Part 1. Practice 'Matrix Manipulation Skills' examples: Matrices – Gavin Binder

Part 1 MATLAB code

```
a = [12, 17, 3, 6]
b = [5, 8, 3;
    1, 2, 3;
    2, 4, 6]
c = [22;
    17;
    4]
x1 = a(2)
x2 = b(:,3)
x3 = b(3,:)
x4 = diag(b)
x5 = [a(:,1:3);
    b(:,:)]
x6 = [22 5 1 2; 17 8 2 4; 4 3 3 6; 12 17 3 6]
x7 = b(8)
x8 = reshape(b,[],1)
```

Prerequisite:

```
a =

    12    17     3     6


b =

     5     8     3
     1     2     3
     2     4     6


c =

    22
    17
     4
```

Part 1. #1 Answer

```
x1 =

    17
```

Part 1. #2 Answer

```
x2 =

     3
     3
     6
```

Part 1. #3 Answer

```
x3 =

     2     4     6
```

Part 1. #4 Answer

```
x4 =

     5
     2
     6
```

Part 1. #5 Answer

```
x5 =

    12    17     3
     5     8     3
     1     2     3
     2     4     6
```

Part 1. #6 Answer

```
x6 =

    22     5     1     2
    17     8     2     4
     4     3     3     6
    12    17     3     6
```

Part 1. #7 Answer

```
x7 =

     3
```

Part 1. #8 Answer

```
x8 =

     5
     1
     2
     8
     2
     4
     3
     3
     6
```

Part 2. Practice ‘Matrix Manipulation 2 Skills’ examples: Matrices_2 – Gavin Binder

Part 2ia Code and Answer

```
A = [12, 4;
    3, -5]
B = [2, 12;
    0, 0]
A * B
B * A
```

```
A =

    12     4
     3    -5


B =

     2    12
     0     0


ans =

    24   144
     6    36


ans =

    60   -52
     0     0
```

Part 2ib Code and Answer

```
A=[1,3,5;
    2,4,6]
B=[-2,4;
    3,8;
    12,-2]
A*B
B*A
```

```
A =

     1     3     5
     2     4     6


B =

    -2     4
     3     8
    12    -2


ans =

    67    18
    80    28


ans =

     6    10    14
    19    41    63
     8    28    48
```

Part 2ii1 Code and Answer

```
A=[2,5;
    2,9;
    6,5]
B=[2,5;
    2,9
    6,5]
A*B
B*A
%can't be multiplied%
```

```
A =

     2     5
     2     9
     6     5


B =

     2     5
     2     9
     6     5

Error using  * 
Incorrect dimensions for matrix multiplication. Check that the
number of columns in the first matrix matches the number of
rows in the second matrix. To perform elementwise
multiplication, use '.*'.

Error in Part2ii1 (line 7)
A*B

Related documentation
```

Part 2ii2 Code and Answer

```
A=[2,5;
    2,9;
    6,5]
B=[1,3,12;
    5,2,9]
A*B
B*A
%can be multiplied
```

```
A =

     2     5
     2     9
     6     5


B =

     1     3    12
     5     2     9


ans =

    27    16    69
    47    24   105
    31    28   117


ans =

    80    92
    68    88
```

Part 2ii3 Code and Answer

```
A=[5,1,9;
    7,2,2]
B=[8,5;
    4,2;
    8,9]
A*B
B*A
%can be multiplied
```

```
A =

     5     1     9
     7     2     2


B =

     8     5
     4     2
     8     9


ans =

   116   108
    80    57


ans =

    75    18    82
    34     8    40
   103    26    90
```

Part 2ii4 Code and Answer

```
A=[1,9,8;
    8,4,7;
    2,5,3]
B=[7;
    1;
    5]
A*B
B*A
%can't be multiplied
```

```
A =

     1     9     8
     8     4     7
     2     5     3


B =

     7
     1
     5


ans =

    56
    95
    34

Error using  * 
Incorrect dimensions for matrix multiplication. Check that the
number of columns in the first matrix matches the number of
rows in the second matrix. To perform elementwise
multiplication, use '.*'.

Error in Part2ii4 (line 8)
B*A

Related documentation
```

Part 2iiia Typed and Answer

Determinant of A = (-1)(2)-(3)(4)=-2-12=-14

Part 2iiib Code and Answer

```
A = [-1 3; 4 2]
det(A)
```

```
A =

    -1     3
     4     2


ans =

   -14
```

Part 3. Practice ‘Systems of Linear Equations’ examples: Systems of equations - Gavin Binder

Part 3ia Code and Answer

```
A = [-2 1; 1 1];
B = [3; 10];
x = inv(A)*B
X = A\B
```

```
x =

    2.3333
    7.6667


X =

    2.3333
    7.6667
```

