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1NT21CS021

MATLAB – LA

1. Given are a matrix A, a matrix B, and a 9-element vector v.

$$A = \begin{bmatrix} 2 & 5 & 8 & 11 & 14 & 17 \\ 3 & 6 & 9 & 12 & 15 & 18 \\ 4 & 7 & 10 & 13 & 16 & 19 \\ 5 & 8 & 11 & 14 & 17 & 20 \\ 6 & 9 & 12 & 15 & 18 & 21 \end{bmatrix} \qquad B = \begin{bmatrix} 5 & 10 & 15 & 20 & 25 & 30 \\ 30 & 35 & 40 & 45 & 50 & 55 \\ 55 & 60 & 65 & 70 & 75 & 80 \end{bmatrix}$$

$$v = \begin{bmatrix} 99 & 98 & 97 & 96 & 95 & 94 & 93 & 92 & 91 \end{bmatrix}$$

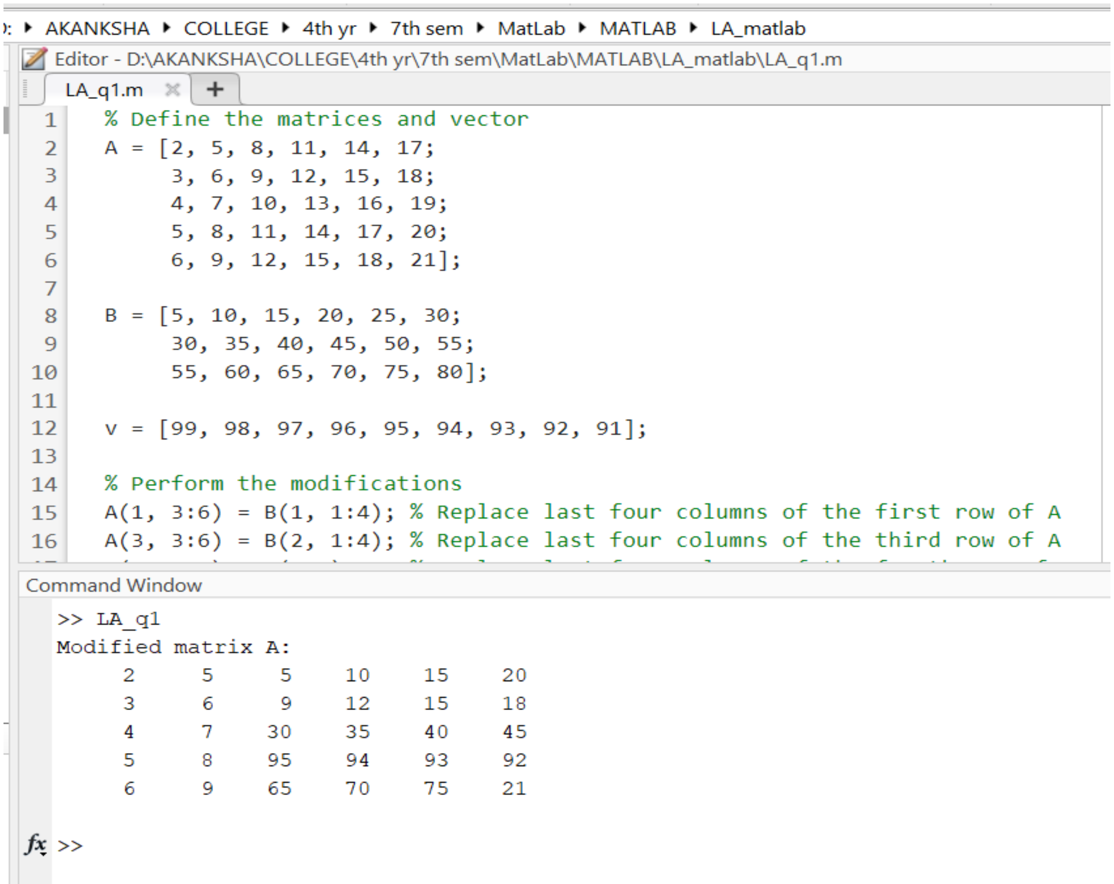
Create the three arrays in the Command Window, and then, by writing one command, replace the last four columns of the first and third rows of A with the first four columns of the first two rows of B, the last four columns of the fourth row of A with the elements 5 through 8 of v, and the last four columns of the fifth row of A with columns 3 through 5 of the third row of B

