MISR UNIVERSITY FOR SCIENCE AND TECHNOLOGY
COLLEGE OF ENGINEERING
MECHATRONICS ENGINEERING DEPARTMENT
MTE 408 ROBOTICS

SESSION 2
INTRODUCTION TO ROBOTICS LAB

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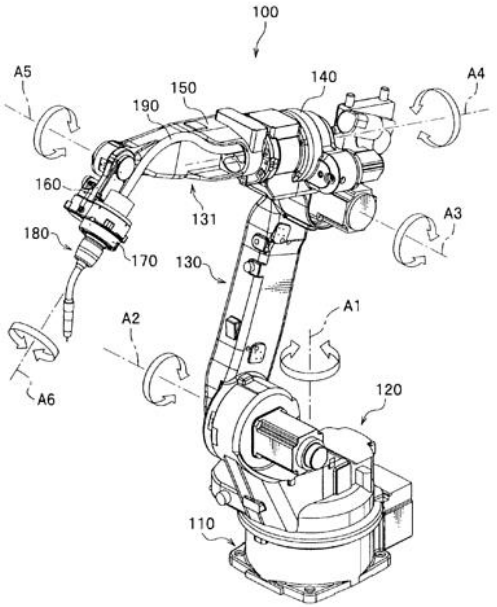
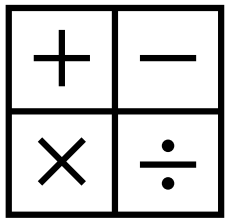
MARCH 2022



SHEET 1



1. *Use matrices to solve the following system of equations*

$x + y - 2z = 3$

$3x - y + z = 5$

$3x + 3y - 6z = 9$

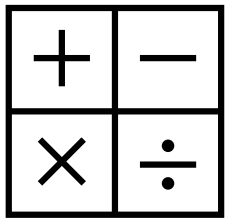
SOLUTION

Taking the variables coefficients and arranging it into a mtrix form

$$A = \begin{bmatrix} 1 & 1 & -2 \\ 3 & -1 & 1 \\ 3 & 3 & -6 \end{bmatrix}$$

$$|A| = 1(-1 * -6 - 1 * 3) - (1)(3 * -6 - 1 * 3) + (-2)(3 * 3 - -1 * 3)$$

SHEET 1



SOLUTION

Taking the variables coefficients and arranging it into a mtrix form

$$A = \begin{bmatrix} 1 & 1 & -2 \\ 3 & -1 & 1 \\ 3 & 3 & -6 \end{bmatrix}$$

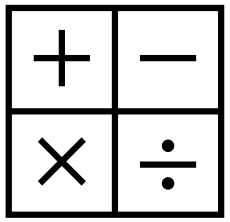
$$|A| = 1(-1 * -6 - 1 * 3) - (1)(3 * -6 - 1 * 3) + (-2)(3 * 3 - -1 * 3)$$

$$|A| = 1(3) - (1)(-21) + (-2)(12)$$

$$|A| = 3 + 21 - 24 = 0$$

$$\boldsymbol{|A| = 0 \rightarrow The\ solution\ doesn't\ exist}$$

SHEET 1

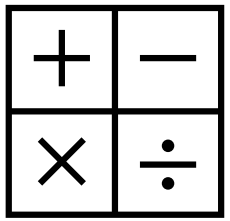


MATLAB VERIFICATION

$$A = \begin{bmatrix} 1 & 1 & -2 \\ 3 & -1 & 1 \\ 3 & 3 & -6 \end{bmatrix}$$

```
Command Window
>> A = [1 1 -2;3 -1 1;3 3 -6]

A =

     1     1    -2
     3    -1     1
     3     3    -6

>> det(A)

ans =

  -3.3307e-15
```

SHEET 1



2. *Use matrices to solve the following system of equations*

$4x + 8y + z = -6$

$2x - 3y + 2z = 0$

$x + 7y - 3z = -8$

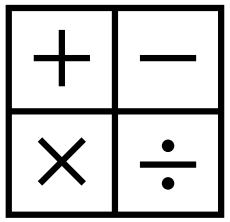
SOLUTION

Taking the variables coefficients and arranging it into a mtrix form

$$A = \begin{bmatrix} 4 & 8 & 1 \\ 2 & -3 & 2 \\ 1 & 7 & -3 \end{bmatrix} \quad Y = \begin{bmatrix} -6 \\ 0 \\ -8 \end{bmatrix}$$

$$|A| = (4)(-3 * -3 - 2 * 7) - (8)(2 * -3 - 2 * 1) + (1)(2 * 7 - -3 * 1)$$

SHEET 1



SOLUTION

Taking the variables coefficients and arranging it into a mtrix form

$$A = \begin{bmatrix} 4 & 8 & 1 \\ 2 & -3 & 2 \\ 1 & 7 & -3 \end{bmatrix} \quad Y = \begin{bmatrix} -6 \\ 0 \\ -8 \end{bmatrix}$$

