GENG8030-MATLAB
Winter 2026

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Course Notes

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Tutorial 1: An Overview of MATLAB

Problem 3

Suppose that $x = 5$ and $y = 2$. Use MATLAB to compute the following, and check the results with a calculator.

a. $(1 - \frac{1}{x^5})^{-1}$

b. $3\pi x^2$

c. $\frac{3y}{4x-8}$

d. $\frac{4(y-5)}{3x-6}$

```
clear; clc;
x = 5;
y = 2;

% a. (1 - 1/x^5)^-1
result_a = (1 - 1/x^5)^-1;

% b. 3 * pi * x^2
result_b = 3 * pi * x^2;

% c. (3*y) / (4*x - 8)
result_c = (3*y) / (4*x - 8);

% d. (4*(y - 5)) / (3*x - 6)
result_d = (4*(y - 5)) / (3*x - 6);

% Display results
disp(table(result_a, result_b, result_c, result_d));
```

Problem 5

Assuming that the variables a, b, c, d, and f are scalars, write MATLAB statements to compute and display the following expressions. Test your statements for the values $a = 1.12$, $b = 2.34$, $c = 0.72$, $d = 0.81$ and $f = 19.83$.

- $x = 1 + \frac{a}{b} + \frac{c}{f^2}$
- $r = \frac{1}{\frac{1}{a}+\frac{1}{b}+\frac{1}{c}+\frac{1}{d}}$
- $s = \frac{b-a}{d-c}$
- $y = ab\frac{1}{c}\frac{f^2}{2}$

```
clear; clc;
a = 1.12; b = 2.34; c = 0.72; d = 0.81; f = 19.83;

x = 1 + a/b + c/f^2;
r = 1 / (1/a + 1/b + 1/c + 1/d);
s = (b - a) / (d - c);
y = a * b * (1/c) * (f^2/2);

disp(['x = ', num2str(x)]);
disp(['r = ', num2str(r)]);
disp(['s = ', num2str(s)]);
disp(['y = ', num2str(y)]);
```

Problem 9

The functions `realmax` and `realmin` give the largest and smallest possible numbers that can be handled by MATLAB. Suppose you have variables $a = 3 \times 10^{150}$, $b = 5 \times 10^{200}$.

a. Use MATLAB to calculate $c = ab$.

b. Supposed $d = 5 \times 10^{-200}$ use MATLAB to calculate $f = d/a$.

c. Use MATLAB to calculate the product $x = abd$ two ways.

```
% Check limits
realmax
realmin

a = 3e150;
b = 5e200;

% a. Calculate c = a*b (Expect Overflow)
c = a * b

```

```
% b. d = 5e-200, calculate f = d/a (Expect Underflow)
d = 5e-200;
f = d / a

% c. Calculate x = abd in two ways
x1 = a * b * d; % Risk of intermediate overflow
y = b * d;
x2 = a * y;      % Safer calculation

disp(['Method 1: ', num2str(x1)]);
disp(['Method 2: ', num2str(x2)]);
```

Problem 22

Use MATLAB to calculate:

a. $e^{(-2.1)^3} + 3.47\log(14) + \sqrt[4]{287}$

b. $(3.4)^7 \log(14) + \sqrt[4]{287}$

c. $\cos^2(\frac{4.12\pi}{6})$

d. $\cos(\frac{4.12\pi}{6})^2$

```
% Note: Source likely implies log base 10 for "log(14)" in standard notation,
% but MATLAB's log() is natural log. Using log10() for base 10.
ans_a = exp((-2.1)^3) + 3.47 * log10(14) + nthroot(287, 4);
ans_b = (3.4)^7 * log10(14) + nthroot(287, 4);
ans_c = cos((4.12 * pi) / 6)^2;
ans_d = cos(((4.12 * pi) / 6)^2);
```

Problem 27

Use MATLAB to plot the function $T = 7\ln t - 8e^{0.3t}$ over the interval $1 \le t \le 3$.

```
t = 1:0.01:3;
T = 7 .* log(t) - 8 .* exp(0.3 .* t);

plot(t, T);
title('Temperature vs Time');
xlabel('Time (min)');
ylabel('Temperature (C)');
grid on;
```