- **PROGRAM:**

```
A = [2, 5, 8, 11, 14, 17;
    3, 6, 9, 12, 15, 18;
    4, 7, 10, 13, 16, 19;
    5, 8, 11, 14, 17, 20;
    6, 9, 12, 15, 18, 21];

B = [5, 10, 15, 20, 25, 30;
    30, 35, 40, 45, 50, 55;
    55, 60, 65, 70, 75, 80];

v = [99, 98, 97, 96, 95, 94, 93, 92, 91];

% modifications
A(1, 3:6) = B(1, 1:4); % Replace last 4 columns of the 1st row of A
A(3, 3:6) = B(2, 1:4); % Replace last 4 columns of the 3rd row of A
A(4, 3:6) = v(5:8);    % Replace last 4 columns of the 4th row of A
A(5, 3:5) = B(3, 3:5); % Replace columns 3-5 of the 5th row of A
```

```
% result
disp('Modified matrix A:');
disp(A);
```

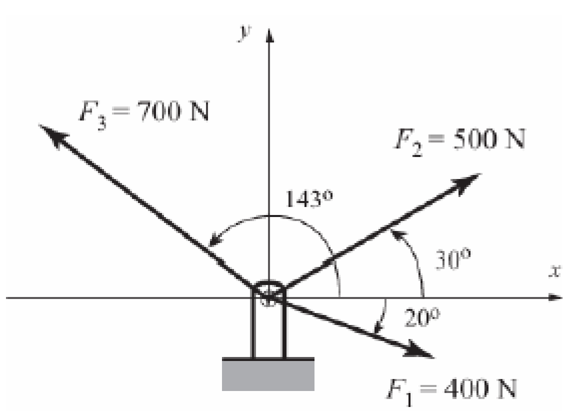
- **<u>OUTPUT:</u>**




```
% Define the matrices and vector
A = [2, 5, 8, 11, 14, 17;
     3, 6, 9, 12, 15, 18;
     4, 7, 10, 13, 16, 19;
     5, 8, 11, 14, 17, 20;
     6, 9, 12, 15, 18, 21];

B = [5, 10, 15, 20, 25, 30;
     30, 35, 40, 45, 50, 55;
     55, 60, 65, 70, 75, 80];

v = [99, 98, 97, 96, 95, 94, 93, 92, 91];

% Perform the modifications
A(1, 3:6) = B(1, 1:4); % Replace last four columns of the first row of A
A(3, 3:6) = B(2, 1:4); % Replace last four columns of the third row of A
```

```
>> LA_q1
Modified matrix A:
     2     5     5    10    15    20
     3     6     9    12    15    18
     4     7    30    35    40    45
     5     8    95    94    93    92
     6     9    65    70    75    21

fx >>
```

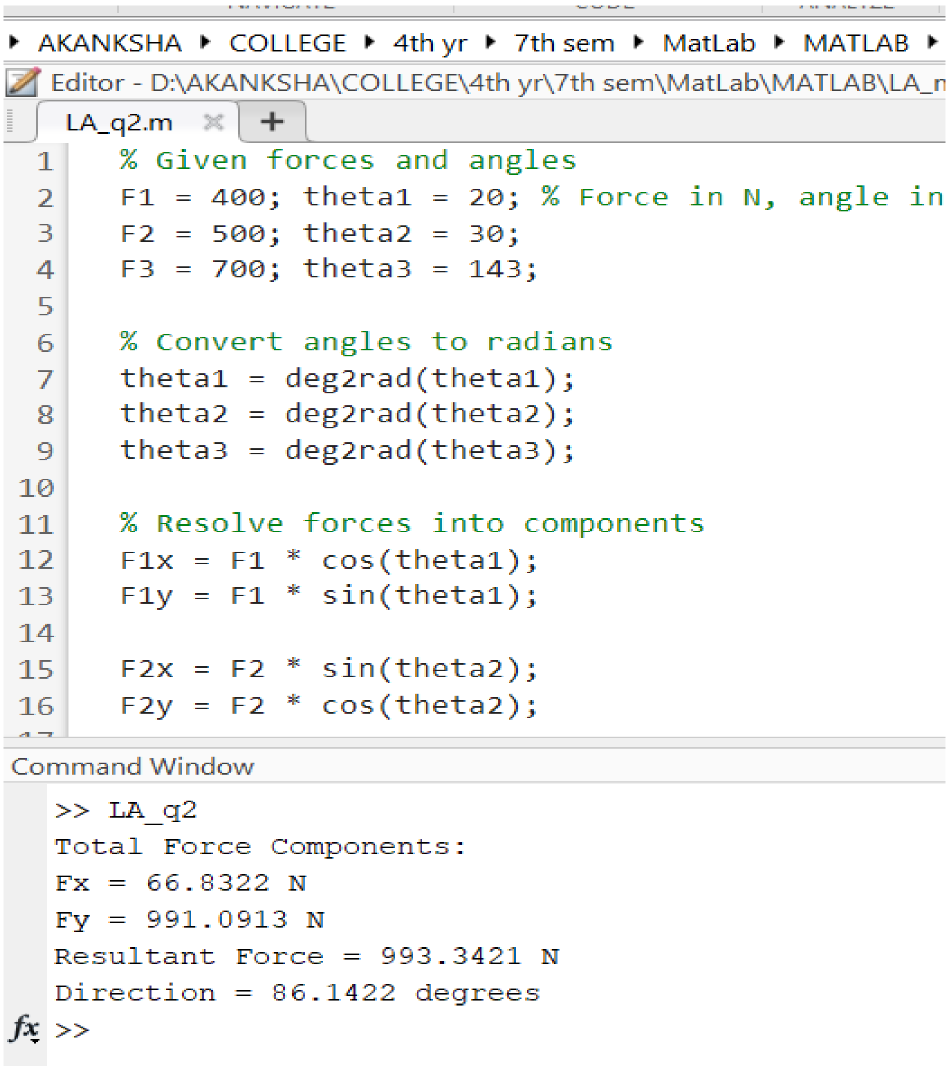
2. Three forces are applied to a bracket as shown. Determine the total (equivalent) force applied to the bracket:



- **PROGRAM:**

```
% Given forces and angles
F1 = 400; theta1 = 20; % Force in N, angle in degrees
F2 = 500; theta2 = 30;
F3 = 700; theta3 = 143;

% Convert angles to radians
theta1 = deg2rad(theta1);
theta2 = deg2rad(theta2);
theta3 = deg2rad(theta3);

% Resolve forces into components
F1x = F1 * cos(theta1);
F1y = F1 * sin(theta1);

F2x = F2 * sin(theta2);
F2y = F2 * cos(theta2);

F3x = F3 * cos(theta3);
F3y = F3 * sin(theta3);

% Calculate total x and y components
Fx_total = F1x + F2x + F3x;
Fy_total = F1y + F2y + F3y;

% Calculate resultant force and direction
F_total = sqrt(Fx_total^2 + Fy_total^2);
theta_total = atan2(Fy_total, Fx_total); % Angle in radians

% Convert angle to degrees
theta_total_deg = rad2deg(theta_total);

% Display results
disp('Total Force Components:');
disp(['Fx = ', num2str(Fx_total), ' N']);
disp(['Fy = ', num2str(Fy_total), ' N']);
disp(['Resultant Force = ', num2str(F_total), ' N']);
disp(['Direction = ', num2str(theta_total_deg), ' degrees']);
```

- **OUTPUT:**



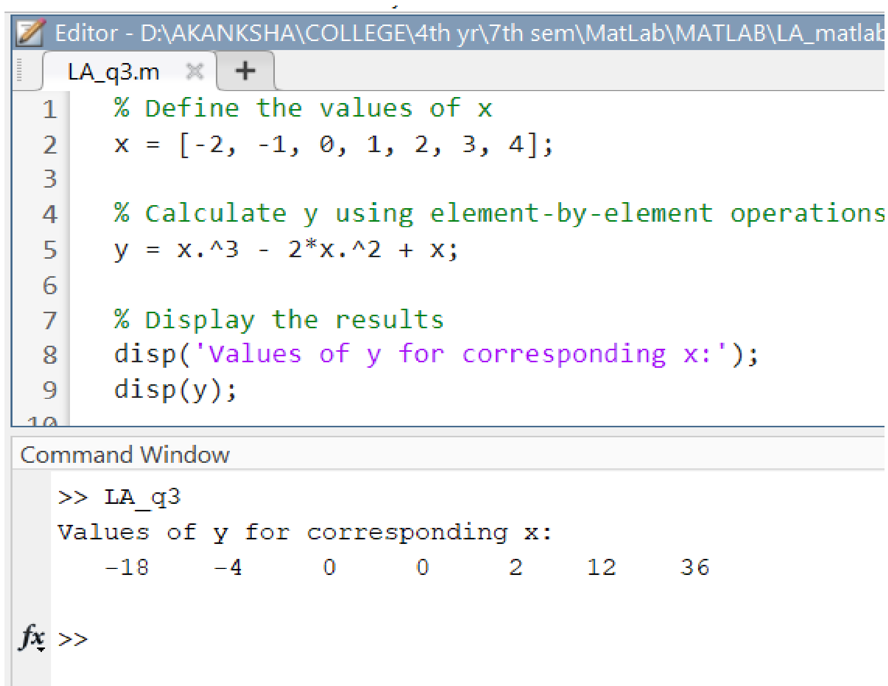
3. For the function $y = x^3 - 2x^2 + x$, calculate the value of y for the following values of x using element-by-element operations: $-2, -1, 0, 1, 2, 3, 4$.

- **PROGRAM:**

```
% Define the values of x
x = [-2, -1, 0, 1, 2, 3, 4];

% Calculate y using element-by-element operations
y = x.^3 - 2*x.^2 + x;

% Display the results
```

```
disp('Values of y for corresponding x:');
disp(y);
```

- **OUTPUT:**



4. For the function $y = \frac{x^2 - 2}{x + 4}$, calculate the value of y for the following values of x using element-by-element operations: $-3, -2, -1, 0, 1, 2, 3$.