Part 3ib Code and Answer

```
A = [5 3 -1; 3 2 1; 4 -1 3]
B = [10; 4; 12]
x = inv(A)*B
X = A\B
```

```
A =

     5     3    -1
     3     2     1
     4    -1     3


B =

    10
     4
    12


x =

    3.1613
   -2.2581
   -0.9677


X =

    3.1613
   -2.2581
   -0.9677
```

Part 3ii

```
A = [3 4 2 -1 1 7 1; 2 -2 3 -4 5 2 8; 1 2 3 1 2 4 6; 5 10 4 3 9 -2 1; 3 2 -2 -4 -5 -6 7; -2 9 1 3 -3 5 1; 1 -2 -8 4 2 4 5]
B = [42; 32; 12; -5; 10; 18; 17]
tic
x = inv(A)*B
toc
tic
X = A\B
toc
```

```
A =

     3     4     2    -1     1     7     1
     2    -2     3    -4     5     2     8
     1     2     3     1     2     4     6
     5    10     4     3     9    -2     1
     3     2    -2    -4    -5    -6     7
    -2     9     1     3    -3     5     1
     1    -2    -8     4     2     4     5


B =

    42
    32
    12
    -5
    10
    18
    17


x =

   -0.1890
    2.5459
   -3.2806
   -6.7578
    1.3212
    4.3194
    0.6294

Elapsed time is 0.000263 seconds.

X =

   -0.1890
    2.5459
   -3.2806
   -6.7578
    1.3212
    4.3194
    0.6294

Elapsed time is 0.000281 seconds.
```

Part 4. Intro to STEM application' Problem – electrical circuits – Gavin Binder

Part 4a.

Part 4a

(1) An analysis of the circuit shown in Fig. P7.7 yields the following system of equations

$-4V_2+7V_1=0$ (7.96)

$2V_1-7V_2+10=0$ (7.97)

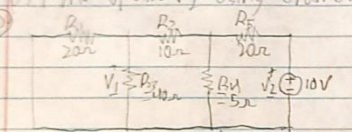
(a) Find V_1 and V_2 using the substitution method.

(b) Write the system of equations (7.96) and (7.97) in the matrix form $AV=b$, where $V=\begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$.

(c) Find V_1 and V_2 using the matrix algebra method. Perform all computations by hand and show all steps.

(d) Find V_1 and V_2 using Cramer's rule.

(2)



(3) (7.96) and (7.97)

(4) $AV=b$, $V=\boxed{\begin{bmatrix} V_1 \\ V_2 \end{bmatrix}}$

(5) (a) $7V_1=4V_2$

$V_1=\frac{4V_2}{7}$

$2\left(\frac{4}{7}V_2\right)-7V_2+10=0$

$\frac{8}{7}V_2-7V_2=-10$

$V_2\left(\frac{8}{7}-7\right)=-10$

$V_1=\frac{4\left(\frac{70}{41}\right)}{7}=\boxed{\frac{40}{41} \text{ or } .976\ V}$ $\boxed{V_2=\frac{70}{41} \text{ or } 1.707}\ V$

(6.) $\begin{bmatrix} 7 & -4 \\ 2 & -7 \end{bmatrix}\begin{bmatrix} V_1 \\ V_2 \end{bmatrix}=\begin{bmatrix} 0 \\ -10 \end{bmatrix}$

(c) $V=A^{-1}b \Rightarrow \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}=\begin{bmatrix} 7 & -4 \\ 2 & -7 \end{bmatrix}^{-1}\begin{bmatrix} 0 \\ 10 \end{bmatrix}$

$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix}=\frac{1}{-49+8}\begin{bmatrix} -7 & 4 \\ -2 & 7 \end{bmatrix}\begin{bmatrix} 0 \\ -10 \end{bmatrix}=-\frac{1}{41}\begin{bmatrix} 0-40 \\ 0-70 \end{bmatrix}=\begin{bmatrix} \frac{40}{41} \\ \frac{70}{41} \end{bmatrix}$

$\boxed{V_1=\frac{40}{41}V}$ and $\boxed{V_2=\frac{70}{41}V}$

(d) $V_1=\frac{\begin{bmatrix} 0 & -4 \\ -10 & -7 \end{bmatrix}}{\begin{bmatrix} 7 & -4 \\ 2 & -7 \end{bmatrix}}=\frac{0-40}{-41}=\boxed{\frac{40}{41}V}$

$V_2=\frac{\begin{bmatrix} 7 & 0 \\ 2 & -10 \end{bmatrix}}{\begin{bmatrix} 7 & -4 \\ 2 & -7 \end{bmatrix}}=\frac{-70-0}{-40}=\boxed{\frac{70}{41}V}$

(6.) Checked work using desmos.