Problem 30

A cycloid is described by $x = r(\phi - \sin\ \phi)$ and $y = r(1 - \cos\ \phi)$. Plot for $r = 10$ and $0 \leq \phi \leq 4\pi$.

```
r = 10;
phi = 0 : 0.01 : 4*pi;
x = r .* (phi - sin(phi));
y = r .* (1 - cos(phi));

plot(x, y);
title('Cycloid Plot (r=10)');
xlabel('x'); ylabel('y');
axis equal;
```

Problem 34

Develop a procedure for computing the length of side c_2 of the two-triangle figure given sides b_1, b_2, c_1 and angles A_1, A_2. Test with $b_1 = 200$, $b_2 = 1801$, $c_1 = 1201$, $A_1 = 120°$, $A_2 = 100°$.

```
% Inputs
b1 = 200; b2 = 1801; c1 = 1201;
A1_deg = 120; A2_deg = 100;
A1 = deg2rad(A1_deg); A2 = deg2rad(A2_deg);

% 1. Find common side 'a' (Top Triangle Law of Cosines)
a_sq = b1^2 + c1^2 - 2*b1*c1*cos(A1);
a = sqrt(a_sq);

% 2. Find c2 (Bottom Triangle) solving quadratic:
% c2^2 - (2*b2*cos(A2))*c2 + (b2^2 - a^2) = 0
coeff_A = 1;
coeff_B = -2 * b2 * cos(A2);
coeff_C = b2^2 - a_sq;

possible_c2 = roots([coeff_A, coeff_B, coeff_C]);
c2 = possible_c2(possible_c2 > 0); % Filter positive

disp(['Side c2: ', num2str(c2')]);
```

Problem 35

Write a script to compute the three roots of $x^3 + ax^2 + bx + c = 0$.

```
a = input('Enter a: ');
b = input('Enter b: ');
c = input('Enter c: ');
disp(roots([1, a, b, c]));
```

Tutorial 2: Numeric, Cell and Structure Arrays

Problem 10

Consider the array $A = \begin{bmatrix} 1 & 4 & 2 \\ 2 & 4 & 100 \\ 7 & 9 & 7 \\ 3 & \pi & 42 \end{bmatrix}$ and $B = \ln(A)$.

Write MATLAB expressions to do the following:

a. Select just the second row of B.

b. Evaluate the sum of the second row of B.

c. Multiply the second column of B and the first column of A element by element.

d. Evaluate the maximum value in the vector resulting from element-by-element multiplication of the second column of B with the first column of A.

e. Use element-by-element division to divide the first row of A by the first three elements of the third column of B. Evaluate the sum of the elements of the resulting vector.

```
% Define Matrix A
A = [1, 4, 2;
     2, 4, 100;
     7, 9, 7;
     3, pi, 42];

% Define Matrix B (Natural log is log() in MATLAB)
B = log(A);

% a. Select second row of B
part_a = B(2, :);

% b. Sum of second row of B
part_b = sum(B(2, :));

% c. Multiply 2nd col of B and 1st col of A element-wise
part_c = B(:, 2) .* A(:, 1);

% d. Max value of result from c
part_d = max(part_c);
```

```
% e. Divide 1st row of A by first 3 elements of 3rd col of B
% Note: A(1,:) is 1x3. B(1:3, 3) is 3x1.
% We must transpose B's slice to match dimensions.
vec_e = A(1, :) ./ B(1:3, 3)';
part_e = sum(vec_e);

disp(['Sum (Part b): ', num2str(part_b)]);
disp(['Max (Part d): ', num2str(part_d)]);
disp(['Sum (Part e): ', num2str(part_e)]);
```