- **PROGRAM:**

```
% Define the values of x
x = [-3, -2, -1, 0, 1, 2, 3];

% Calculate y using element-by-element operations
y = (x.^2 - 2) ./ (x + 4);

% Display the results
disp('Values of y for corresponding x:');
disp(y);
```

- **OUTPUT:**

LA_q4.m

```
% Define the values of x
x = [-3, -2, -1, 0, 1, 2, 3];

% Calculate y using element-by-element operations
y = (x.^2 - 2) ./ (x + 4);

% Display the results
disp('Values of y for corresponding x:');
disp(y);
```

nmand Window

```
>> LA_q4
Values of y for corresponding x:
    7.0000    1.0000   -0.3333   -0.5000   -0.2000    0.3333    1.0000
```

5. The following two vectors are defined in MATLAB:

$$v = [3, -2, 4] \qquad u = [5, 3, -1]$$

By hand (pencil and paper) write what will be displayed if the following commands are executed by MATLAB. Check your answers by executing the commands with MATLAB.

(*a*) `v.*u` (*b*) `v*u'` (*c*) `v'*u`

- **PROGRAM:**

```
v = [3, -2, 4];
u = [5, 3, -1];

result_a = v.*u; % Element-wise multiplication
result_b = v*u'; % Dot product
result_c = v'*u; % Outer product

disp('Result of (a):');
disp(result_a);

disp('Result of (b):');
disp(result_b);
```

```
disp('Result of (c):');
disp(result_c);
```

- **OUTPUT:**

LA_q5.m

```
v = [3, -2, 4];
u = [5, 3, -1];

result_a = v.*u; % Element-wise multip
result_b = v*u'; % Dot product
result_c = v'*u; % Outer product

disp('Result of (a):');
disp(result_a);

disp('Result of (b):');
disp(result_b);

disp('Result of (c):');
disp(result_c);
```

Command Window

```
>> LA_q5
Result of (a):
    15    -6    -4

Result of (b):
     5

Result of (c):
    15     9    -3
   -10    -6     2
    20    12    -4
```

6. Two vectors are given:

$$\mathbf{u} = -3\mathbf{i} + 8\mathbf{j} - 2\mathbf{k} \quad \text{and} \quad \mathbf{v} = 6.5\mathbf{i} - 5\mathbf{j} - 4\mathbf{k}$$

Use MATLAB to calculate the dot product $\mathbf{u} \cdot \mathbf{v}$ of the vectors in three ways:

(*a*) Write an expression using element-by-element calculation and the MATLAB built-in function `sum`.

(*b*) Define **u** as a row vector and **v** as a column vector, and then use matrix multiplication.

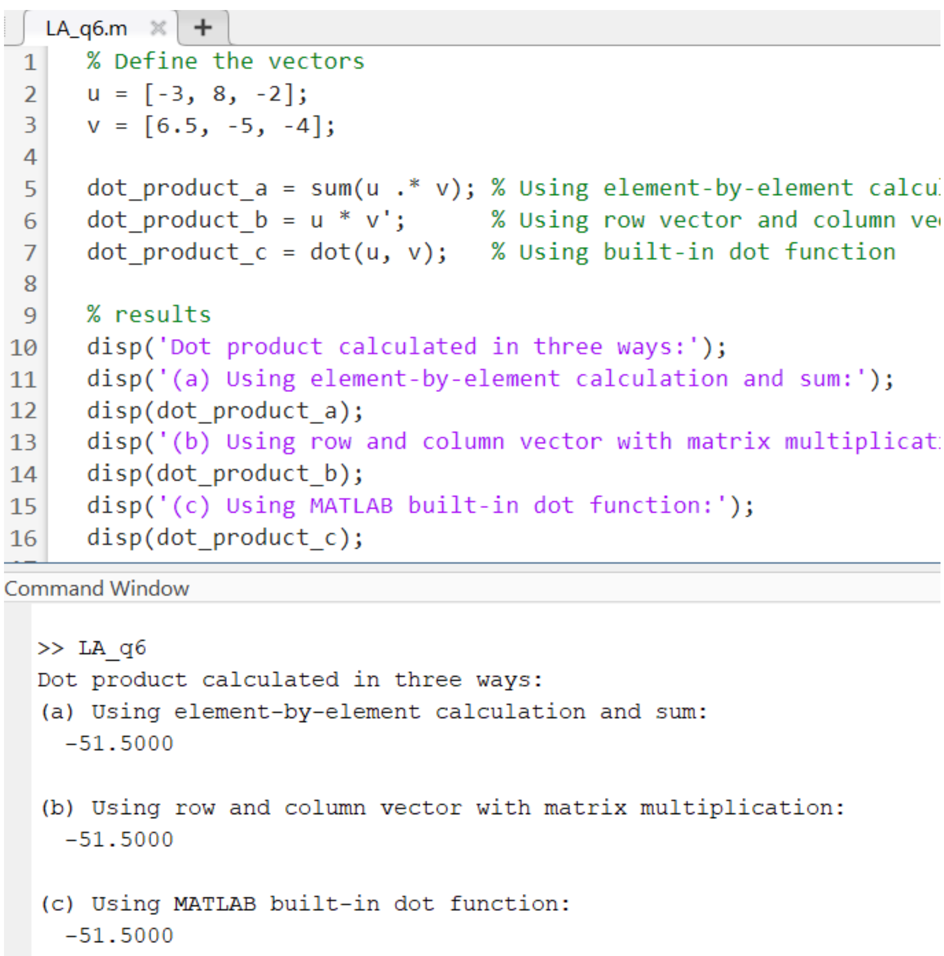
(*c*) Use the MATLAB built-in function `dot`.

