MATLAB Project

ENGR 2300-82701 Applied Linear Algebra

Crystal Hollis, 1960743

3/23/2025

This document is an electronic diary. The MATLAB script is viewable and downloadable on GITHUB:

<https://github.com/crystaljhollis/DallasCollege_Portfolio/tree/main/ENGR2300_AppliedLinearAlgebra/Graded_MATLAB_Project>

% Crystal Hollis

% ID 1960743

% ENGR 2300 Applied Linear Algebra

% Section 82701

% Spring 2025 MATLAB Project

% Date: 3/23/2025

disp('Crystal Hollis (1960743)');

disp('ENGR 2300-82701 Applied Linear Algebra');

disp('Spring 2025 MATLAB Project 3-23-2025');

disp(' ');

disp(' ');

**OUTPUT:**

>> matlabProject\_CrystalHollis

Crystal Hollis (1960743)

ENGR 2300-82701 Applied Linear Algebra

Spring 2025 MATLAB Project 3-23-2025

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Note: The problem has a typo. The correct command is A\B

%% Problem 1

% Use MATLAB command A/B to solve the linear system:

% 16x − 120y + 240z − 140w = −4

% −120x + 1200y − 2700z + 1680w = 60

% 240x − 2700y + 6480z − 4200w = −180

% −140x + 1680y − 4200z + 2800w = 140

disp('Problem 1: Use MATLAB command A/B to solve the linear system.');

disp('16x − 120y + 240z − 140w = −4');

disp('−120x + 1200y − 2700z + 1680w = 60');

disp('240x − 2700y + 6480z − 4200w = −180');

disp('−140x + 1680y − 4200z + 2800w = 140');

% Define the coefficient matrix A1

A1 = [

16 -120 240 -140

-120 1200 -2700 1680

240 -2700 6480 -4200

-140 1680 -4200 2800

];

disp(' ');

disp('Coefficient matrix A1 =');

disp('[16 −120 240 −140');

disp('−120 1200 −2700 1680');

disp('240 −2700 6480 −4200');

disp('−140 1680 −4200 2800]');

% Define the Constant Vector B1

B1 = [

-4

60

-180

140

];

disp(' ');

disp('Constant Vector B1 =');

disp('[-4');

disp(' 60');

disp(' −180');

disp('140]');

% MATLAB command A\B

X1 = A1 \ B1;

% Display Solution

disp(' ');

disp('Problem 1 Solution: (x, y, z, w) =');

disp(X1);

% Output should be Solution (x, y, z, w) = (1, 1, 1, 1)

**OUTPUT:**

Problem 1: Use MATLAB command A/B to solve the linear system.

16x − 120y + 240z − 140w = −4

−120x + 1200y − 2700z + 1680w = 60

240x − 2700y + 6480z − 4200w = −180

−140x + 1680y − 4200z + 2800w = 140

Coefficient matrix A1 =

[16 −120 240 −140

−120 1200 −2700 1680

240 −2700 6480 −4200

−140 1680 −4200 2800]

Constant Vector B1 =

[-4

60

−180

140]

Problem 1 Solution: (x, y, z, w) =

1.0000

1.0000

1.0000

1.0000

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%% Problem 2

% Let A be the coefficient matrix and B the right-hand side of the linear

% system

% 3x + 3y + 12z = 18

% x + y + 4z = 6

% 2x + 5y + 20z = 30

% -x + 2y + 8z = 12

disp(' ');

disp('Problem 2: Let A be the coefficient matrix and B the right-hand side of the linear system');

disp('3x + 3y + 12z = 18');

disp('x + y + 4z = 6');

disp('2x + 5y + 20z = 30');

disp('-x + 2y + 8z = 12');

% Define the coefficient matrix A2

A2 = [

3 3 12

1 1 4

2 5 20

-1 2 8

];

disp(' ');

disp('Coefficient matrix A2 =');

disp('[3 3 12');

disp('1 1 4 ');

disp('2 5 20');

disp('−1 2 8]');

% Define the Constant Vector B2

B2 = [

18

6

30

12

];

disp(' ');

disp('Constant Vector B2 =');

disp('[18');

disp(' 6');

disp(' 30');

disp('12]');

