1     2     4
     0     2    -1    -1
     0     0     3     0
     0     0     0     1


Q =

     1     2     0     0
     3     1     3     3
     0     0    -1     0
     1     0     4     0
```

```
%b)
R=Q\P;
disp(R)
```

```
     0     0    12     1
   1/2   1/2    -5   3/2
     0     0    -3     0
  -1/6   1/2 -23/3 -11/6
```

```
%c)
u=[0,0,0,1]';
v=Q\u;
disp(v)
```

```
       1
    -1/2
       0
    -5/6
```

```
%d)
u=[0,3,2,1]';
v=R*u;
disp(v)
```

```
      25
      -7
      -6
   -47/3
```

```
%e)
fprintf('p(t)=25-7t-7t^2-47/3t^3');
```

```
p(t)=25-7t-7t^2-47/3t^3
```

Problem 2

(a)

```
format short
A = [163 34 -8; -522 -108 26; 990 210 -47]
[P, D] = eig(A)
```

```
A =

   163    34    -8
  -522  -108    26
   990   210   -47


P =

   -0.1229    0.1617   -0.1961
    0.3686   -0.5659    0.7845
   -0.9214    0.8085   -0.5883


D =

    1.0000         0         0
```

```
         0    4.0000         0
         0         0    3.0000
```

(b)

```
PDP_inv = P*D*inv(P);
disp('P*D*P^(-1) ='), disp(PDP_inv)
disp('Hence, A = P*D*P^(-1)')
```

```
P*D*P^(-1) =
  163.0000   34.0000   -8.0000
 -522.0000 -108.0000   26.0000
  990.0000  210.0000  -47.0000

Hence, A = P*D*P^(-1)
```

(c)

```
%Matrix D contains the Eigen values on its main diagonal.
%Matrix P contains the Eigen vectors in its columns.
disp('Eigen values:'), disp(diag(D)')
disp('Eigen vectors:'), disp(P)
```

```
Eigen values:
    1.0000    4.0000    3.0000

Eigen vectors:
   -0.1229    0.1617   -0.1961
    0.3686   -0.5659    0.7845
   -0.9214    0.8085   -0.5883
```

Problem 3

(a)

```
A = [-23 -32 -10; 11 15 5; 18 26 7];

for n = 2:1:8
B = A^n;
fprintf('A^%d =\n', n), disp(B)
end
disp('Yes, the pattern that I noticed is: A^(4k) = I,a positive
 integer k.')
```

```
A^2 =
    -3    -4     0
     2     3     0
    -2    -4    -1

A^3 =
    25    36    10
   -13   -19    -5
   -16   -22    -7
```

```
A^4 =
     1     0     0
     0     1     0
     0     0     1

A^5 =
   -23   -32   -10
    11    15     5
    18    26     7

A^6 =
    -3    -4     0
     2     3     0
    -2    -4    -1

A^7 =
    25    36    10
   -13   -19    -5
   -16   -22    -7

A^8 =
     1     0     0
     0     1     0
     0     0     1
```

Yes, the pattern that I noticed is: A^(4k) = I,a positive integer k.

(b)

```
[P, D] = eig(A)


P =

  -0.7559 + 0.0000i  -0.7559 + 0.0000i   0.5774 + 0.0000i
   0.3780 + 0.0000i   0.3780 - 0.0000i  -0.5774 + 0.0000i
   0.5292 + 0.0756i   0.5292 - 0.0756i   0.5774 + 0.0000i


D =

   0.0000 + 1.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
   0.0000 + 0.0000i   0.0000 - 1.0000i   0.0000 + 0.0000i
   0.0000 + 0.0000i   0.0000 + 0.0000i  -1.0000 + 0.0000i
```

(c)

```
for n = 2:8
fprintf('D^%d =\n', n), disp(D^n)
end
disp('The pattern that I noticed is: D^(4m) an identity matrix.')