Problem 11

Create a three-dimensional array D whose three "layers" are matrices A, B, and C. Use MATLAB to find the largest element in each layer of D and the largest element in D.

```
A = [3, -2, 1; 6, 8, -5; 7, 9, 10];
B = [6, 9, -4; 7, 5, 3; -8, 2, 1];
C = [-7, -5, 2; 10, 6, 1; 3, -9, 8];

% Create 3D array D
D(:, :, 1) = A;
D(:, :, 2) = B;
D(:, :, 3) = C;

% Largest element in each layer
max_layer_1 = max(max(D(:, :, 1)));
max_layer_2 = max(max(D(:, :, 2)));
max_layer_3 = max(max(D(:, :, 3)));

% Largest element in D
max_total = max(D(:));

disp(['Max Total: ', num2str(max_total)]);
```

Problem 15

Given matrices A, B, and C, verify the associative and commutative laws for addition.

```
A = [-7, 11; 4, 9];
B = [4, -5; 12, -2];
C = [-3, -9; 7, 8];

% a. A + B + C
res_a = A + B + C;

```

```
% b. A - B + C
res_b = A - B + C;

% c. Verify Associative Law: (A+B)+C = A+(B+C)
check_assoc = isequal((A+B)+C, A+(B+C));

% d. Verify Commutative Law: A+B+C = B+C+A = A+C+B
term1 = A + B + C;
term2 = B + C + A;
term3 = A + C + B;
check_comm = isequal(term1, term2) && isequal(term2, term3);

if check_assoc && check_comm
    disp('Laws Verified');
else
    disp('Verification Failed');
end
```

Problem 19

Plot the function $f(x) = \frac{4\cos x}{x+e^{-0.75x}}$ over the interval $-2 \leq x \leq 16$.

```
x = -2 : 0.05 : 16; % Smooth interval
f = (4 .* cos(x)) ./ (x + exp(-0.75 .* x));

plot(x, f);
title('Plot of f(x)');
xlabel('x');
ylabel('f(x)');
grid on;
```

Problem 22

A ship travels on a straight line course described by $y = (200 - 5x)/6$. The ship starts when $x = -20$ and ends when $x = 40$. Calculate the distance at closest approach to a lighthouse located at the origin (0,0) without using a plot.

```
% Define path range
x = -20 : 0.01 : 40;
y = (200 - 5 .* x) ./ 6;

% Distance formula d = sqrt(x^2 + y^2)
distances = sqrt(x.^2 + y.^2);

% Find minimum distance
```

```
min_dist = min(distances);

disp(['Closest approach distance: ', num2str(min_dist), ' km']);
```

Problem 23

Calculate work done $W = FD$ for five segments of a path given force and distance data. Find (a) work for each segment and (b) total work.

```
% Data vectors
Force = [400, 550, 700, 500, 600]; % Newtons
Distance = [3, 0.5, 0.75, 1.5, 5]; % Meters

% a. Work per segment (Element-wise multiplication)
Work_segments = Force .* Distance;

% b. Total work
Work_total = sum(Work_segments);

disp('Work per segment (J):');
disp(Work_segments);
disp(['Total Work (J): ', num2str(Work_total)]);
```

Problem 27

Calculate compression x and potential energy $PE = \frac{1}{2}kx^2$ for five springs given Force $F = kx$ and spring constant k.

```
% Data
F = [11, 7, 8, 10, 9];          % Force (N)
k = [1000, 600, 900, 1300, 700]; % Constant (N/m)

% a. Compression x = F / k
x = F ./ k;

% b. Potential Energy PE = 0.5 * k * x^2
PE = 0.5 .* k .* (x.^2);

% Display results table
disp(table(F', k', x', PE', 'VariableNames', {'Force','k','Compression','PE'}));
```

Problem 41

Solve the following system using the left-division method.

$$
\begin{aligned}
6x - 3y + 4z &= 41 \\
12x + 5y - 7z &= -26 \\
-5x + 2y - 6z &= 16
\end{aligned}
$$

```matlab
% Coefficient Matrix A
A = [ 6, -3,  4;
     12,  5, -7;
     -5,  2, -6];

% Constant Vector B
B = [41; -26; 16];

% Solve for X = [x; y; z] using left division
Solution = A \ B;

disp('Solution [x; y; z]:');
disp(Solution);
```