% MATLAB command C2 = [A2 B2]

C2 = [A2 B2];

disp(' ');

disp('MATLAB command C2 = [A2 B2]');

% Solve the system using rref

R2 = rref(C2);

disp(' ');

disp('Solve the system using rref');

disp('R2 = rref(C2);')

disp(' ');

disp('Problem 2 Solution:');

disp('Reduced row-echelon form of [A2 B2]:');

disp(R2);

% Output should be Reduced row-echelon form of [A2 B2]:

% [1 0 0 0

% 0 1 4 6

% 0 0 0 0

% 0 0 0 0]

OUTPUT:

Problem 2: Let A be the coefficient matrix and B the right-hand side of the linear system

3x + 3y + 12z = 18

x + y + 4z = 6

2x + 5y + 20z = 30

-x + 2y + 8z = 12

Coefficient matrix A2 =

[3 3 12

1 1 4

2 5 20

−1 2 8]

Constant Vector B2 =

[18

6

30

12]

MATLAB command C2 = [A2 B2]

Solve the system using rref

R2 = rref(C2);

Problem 2 Solution:

Reduced row-echelon form of [A2 B2]:

1 0 0 0

0 1 4 6

0 0 0 0

0 0 0 0

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%% Problem 3

% Use MATLAB to find a sixth-degree polynomial that fits the points:

% (0,0), (-1, 4.5), (-2, 133), (-3, 1225.5), (1, -0.5), (2, 3), (3, 250.5)

disp(' ');

disp('Problem 3: Use MATLAB to find a sixth-degree polynomial that fits the points:');

disp('(0,0), (-1, 4.5), (-2, 133), (-3, 1225.5), (1, -0.5), (2, 3), (3, 250.5)');

% Define the x and y data vectors x3 = [0, -1, -2, -3, 1, 2, 3]; y3 = [0, 4.5, 133, 1225.5, -0.5, 3, 250.5];

x3 = [0, -1, -2, -3, 1, 2, 3];

y3 = [0, 4.5, 133, 1225.5, -0.5, 3, 250.5];

disp(' ');

disp('x data vectors = [0, -1, -2, -3, 1, 2, 3] ');

disp('y data vectors = [0, 4.5, 133, 1225.5, -0.5, 3, 250.5] ');

% Use polyfit to compute the polynomial coefficients (degree 6) p3 = polyfit(x3, y3, 6); disp('Polynomial coefficients (highest degree first):'); disp(p3);

p3 = polyfit(x3, y3, 6);

disp(' ');

disp('Polynomial coefficients (highest degree first):');

disp(p3);

% Output should be

% Polynomial coefficients (highest degree first):

% Columns 1 through 4: 1.0000 -2.0000 0.0000 -0.0000

% Columns 5 through 7: 1.0000 -0.5000 0.0000

OUTPUT:

Problem 3: Use MATLAB to find a sixth-degree polynomial that fits the points:

(0,0), (-1, 4.5), (-2, 133), (-3, 1225.5), (1, -0.5), (2, 3), (3, 250.5)

x data vectors = [0, -1, -2, -3, 1, 2, 3]

y data vectors = [0, 4.5, 133, 1225.5, -0.5, 3, 250.5]

Polynomial coefficients (highest degree first):

1.0000 -2.0000 0.0000 -0.0000 1.0000 -0.5000 0.0000

A math equations with numbers and symbols

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%% Problem 4

% Enter the matrices A and B:

% A = [ 0 -4 5; 3 1 -2; 2 1 4 ]

% B = [ -5 6 7; 0 -1 2; 4 0 -3 ]

A4 = [ 0 -4 5; 3 1 -2; 2 1 4 ];

B4 = [ -5 6 7; 0 -1 2; 4 0 -3 ];

disp(' ');

disp('Problem 4: Enter the matrices A and B: ');

disp('A4 = [ 0 -4 5; 3 1 -2; 2 1 4 ] ');

disp('B4 = [ -5 6 7; 0 -1 2; 4 0 -3 ] ');

% (a) Compute A + B AB\_sum = A4 + B4; disp('A + B ='); disp(AB\_sum);