D^2 =
```

```
  -1.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
   0.0000 + 0.0000i  -1.0000 - 0.0000i   0.0000 + 0.0000i
   0.0000 + 0.0000i   0.0000 + 0.0000i   1.0000 + 0.0000i

D^3 =
  -0.0000 - 1.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
   0.0000 + 0.0000i  -0.0000 + 1.0000i   0.0000 + 0.0000i
   0.0000 + 0.0000i   0.0000 + 0.0000i  -1.0000 + 0.0000i

D^4 =
   1.0000 - 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
   0.0000 + 0.0000i   1.0000 + 0.0000i   0.0000 + 0.0000i
   0.0000 + 0.0000i   0.0000 + 0.0000i   1.0000 + 0.0000i

D^5 =
   0.0000 + 1.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
   0.0000 + 0.0000i   0.0000 - 1.0000i   0.0000 + 0.0000i
   0.0000 + 0.0000i   0.0000 + 0.0000i  -1.0000 + 0.0000i

D^6 =
  -1.0000 + 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
   0.0000 + 0.0000i  -1.0000 - 0.0000i   0.0000 + 0.0000i
   0.0000 + 0.0000i   0.0000 + 0.0000i   1.0000 + 0.0000i

D^7 =
  -0.0000 - 1.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
   0.0000 + 0.0000i  -0.0000 + 1.0000i   0.0000 + 0.0000i
   0.0000 + 0.0000i   0.0000 + 0.0000i  -1.0000 + 0.0000i

D^8 =
   1.0000 - 0.0000i   0.0000 + 0.0000i   0.0000 + 0.0000i
   0.0000 + 0.0000i   1.0000 + 0.0000i   0.0000 + 0.0000i
   0.0000 + 0.0000i   0.0000 + 0.0000i   1.0000 + 0.0000i

The pattern that I noticed is: D^(4m) an identity matrix.
```

(d)

```
fprintf('A^20000001 = A^(4*5000000 + 1) = A^(4*5000000) * A = I*A = A
\n')
fprintf('Since, A^20000001 = A =\n'), disp(A)

% Problem 4
```

```
A^20000001 = A^(4*5000000 + 1) = A^(4*5000000) * A = I*A = A
Since, A^20000001 = A =
   -23   -32   -10
    11    15     5
    18    26     7
```

(a)

```
A = [3 1; 0 3];
disp('A = ');
```

```
disp(A);
[P,D] = eig(A);
disp('P = ');
disp(P);
disp('D = ');
disp(D);
```

```
A =
     3     1
     0     3

P =
    1.0000   -1.0000
         0    0.0000

D =
     3     0
     0     3
```

(b)

```
pdp = P*D*inv(P);
disp('P*D*(P^-1) = ');
disp(pdp);
disp('Hence, they are NOT equal');
```

```
P*D*(P^-1) =
     3     0
     0     3

Hence, they are NOT equal
```

(c)

```
fprintf('\nBasis for the eigen space (lambda = 3) = [%f; %f]\n',
 P(:,1));
```

```
Basis for the eigen space (lambda = 3) = [1.000000; 0.000000]
```

(d)

```
fprintf('\nBoth of the eigen vectors are the same and that too the
 second term is \n');
fprintf('\n0 becuase of this we can not get \n');
fprintf('\nthe basis in R2/nusing the eigen vectors.\n');

% Problem 5
```

```
Both of the eigen vectors are the same and that too the second term
 is

0 becuase of this we can not get
```

the basis in R2/nusing the eigen vectors.

(a)

```
v1=[9 14 -11 3 0]'
v2=[-14 -4 -10 9 -5]'
v3=[1 -10 4 -7 5]'
v4=[6 8 -1 -12 -8]'
```

```
v1 =

     9
    14
   -11
     3
     0


v2 =

   -14
    -4
   -10
     9
    -5


v3 =

     1
   -10
     4
    -7
     5


v4 =

     6
     8
    -1
   -12
    -8
```

(b)

```
A=[v1 v2 v3 v4]
rank(A)

%W =column space of the matrix A
%Rank= column rank = number of linearly independent vectors in the
 column
```

```
%Since all four are linearly independent, becuase of a basis for the
 space
%that are spanned by the four vectors.