(7) In this problem, we find V_1 and V_2 using the three methods of substitution, matrix algebra and cramer's rule.

Part 4b

Code

```
R1 = input('Input the value of R1: ');
R2 = input('Input the value of R2: ');
R3 = input('Input the value of R3: ');
R4 = input('Input the value of R4: ');
R5 = input('Input the value of R5: ');
V = input('Input the value of voltage: ');
coef = [(R2+R4), -R2, -R4;
    -R2, (R1 + R2 + R3), (-R3);
    -R4, -R3, (R3 + R4 + R5)];
result = [V; 0; 0];
I = inv(coef)*result
```

Test 1

```
Input the value of R1: 5
Input the value of R2: 5
Input the value of R3: 5
Input the value of R4: 5
Input the value of R5: 5
Input the value of voltage: 0

I =

     0
     0
     0
```

Test 2

```
Input the value of R1: 2
Input the value of R2: 4
Input the value of R3: 6
Input the value of R4: 8
Input the value of R5: 10
Input the value of voltage: 10

I =

    1.6935
    0.9677
    0.8065
```

Part 4c Code and Answer

```
coef = [7, -4;
    2, -7]
result = [0; -10]
v = inv(coef)*result
V = coef\result
```

```
coef =

     7    -4
     2    -7


result =

     0
   -10


v =

    0.9756
    1.7073


V =

    0.9756
    1.7073
```

Part 4d Code and Answer

```
R1 = input('Input the value of R1: ');
R2 = input('Input the value of R2: ');
R3 = input('Input the value of R3: ');
R4 = input('Input the value of R4: ');
R5 = input('Input the value of R5: ');
V = input('Input the value of voltage: ');
coef = [(R2+R4), -R2, -R4;
    -R2, (R1 + R2 + R3), (-R3);
    -R4, -R3, (R3 + R4 + R5)];
result = [V; 0; 0];
I = coef\result
```

```
Input the value of R1: 2
Input the value of R2: 4
Input the value of R3: 6
Input the value of R4: 8
Input the value of R5: 10
Input the value of voltage: 10

I =

    1.6935
    0.9677
    0.8065
```

Part 5. Intro to STEM application' Problem – mechanical systems

Part 5a.

Part 5a

(1.) A $F = 100N$ force is applied to a two-bar truss as shown in Fig. P7.14. The forces F_1 and F_2 satisfy the following system of equations:

$-0.5548F_1 - 0.8572F_2 = -100$ (7.110)

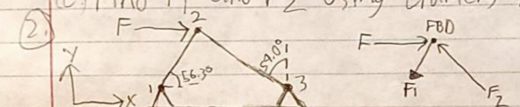
$0.832F_1 = 0.515F_2$. (7.111)

(a) Write the system of equations (7.110) and (7.111) in the matrix form $AF = b$, where $F = \begin{bmatrix} F_1 \\ F_2 \end{bmatrix}$. In other words, find matrices A and b.

(b) Find F_1 and F_2 using the matrix algebra method. Perform all matrix computation by hand and show all steps.

(c) Find F_1 and F_2 using Cramer's rule.

(2.)



(3.) (7.110) and (7.111)

(4.) $AF = b$, $F = \begin{bmatrix} F_1 \\ F_2 \end{bmatrix}$

(5.) (a)

$$\begin{bmatrix} -0.5548 & -.8572 \\ 0.832 & -0.515 \end{bmatrix} \begin{bmatrix} F_1 \\ F_2 \end{bmatrix} = \begin{bmatrix} -100 \\ 0 \end{bmatrix}$$

(b)

$$\begin{bmatrix} F_1 \\ F_2 \end{bmatrix} = \begin{bmatrix} -0.5548 & -.8572 \\ .832 & -.515 \end{bmatrix}^{-1} \cdot \begin{bmatrix} -100 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} F_1 \\ F_2 \end{bmatrix} = \frac{1}{.9987} \begin{bmatrix} -.515 & .8572 \\ -.832 & -.5548 \end{bmatrix} \begin{bmatrix} -100 \\ 0 \end{bmatrix} = \begin{bmatrix} -.515 & .8572 \\ -.832 & -.5548 \end{bmatrix} \begin{bmatrix} -100 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} F_1 \\ F_2 \end{bmatrix} = \begin{bmatrix} (-.515)(-100) \\ (-.832)(-100) \end{bmatrix} = \begin{bmatrix} 51.5 \\ 83.2 \end{bmatrix} N$$

(c)

$$F_1 = \frac{\begin{vmatrix} -100 & -.8572 \\ 0 & -.515 \end{vmatrix}}{|A| = 1} = \frac{(-100)(-.515)}{1} = \boxed{51.5N}$$

$$F_2 = \frac{\begin{vmatrix} -.5548 & -100 \\ .832 & 0 \end{vmatrix}}{|A| = 1} = \frac{-(.832)(-100)}{1} = \boxed{83.2N}$$

(6.) Checked using desmos.