- **PROGRAM:**

```
% Define the vectors
```

```
u = [-3, 8, -2];
v = [6.5, -5, -4];

dot_product_a = sum(u .* v); % Using element-by-element calculation and sum
dot_product_b = u * v';     % Using row vector and column vector with matrix
multiplication
dot_product_c = dot(u, v);   % Using built-in dot function

% results
disp('Dot product calculated in three ways:');
disp('(a) Using element-by-element calculation and sum:');
disp(dot_product_a);
disp('(b) Using row and column vector with matrix multiplication:');
disp(dot_product_b);
disp('(c) Using MATLAB built-in dot function:');
disp(dot_product_c);
```

- **OUTPUT:**


LA_q6.m

```
% Define the vectors
u = [-3, 8, -2];
v = [6.5, -5, -4];

dot_product_a = sum(u .* v); % Using element-by-element calcu
dot_product_b = u * v';      % Using row vector and column ve
dot_product_c = dot(u, v);   % Using built-in dot function

% results
disp('Dot product calculated in three ways:');
disp('(a) Using element-by-element calculation and sum:');
disp(dot_product_a);
disp('(b) Using row and column vector with matrix multiplicat
disp(dot_product_b);
disp('(c) Using MATLAB built-in dot function:');
disp(dot_product_c);
```

Command Window

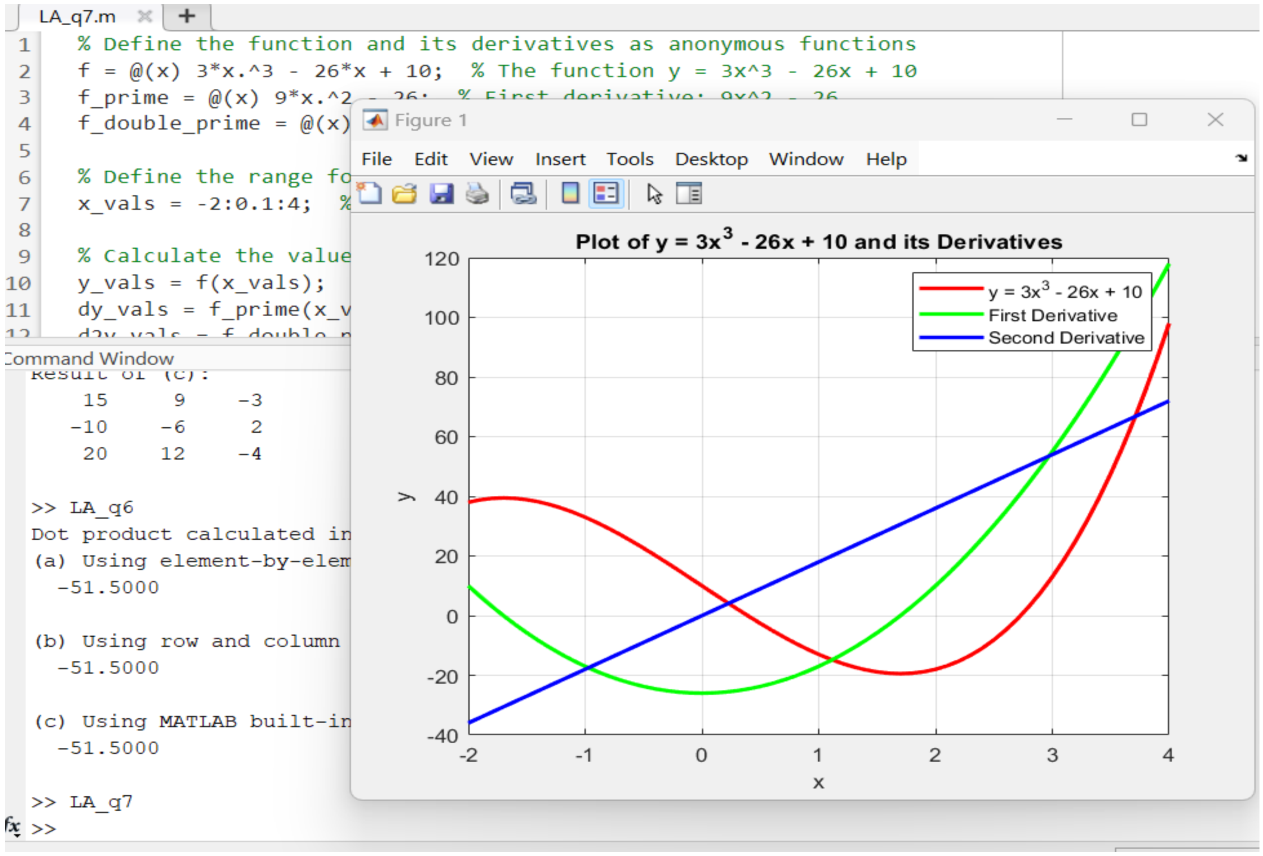
```
>> LA_q6
Dot product calculated in three ways:
(a) Using element-by-element calculation and sum:
  -51.5000

(b) Using row and column vector with matrix multiplication:
  -51.5000

(c) Using MATLAB built-in dot function:
  -51.5000
```