A =

     9   -14     1     6
    14    -4   -10     8
   -11   -10     4    -1
     3     9    -7   -12
     0    -5     5    -8


ans =

     4
```

(c)

```
w1=v1
w2=v2-(dot(w1,v2)/dot(w1,w1))*w1
w2=v2-(dot(w1,v2)/dot(w1,w1))*w1


w1 =

     9
    14
   -11
     3
     0


w2 =

  -13.0049
   -2.4521
  -11.2162
    9.3317
   -5.0000


w2 =

  -13.0049
   -2.4521
  -11.2162
    9.3317
   -5.0000
```

(d)

```
w3=v3-(dot(w1,v3)/dot(w1,w1))*w1-(dot(w2,v3)/dot(w2,w2))*w2
w4=v4-(dot(w1,v4)/dot(w1,w1))*w1-(dot(w2,v4)/dot(w2,w2))*w2-
(dot(w3,v4)/dot(w3,w3))*w3
```

```
w3 =

    1.4401
   -3.9922
   -4.6557
   -2.7611
    3.5029
```

```
w4 =

   -1.7788
    1.3028
   -2.5483
  -10.0873
   -9.1222
```

(e)

```
u1=w1/norm(w1)
u2=w2/norm(w2)
u3=w3/norm(w3)
u4=w4/norm(w4)
```

```
u1 =

    0.4461
    0.6940
   -0.5452
    0.1487
         0
```

```
u2 =

   -0.6399
   -0.1207
   -0.5519
    0.4592
   -0.2460
```

```
u3 =

    0.1866
   -0.5172
   -0.6032
   -0.3577
```

```
    0.4538
```

```
u4 =

   -0.1269
    0.0930
   -0.1819
   -0.7199
   -0.6510
```

(f)

```
Q=[u1 u2 u3 u4]
```

```
Q =

    0.4461   -0.6399    0.1866   -0.1269
    0.6940   -0.1207   -0.5172    0.0930
   -0.5452   -0.5519   -0.6032   -0.1819
    0.1487    0.4592   -0.3577   -0.7199
         0   -0.2460    0.4538   -0.6510
```

(g)

```
Q'*Q
R=Q'*A
A
Q*R
```

```
ans =

    1.0000    0.0000         0    0.0000
    0.0000    1.0000    0.0000   -0.0000
         0    0.0000    1.0000    0.0000
    0.0000   -0.0000    0.0000    1.0000
```

```
R =

   20.1742   -2.2306   -9.7154    6.9891
   -0.0000   20.3230   -6.0853   -7.7946
         0    0.0000    7.7189   -1.7529
    0.0000   -0.0000    0.0000   14.0115
```

```
A =

     9   -14     1     6
    14    -4   -10     8
   -11   -10     4    -1
```

```
     3     9    -7   -12
     0    -5     5    -8


ans =

    9.0000  -14.0000    1.0000    6.0000
   14.0000   -4.0000  -10.0000    8.0000
  -11.0000  -10.0000    4.0000   -1.0000
    3.0000    9.0000   -7.0000  -12.0000
   -0.0000   -5.0000    5.0000   -8.0000
```

(e)

```
[Q1 R1]=qr(A,0)
Q
R


Q1 =

   -0.4461    0.6399    0.1866   -0.1269
   -0.6940    0.1207   -0.5172    0.0930
    0.5452    0.5519   -0.6032   -0.1819
   -0.1487   -0.4592   -0.3577   -0.7199
         0    0.2460    0.4538   -0.6510


R1 =

  -20.1742    2.2306    9.7154   -6.9891
         0  -20.3230    6.0853    7.7946
         0         0    7.7189   -1.7529
         0         0         0   14.0115


Q =

    0.4461   -0.6399    0.1866   -0.1269
    0.6940   -0.1207   -0.5172    0.0930
   -0.5452   -0.5519   -0.6032   -0.1819
    0.1487    0.4592   -0.3577   -0.7199
         0   -0.2460    0.4538   -0.6510