(7.) Here, we find F_1 and F_2 using matrix algebra and Cramer's rule.

Part 5b.

Test 1 Code and Answer

```
theta1=45
theta2=45
f1x=0
f1y=-1000
A=[-cosd(theta1),cosd(theta2),0,0,0,0
    -sind(theta1),-sind(theta2),0,0,0,0
    cosd(theta1),0,1,1,0,0
    sind(theta1),0,0,0,1,0
    0,-cosd(theta2),-1,0,0,0
    0,sind(theta2),0,0,0,1]
B=[f1x,-f1y,0,0,0,0]'
x=(A\B)'
```

```
theta1 =

    45


theta2 =

    45


f1x =

     0


fly =

       -1000


A =

   -0.7071    0.7071         0         0         0         0
   -0.7071   -0.7071         0         0         0         0
    0.7071         0    1.0000    1.0000         0         0
    0.7071         0         0         0    1.0000         0
         0   -0.7071   -1.0000         0         0         0
         0    0.7071         0         0         0    1.0000


B =

           0
        1000
           0
           0
           0
           0


x =

 -707.1068 -707.1068  500.0000         0  500.0000  500.0000
```

Test 2 Code and Answer

```
theta1=30
theta2=60
f1x=1000
f1y=0
A=[-cosd(theta1),cosd(theta2),0,0,0,0
    -sind(theta1),-sind(theta2),0,0,0,0
    cosd(theta1),0,1,1,0,0
    sind(theta1),0,0,0,1,0
    0,-cosd(theta2),-1,0,0,0
    0,sind(theta2),0,0,0,1]
B=[f1x,-f1y,0,0,0,0]'
x=inv(A)*B
x=A\B
```

```
f1y =

     0


A =

   -0.8660    0.5000         0         0         0         0
   -0.5000   -0.8660         0         0         0         0
    0.8660         0    1.0000    1.0000         0         0
    0.5000         0         0         0    1.0000         0
         0   -0.5000   -1.0000         0         0         0
         0    0.8660         0         0         0    1.0000


B =

        1000
           0
           0
           0
           0
           0


x =

   1.0e+03 *

   -0.8660
    0.5000
   -0.2500
    1.0000
    0.4330
   -0.4330


x =

   1.0e+03 *

   -0.8660
    0.5000
   -0.2500
    1.0000
    0.4330
   -0.4330
```

Part 5c. Code and Answer

```
coef = [-0.5548, -0.8572;
    0.832, -0.515]
result = [-100; 0]
f = inv(coef)*result
F = coef\result
```

```
coef =

   -0.5548   -0.8572
    0.8320   -0.5150


result =

  -100
     0


f =

   51.5561
   83.2906


F =

   51.5561
   83.2906
```

Part 5d Code and Answer

```
theta1=59.0
theta2=56.3
f1x=0
f1y=-100
A=[-cosd(theta1),cosd(theta2),0,0,0,0
    -sind(theta1),-sind(theta2),0,0,0,0
    cosd(theta1),0,1,1,0,0
    sind(theta1),0,0,0,1,0
    0,-cosd(theta2),-1,0,0,0
    0,sind(theta2),0,0,0,1]
B=[f1x,-f1y,0,0,0,0]'
F=(A\B)'
```

```
theta1 =

    59


theta2 =

   56.3000


f1x =

     0


f1y =

  -100


A =

   -0.5150    0.5548         0         0         0         0
   -0.8572   -0.8320         0         0         0         0
    0.5150         0    1.0000    1.0000         0         0
    0.8572         0         0         0    1.0000         0
         0   -0.5548   -1.0000         0         0         0
         0    0.8320         0         0         0    1.0000


B =

     0
   100
     0
     0
     0
     0


F =

  -61.3710  -56.9680   31.6084   -0.0000   52.6052   47.3948
```

Part 6. Reflection on P3F group ‘collaboration’ activities – Gavin Binder

A. My group included Jeffrey Hsu and Phoenix Martin. Other than some help with MATLAB code, there where no other points of assistance.
B. MATLAB could be very useful in calculating derivates, including finding maxima and minima values. You could also do integration in MATLAB, likely making complicated problems much easier. –Gavin Binder
   MATLAB could be a useful STEM tool because it can do all sorts of calculations which may be necessary for the field. Projects that would normally take time to write out and calculate by hand can be finished and replicated by MATLAB should one take the time to set up code for it. -Phoenix Martin