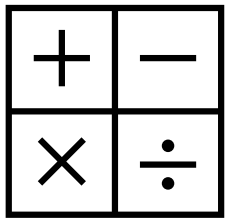
$$|A| = (4)(-3 * -3 - 2 * 7) - (8)(2 * -3 - 2 * 1) + (1)(2 * 7 - -3 * 1)$$

$$|A| = (4)(9 - 14) - (8)(-6 - 2) + (1)(14 + 3)$$

$$|A| = (4)(-5) - (8)(-8) + (1)(17)$$

$$|A| = -20 + 64 + 17 = 61 \rightarrow \textbf{\textit{Solution exists}}$$

SHEET 1



SOLUTION

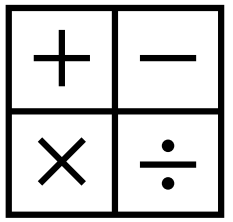
Taking the variables coefficients and arranging it into a mtrix form

$$A = \begin{bmatrix} 4 & 8 & 1 \\ 2 & -3 & 2 \\ 1 & 7 & -3 \end{bmatrix} \quad |A| = -20 + 64 + 17 = 61 \rightarrow \textbf{\textit{Solution exists}}$$

```
Command Window
>> A = [4 8 1;2 -3 2;1 7 -3]

A =

     4     8     1
     2    -3     2
     1     7    -3

>> det(A)

ans =

   61.0000
```

MATLAB CHECK

SHEET 1



SOLUTION

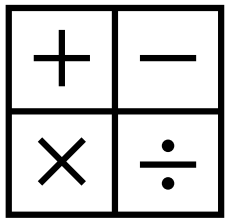
Taking the variables coefficients and arranging it into a mtrix form

$$A = \begin{bmatrix} 4 & 8 & 1 \\ 2 & -3 & 2 \\ 1 & 7 & -3 \end{bmatrix} \quad |A| = -20 + 64 + 17 = 61 \rightarrow \textbf{\textit{Solution exists}}$$

Matrix of minors , Cofactors and Adjoint

$$M = \begin{bmatrix} -5 & -8 & 17 \\ -31 & -13 & 20 \\ 19 & 6 & -28 \end{bmatrix} \quad C = \begin{bmatrix} -5 & 8 & 17 \\ 31 & -13 & -20 \\ 19 & -6 & -28 \end{bmatrix} \quad Adj = \begin{bmatrix} -5 & 31 & 19 \\ 8 & -13 & -6 \\ 17 & -20 & -28 \end{bmatrix}$$

SHEET 1



SOLUTION

Taking the variables coefficients and arranging it into a mtrix form

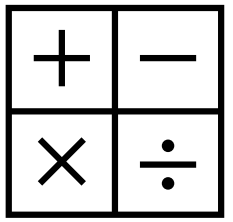
$$A = \begin{bmatrix} 4 & 8 & 1 \\ 2 & -3 & 2 \\ 1 & 7 & -3 \end{bmatrix} \quad |A| = -20 + 64 + 17 = 61 \rightarrow \textbf{\textit{Solution exists}}$$

$$Adj = \begin{bmatrix} -5 & 31 & 19 \\ 8 & -13 & -6 \\ 17 & -20 & -28 \end{bmatrix}$$

```
Command Window
>> A = [4 8 1;2 -3 2;1 7 -3]

A =

     4     8     1
     2    -3     2
     1     7    -3

>> adjoint(A)

ans =

   -5.0000   31.0000   19.0000
    8.0000  -13.0000   -6.0000
   17.0000  -20.0000  -28.0000
```

MATLAB CHECK

SHEET 1



SOLUTION

Taking the variables coefficients and arranging it into a mtrix form

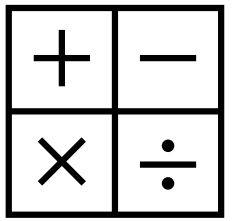
$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = A^{-1}Y = \frac{1}{|A|}Adj(A)Y = \frac{1}{61}\begin{bmatrix} -5 & 31 & 19 \\ 8 & -13 & -6 \\ 17 & -20 & -28 \end{bmatrix}\begin{bmatrix} -6 \\ 0 \\ -8 \end{bmatrix}$$

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} \mathbf{-2.0} \\ \mathbf{0.0} \\ \mathbf{2.0} \end{bmatrix}$$

MATLAB CHECK

```
A =

     4     8     1
     2    -3     2
     1     7    -3

>> Y = [-6 ; 0 ; -8]

Y =

    -6
     0
    -8

>> inv(A)*Y

ans =

   -2.0000
    0.0000
    2.0000
```

SHEET 1



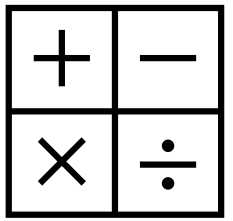
Determine if this matrix is ***singular*** *or* ***not***

$$A = \begin{bmatrix} 1 & 2 & -1 \\ -3 & 4 & 5 \\ -4 & 2 & 6 \end{bmatrix}$$

SOLUTION

$$|A| = (1)(14) - (2)(2) - (1)(10) = 14 - 4 - 10 = \mathbf{0} \rightarrow \textbf{\textit{Singular}}$$

SHEET 1



FInd the K value causing the value to be simgular

$$A = \begin{bmatrix} K & 6 \\ 4 & 3 \end{bmatrix}$$

SOLUTION

$$|A| = 3K - 24 = 0 \rightarrow \boldsymbol{K} = \frac{24}{3} = \mathbf{8}$$