R =

   20.1742   -2.2306   -9.7154    6.9891
   -0.0000   20.3230   -6.0853   -7.7946
         0    0.0000    7.7189   -1.7529
    0.0000   -0.0000    0.0000   14.0115
```

Problem 6

(a)

```
u1 = [5 -5 0 -4 -3 4]';
u2 = [9 -12 2 -3 -7 2]';
u3 = [-2 -4 4 10 -2 -12]';
u4 = [2 3 -2 -4 -2 7]';
u5 = [-1 -2 2 5 -1 -6]';
A = [u1 u2 u3 u4 u5]
rank(A)
rref(A);
```

```
A =

     5     9    -2     2    -1
    -5   -12    -4     3    -2
     0     2     4    -2     2
    -4    -3    10    -4     5
    -3    -7    -2    -2    -1
     4     2   -12     7    -6


ans =

     3
```

(b)

```
B = [u1 u2 u4]
```

```
B =

     5     9     2
    -5   -12     3
     0     2    -2
    -4    -3    -4
    -3    -7    -2
     4     2     7
```

(c)

```
[Q,R] = qr(B)
P = orth(B)
E = Q*Q';
v = [1 1 1 1 1 1]';
```

```
Q =

   -0.5241    0.1298   -0.1332    0.4408    0.4005   -0.5796
    0.5241   -0.5280   -0.4833   -0.0858    0.2075   -0.4030
         0    0.2655    0.0261   -0.5814    0.7568    0.1343
    0.4193    0.4536   -0.3585    0.5534    0.2123    0.3723
```

```
    0.3145   -0.2903    0.7521    0.3571    0.3516   -0.0077
   -0.4193   -0.5864   -0.2321    0.1630    0.2347    0.5873


R =

   -9.5394  -15.3050   -4.7173
         0    7.5338   -7.1939
         0         0   -3.4633
         0         0         0
         0         0         0
         0         0         0


P =

   -0.5421    0.0673   -0.1043
    0.6442    0.4968   -0.3540
   -0.0770   -0.2488   -0.0577
    0.2600   -0.4046   -0.5280
    0.4029   -0.0704    0.7626
   -0.2349    0.7198    0.0120
```

(d)

```
E*v


ans =

    1.0000
    1.0000
    1.0000
    1.0000
    1.0000
    1.0000
```

(e)

```
C = null(B')


C =

    0.4408    0.4005   -0.5796
   -0.0858    0.2075   -0.4030
   -0.5814    0.7568    0.1343
    0.5534    0.2123    0.3723
    0.3571    0.3516   -0.0077
    0.1630    0.2347    0.5873
```

(f)

```
[Q,R] = qr(C)
```

```
Q =

   -0.4408   -0.4005    0.5796   -0.3953   -0.3904   -0.0259
    0.0858   -0.2075    0.4030    0.6457    0.0203    0.6082
    0.5814   -0.7568   -0.1343    0.0079   -0.0703   -0.2572
   -0.5534   -0.2123   -0.3723    0.5687   -0.2633   -0.3426
   -0.3571   -0.3516    0.0077   -0.0837    0.8611   -0.0145
   -0.1630   -0.2347   -0.5873   -0.3105   -0.1771    0.6677
```

```
R =

   -1.0000   -0.0000    0.0000
         0   -1.0000    0.0000
         0         0   -1.0000
         0         0         0
         0         0         0
         0         0         0
```

(g)

```
F = C*inv(C'*C)*C'
```

```
F =

    0.6907    0.2789   -0.0310    0.1131    0.3027   -0.1746
    0.2789    0.2128    0.1528   -0.1535    0.0454   -0.2020
   -0.0310    0.1528    0.9288   -0.1111    0.0575    0.1617
    0.1131   -0.1535   -0.1111    0.4899    0.2694    0.3586
    0.3027    0.0454    0.0575    0.2694    0.2512    0.1362
   -0.1746   -0.2020    0.1617    0.3586    0.1362    0.4265
```

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