7. Plot the function $y = 3x^3 - 26x + 10$, and its first and second derivatives, for $-2 \leq x \leq 4$, all in the same plot.

- **PROGRAM:**

```
% Define the function and its derivatives as anonymous functions
f = @(x) 3*x.^3 - 26*x + 10;  % The function y = 3x^3 - 26x + 10
f_prime = @(x) 9*x.^2 - 26;  % First derivative: 9x^2 - 26
f_double_prime = @(x) 18*x;   % Second derivative: 18x

% Define the range for x
x_vals = -2:0.1:4;  % From -2 to 4 with step 0.1

% Calculate the values of y, first derivative, and second derivative
y_vals = f(x_vals);
dy_vals = f_prime(x_vals);
d2y_vals = f_double_prime(x_vals);

% Plot the function and its derivatives
figure;
plot(x_vals, y_vals, 'r', 'LineWidth', 2); % Plot y in red
hold on;
plot(x_vals, dy_vals, 'g', 'LineWidth', 2); % Plot first derivative in green
plot(x_vals, d2y_vals, 'b', 'LineWidth', 2); % Plot second derivative in blue
hold off;

% Add labels and legend
xlabel('x');
ylabel('y');
title('Plot of y = 3x^3 - 26x + 10 and its Derivatives');
legend('y = 3x^3 - 26x + 10', 'First Derivative', 'Second Derivative');
grid on;
```