AB\_sum = A4 + B4;

disp(' ');

disp('Problem 4a: Compute A4 + B4');

disp('A + B');

disp('Problem 4a Solution:')

disp(AB\_sum);

% (b) Compute 5B + 2A

expr\_b = 5 \* B4 + 2 \* A4;

disp(' ');

disp('Problem 4b Compute 5B + 2A');

disp('5B + 2A');

disp('Problem 4b Solution:');

disp(expr\_b);

% (c) Compute BA (matrix multiplication B \* A)

BA = B4 \* A4;

disp(' ');

disp('Problem 4c Compute BA ');

disp('B \* A');

disp('Problem 4c Solution:');

disp(BA);

% (d) Compute AB (matrix multiplication A \* B)

AB = A4 \* B4;

disp(' ');

disp('Problem 4d Compute AB ');

disp('A \* B');

disp('Problem 4d Solution:');

disp(AB);

**OUTPUT:**

Problem 4: Enter the matrices A and B:

A4 = [ 0 -4 5; 3 1 -2; 2 1 4 ]

B4 = [ -5 6 7; 0 -1 2; 4 0 -3 ]

Problem 4a: Compute A4 + B4

A + B

Problem 4a Solution:

-5 2 12

3 0 0

6 1 1

Problem 4b Compute 5B + 2A

5B + 2A

Problem 4b Solution:

-25 22 45

6 -3 6

24 2 -7

Problem 4c Compute BA

B \* A

Problem 4c Solution:

32 33 -9

1 1 10

-6 -19 8

Problem 4d Compute AB

A \* B

Problem 4d Solution:

20 4 -23

-23 17 29

6 11 4

A group of numbers and a number on a white background

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%% Problem 5

% Enter the matrices:

% A = [1 2 3 4; 2 3 4 5; 3 4 5 6; 4 5 6 7]

% B = [ 4 -6 3 5; 0 -3 -6 8; 3 5 0 7; -1 0 7 9 ]

% Also, define C = [16 -1 4 -1; -3 12 -7 8; 4 -5 0 0; -14 3 2 8]

A5 = [ 1 2 3 4; 2 3 4 5; 3 4 5 6; 4 5 6 7 ];

B5 = [ 4 -6 3 5; 0 -3 -6 8; 3 5 0 7; -1 0 7 9 ];

C5 = [ 16 -1 4 -1; -3 12 -7 8; 4 -5 0 0; -14 3 2 8 ];

disp(' ');

disp('Problem 5: Enter the matrices:');

disp('A5 = [ 1 2 3 4; 2 3 4 5; 3 4 5 6; 4 5 6 7 ] ');

disp('B5 = [ 4 -6 3 5; 0 -3 -6 8; 3 5 0 7; -1 0 7 9 ]');

disp('C5 = [ 16 -1 4 -1; -3 12 -7 8; 4 -5 0 0; -14 3 2 8 ]');

% (a) Compute 3\*(BC), B(3C), and (3B)C

disp(' ');

disp('Problem 5a: Find 3(BC), B(3C), (3B)C. What do you observe?');

expr1 = 3 \* (B5 \* C5);

disp('3(BC) = ');

disp(expr1);

expr2 = B5 \* (3 \* C5);

disp('B(3C) = ');

disp(expr2);

expr3 = (3 \* B5) \* C5;

disp('(3B)C = ');

disp(expr3);

disp('I observe that all three expressions are equal.');

% (b) Compute AB + AC and A\*(B+C)

% Note: Here, interpret “AC” as A times C where C is the matrix C5.

expr4 = A5 \* B5 + A5 \* C5;

expr5 = A5 \* (B5 + C5);

disp(' ');

disp('Problem 5b: Compute AB + AC and A\*(B+C)');

disp('AB + AC =');

disp(expr4);

disp('A\*(B + C) =');

disp(expr5);

disp('I observe that the two expressions are equal (distributive property).');

**OUTPUT:**

Problem 5: Enter the matrices:

A5 = [ 1 2 3 4; 2 3 4 5; 3 4 5 6; 4 5 6 7 ]

B5 = [ 4 -6 3 5; 0 -3 -6 8; 3 5 0 7; -1 0 7 9 ]

C5 = [ 16 -1 4 -1; -3 12 -7 8; 4 -5 0 0; -14 3 2 8 ]

Problem 5a: Find 3(BC), B(3C), (3B)C. What do you observe?