- **OUTPUT:**



8. Use the `fplot` command to plot the function
$f(x) = \sqrt{|\cos(3x)|} + \sin^2(4x)$ in the domain $-2 \le x \le 2$.

- **PROGRAM:**

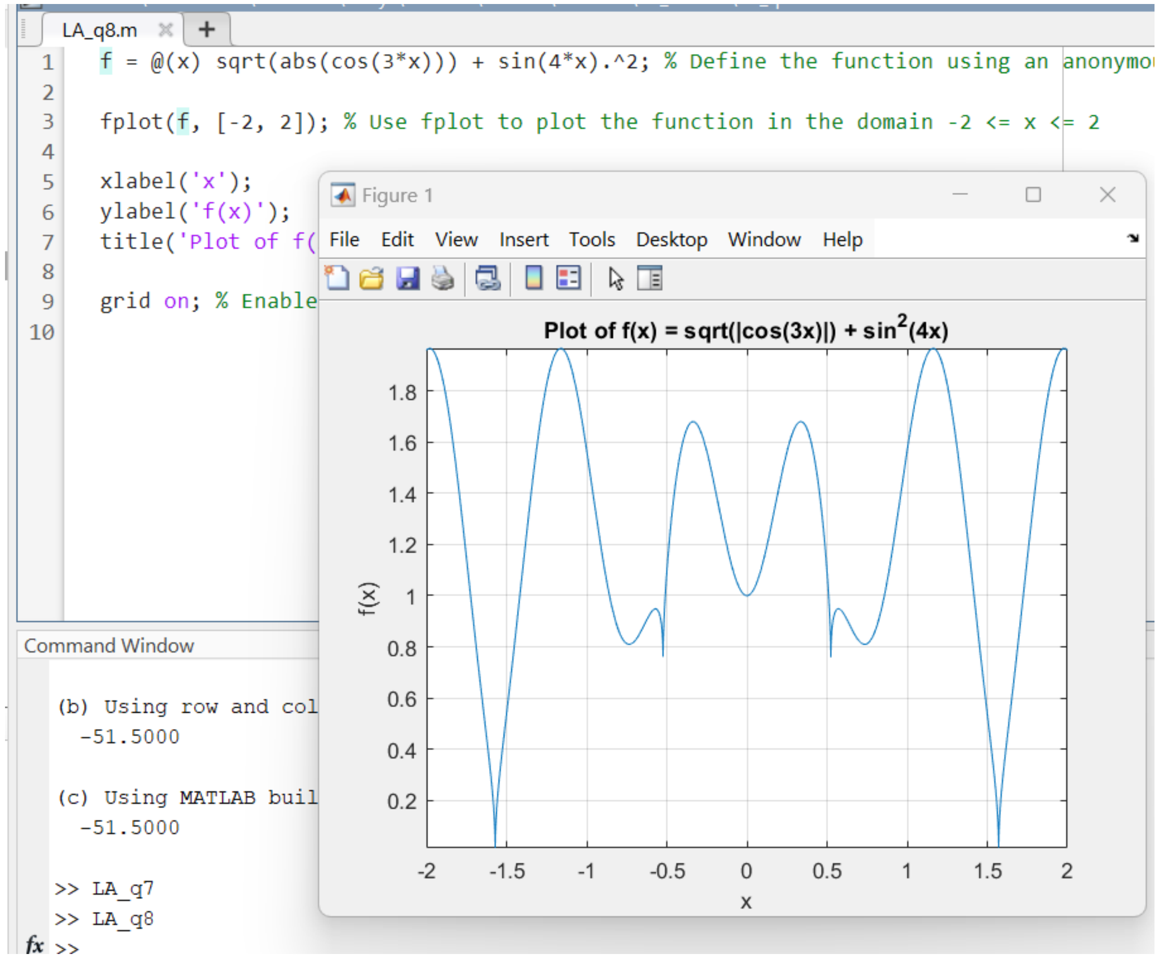
f = @(x) sqrt(abs(cos(3*x))) + sin(4*x).^2; % Define the function using an anonymous function

fplot(f, [-2, 2]); % Use fplot to plot the function in the domain -2 <= x <= 2

xlabel('x');
ylabel('f(x)');
title('Plot of f(x) = sqrt(|cos(3x)|) + sin^2(4x)');

grid on; % Enable grid

- **OUTPUT:**



9. A parametric equation is given by

$$x = 1.5\sin(5t), \quad y = 1.5\cos(3t)$$

Plot the function for $0 \le t \le 2\pi$. Format the plot such that the both axes will range from -2 to 2.

- **PROGRAM:**

```
% Define the parameter t from 0 to 2pi
t = linspace(0, 2*pi, 500);  % 500 points for a smooth curve

% Parametric equations
x = 1.5 * sin(5 * t);
y = 1.5 * cos(3 * t);
```

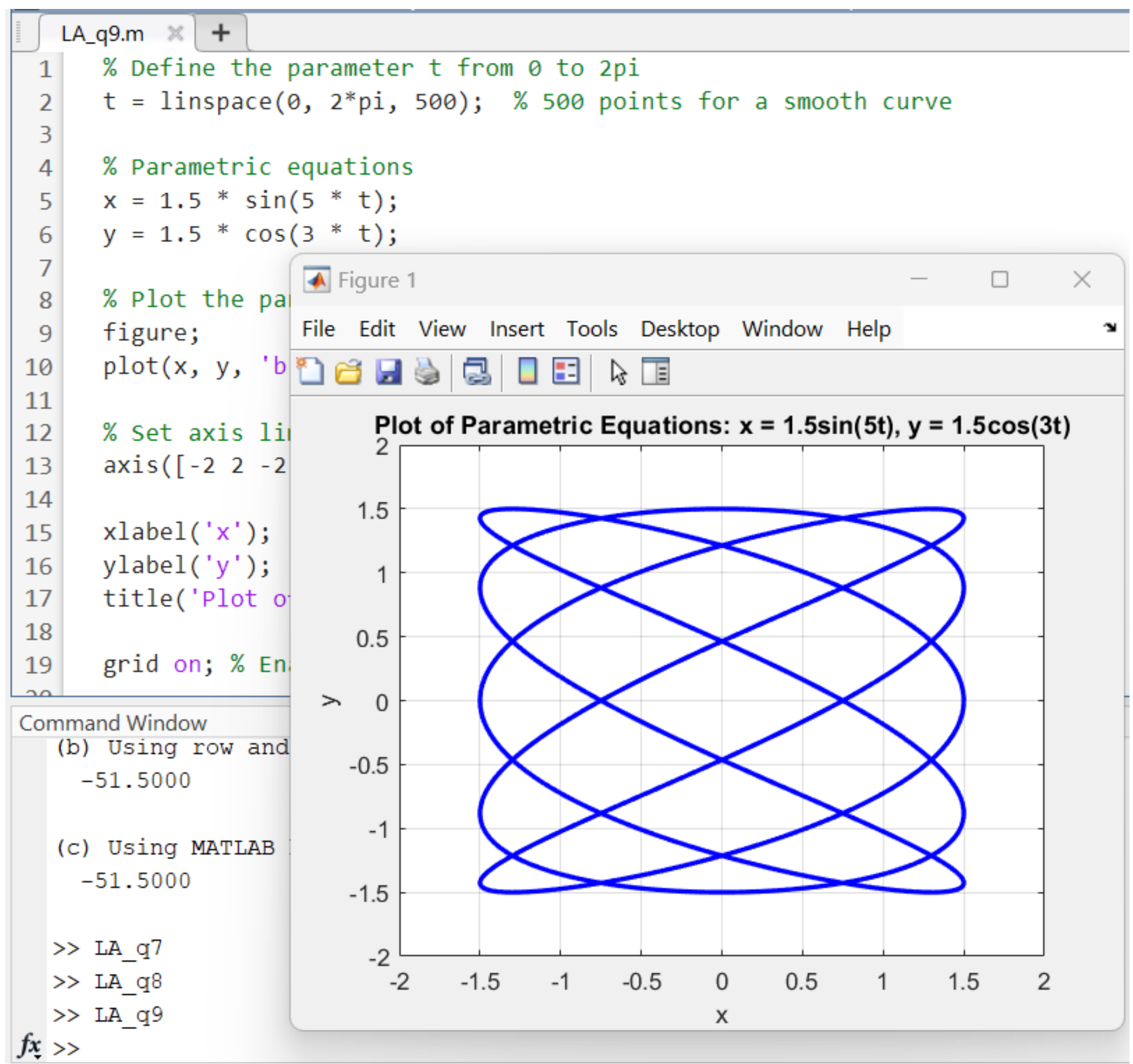
% Plot the parametric equations
figure;
plot(x, y, 'b', 'LineWidth', 2); % Plot in blue with line width of 2