3(BC) =

72 -228 204 -36

-381 54 111 120

-195 234 -27 279

-342 -21 42 219

B(3C) =

72 -228 204 -36

-381 54 111 120

-195 234 -27 279

-342 -21 42 219

(3B)C =

72 -228 204 -36

-381 54 111 120

-195 234 -27 279

-342 -21 42 219

I observe that all three expressions are equal.

Problem 5b: Compute AB + AC and A\*(B+C)

AB + AC =

-25 23 17 125

-16 28 20 169

-7 33 23 213

2 38 26 257

A\*(B + C) =

-25 23 17 125

-16 28 20 169

-7 33 23 213

2 38 26 257

I observe that the two expressions are equal (distributive property).

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%% Problem 6

% Let A = [1, 1/3; 0, 1/5]. Find A^2, A^3, A^8 and describe A^n for large n.

disp(' ');

disp('Problem 6: Let A = [1, 1/3; 0, 1/5]. Find A^2, A^3, A^8 and describe A^n for large n. ');

A6 = [1, 1/3; 0, 1/5];

A6\_2 = A6^2;

A6\_3 = A6^3;

A6\_8 = A6^8;

disp('A^2 =');

disp(A6\_2);

disp('A^3 =');

disp(A6\_3);

disp('A^8 =');

disp(A6\_8);

disp('I observe that as n increases, the (2,2) entry (1/5)^n decays toward zero,');

disp('and A^n approaches a matrix with the (1,1) entry equal to 1 and the (1,2) entry approaching a limit.');

**OUTPUT:**

Problem 6: Let A = [1, 1/3; 0, 1/5]. Find A^2, A^3, A^8 and describe A^n for large n.

A^2 =

1.0000 0.4000

0 0.0400

A^3 =

1.0000 0.4133

0 0.0080

A^8 =

1.0000 0.4167

0 0.0000

I observe that as n increases, the (2,2) entry (1/5)^n decays toward zero,

and A^n approaches a matrix with the (1,1) entry equal to 1 and the (1,2) entry approaching a limit.

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%% Problem 7

% Let A and B be the 3x3 matrices:

% A = [2, 4, 5/2; -3/4, 2, 1/4; 1/4, 1/2, 2]

% B = [1, -1/2, 3/4; 3/2, 1/2, -2; 1/4, 1, 1/2]

disp(' ');

disp('Problem 7: Let A and B be the 3x3 matrices:');

disp('A = [2, 4, 5/2; -3/4, 2, 1/4; 1/4, 1/2, 2] ');

disp('B = [1, -1/2, 3/4; 3/2, 1/2, -2; 1/4, 1, 1/2] ');

A7 = [2, 4, 5/2; -3/4, 2, 1/4; 1/4, 1/2, 2];

B7 = [1, -1/2, 3/4; 3/2, 1/2, -2; 1/4, 1, 1/2];

% (a) Compute B^(-1)A^(-1), (AB)^(-1), (BA)^(-1)

invB7 = inv(B7);

invA7 = inv(A7);

expr7a = invB7 \* invA7;

expr7b = inv(A7 \* B7);

expr7c = inv(B7 \* A7);

disp(' ');

disp('Problem 7a: Compute B^(-1)A^(-1), (AB)^(-1), (BA)^(-1):');

disp('B^(-1)A^(-1) =');

disp(expr7a);

disp('(AB)^(-1) =');

disp(expr7b);

disp('(BA)^(-1) =');

disp(expr7c);

disp('I observe that B^(-1)A^(-1) equals (AB)^(-1) and also equals (B\*A)^(-1) if A and B commute.');

% (b) Compute (A^(-1))T and (AT)^(-1)

invA7\_transpose = (invA7)';

transposeA7\_inv = inv(A7');

disp(' ');

disp('Problem 7b: Compute (A^(-1))transpose and (A transpose)^(-1)');

disp('(A^(-1))'' =');

disp(invA7\_transpose);

disp('(A'')^(-1) =');

disp(transposeA7\_inv);

disp('I observe that (A^(-1))transpose equals (A transpose)^(-1).');