% Set axis limits
axis([-2 2 -2 2]); % Set x and y axes to range from -2 to 2

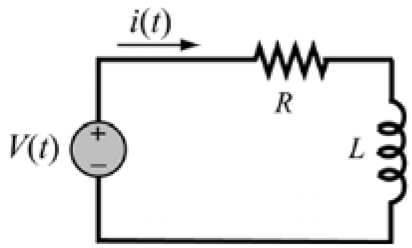
xlabel('x');
ylabel('y');
title('Plot of Parametric Equations: x = 1.5sin(5t), y = 1.5cos(3t)');

grid on; % Enable grid

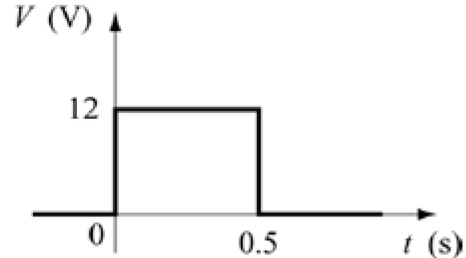
- **OUTPUT:**



10. A resistor, $R = 4\ \Omega$, and an inductor, $L = 1.3$ H, are connected in a circuit to a voltage source as shown in Figure (*a*) (an *RL* circuit). When the voltage



(*a*)



(*b*)

source applies a rectangular voltage pulse with an amplitude of $V = 12$ V and a duration of 0.5 s, as shown in Figure (*b*), the current $i(t)$ in the circuit as a function of time is given by:

$$i(t) = \frac{V}{R}(1 - e^{(-Rt)/L}) \quad \text{for} \quad 0 \le t \le 0.5 \text{ s}$$

$$i(t) = e^{-(Rt)/L}\frac{V}{R}(e^{(0.5R)/L} - 1) \quad \text{for} \quad 0.5 \le t \text{ s}$$

Make a plot of the current as a function of time for $0 \le t \le 2$ s.

- **PROGRAM:**

```
% Define given parameters
R = 4;         % Resistance
L = 1.3;       % Inductance
V = 12;        % Voltage

% Define time intervals
t1 = linspace(0, 0.5, 500);     % Time range for 0 <= t <= 0.5
t2 = linspace(0.5, 2, 500);     % Time range for 0.5 < t <= 2

% Compute current for each interval
i1 = (V / R) * (1 - exp(-R * t1 / L));  % For 0 <= t <= 0.5
i2 = exp(-R * (t2 - 0.5) / L) * (V / R) * (exp(R * 0.5 / L) - 1); % For 0.5 < t <= 2

% Combine time and current values
t = [t1, t2];
i = [i1, i2];

% Plot the current as a function of time
figure;
```

```
plot(t, i, 'b', 'LineWidth', 2);
xlabel('Time (s)');
ylabel('Current i(t) (A)');
title('Current i(t) vs. Time in an RL Circuit');
grid on;
```

- **OUTPUT:**