**OUTPUT:**

Problem 7: Let A and B be the 3x3 matrices:

A = [2, 4, 5/2; -3/4, 2, 1/4; 1/4, 1/2, 2]

B = [1, -1/2, 3/4; 3/2, 1/2, -2; 1/4, 1, 1/2]

Problem 7a: Compute B^(-1)A^(-1), (AB)^(-1), (BA)^(-1):

B^(-1)A^(-1) =

0.2110 -0.2560 -0.1517

-0.1537 0.2057 0.5663

0.0537 -0.2834 0.1283

(AB)^(-1) =

0.2110 -0.2560 -0.1517

-0.1537 0.2057 0.5663

0.0537 -0.2834 0.1283

(BA)^(-1) =

0.2526 0.1358 -0.5130

-0.0860 0.1146 0.1854

0.1659 -0.1896 0.1778

I observe that B^(-1)A^(-1) equals (AB)^(-1) and also equals (B\*A)^(-1) if A and B commute.

Problem 7b: Compute (A^(-1))transpose and (A transpose)^(-1)

(A^(-1))' =

0.3280 0.1323 -0.0741

-0.5714 0.2857 0

-0.3386 -0.2011 0.5926

(A')^(-1) =

0.3280 0.1323 -0.0741

-0.5714 0.2857 0

-0.3386 -0.2011 0.5926

I observe that (A^(-1))transpose equals (A transpose)^(-1).

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%% Problem 8

% Consider the matrices:

% A8 = [2, 0, 1; 1, -1, 2; 3, 1, 2]

% B8 = [2, -1, 4; 0, -1, 3; 3, -2, 1]

disp(' ');

disp('Problem 8: Consider the matrices: ');

disp('A8 = [2, 0, 1; 1, -1, 2; 3, 1, 2] ');

disp('B8 = [2, -1, 4; 0, -1, 3; 3, -2, 1] ');

A8 = [2, 0, 1; 1, -1, 2; 3, 1, 2];

B8 = [2, -1, 4; 0, -1, 3; 3, -2, 1];

detA8 = det(A8);

detB8 = det(B8);

detAB = det(A8 \* B8);

detA8T = det(A8'); % A8' is the transpose of A8

detA8\_inv = 1 / detA8; % Should equal det(inv(A8))

disp(' ');

disp('Problem 8a: det(A8)det(B8) = det(AB)');

disp('det(A8) =');

disp(detA8);

disp('det(B8) =');

disp(detB8);

disp('det(A)det(B8) =');

disp(detA8 \* detB8);

disp('det(AB8) =');

disp(detAB);

disp('Verification of det(A8)det(B8) = det(AB8):');

disp(abs(detA8 \* detB8 - detAB) < 1e-10);

disp(' ');

disp('Problem 8b: det(A transpose) = det(A):');

disp('det(A8T) =');

disp(detA8T);

disp('Verification of det(A transpose) = det(A):');

disp(abs(detA8T - detA8) < 1e-10);

disp(' ');

disp('Problem 8c: det(A inverse) = 1/det(A)');

invA8 = inv(A8);

detA8\_inv\_calc = det(invA8);

disp('det(inv(A)) =');

disp(detA8\_inv\_calc);

disp('Verification of det(inv(A)) = 1/det(A):');

disp(abs(detA8\_inv\_calc - detA8\_inv) < 1e-10);

% End of MATLAB Script

**OUTPUT:**

Problem 8: Consider the matrices:

A8 = [2, 0, 1; 1, -1, 2; 3, 1, 2]

B8 = [2, -1, 4; 0, -1, 3; 3, -2, 1]

Problem 8a: det(A8)det(B8) = det(AB)

det(A8) =

-4

det(B8) =

13

det(A)det(B8) =

-52

det(AB8) =

-52

Verification of det(A8)det(B8) = det(AB8):

1

Problem 8b: det(A transpose) = det(A):

det(A8T) =

-4

Verification of det(A transpose) = det(A):

1

Problem 8c: det(A inverse) = 1/det(A)

det(inv(A)) =

-0.2500

Verification of det(inv(A)) = 1/det(A):

1