



MAT- 105

Vector Analysis

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Question 1

Determine the coefficients of the given polynomial $P(x) = a_0 + a_1x + a_2x^2$ Whose graph passes through the points (1, 3), (2, Last digit of your ID) and (3,8). Also plot the function using MATLAB command (having proper title, x and y axis notation).

Solution:

Given that,

$$p(x) = a_0 + a_1x + a_2x^2$$

So,

$$p(1) = a_0 + a_1 + a_2$$

$$p(2) = a_0 + 2a_1 + 4a_2$$

$$p(3) = a_0 + 3a_1 + 9a_2$$

And,

$$a_0 + a_1 + a_2 = 3$$

$$a_0 + 2a_1 + 4a_2 = 3$$

$$a_0 + 3a_1 + 9a_2 = 8$$

The augmented matrix is :

$$\begin{aligned} & \left(\begin{array}{ccc|c} 1 & 1 & 1 & 3 \\ 1 & 2 & 4 & 3 \\ 1 & 3 & 9 & 8 \end{array} \right) \\ &= \left(\begin{array}{ccc|c} 1 & 1 & 1 & 3 \\ 0 & -1 & -3 & 0 \\ 0 & -2 & -8 & -5 \end{array} \right) \quad r_2' = -r_1 - r_2, \quad r_3' = r_1 - r_3 \\ &= \left(\begin{array}{ccc|c} 1 & 1 & 1 & 3 \\ 0 & -1 & -3 & 0 \\ 0 & 0 & 2 & 5 \end{array} \right) \quad r_3' = 2r_2 - r_3 \\ &= \left(\begin{array}{ccc|c} 1 & 1 & 1 & 3 \\ 0 & 1 & 3 & 3 \\ 0 & 0 & 1 & -0.5 \end{array} \right) \quad r_3' = \frac{1}{2}r_3 \end{aligned}$$

So, the reduced system is :

$$a_0 + a_1 + a_2 = 3$$

$$-a_1 - 3a_2 = 0$$

$$2a_2 = 5$$

$$a_1 = -3 * (2.5) = -7.5$$

$$a_0 = -7.5 + 2.5 - 3 = -8$$

Therefore,

$$a_0 = -8$$

$$a_1 = -7.5$$

$$a_2 = 2.5$$

Solution using MATLAB:

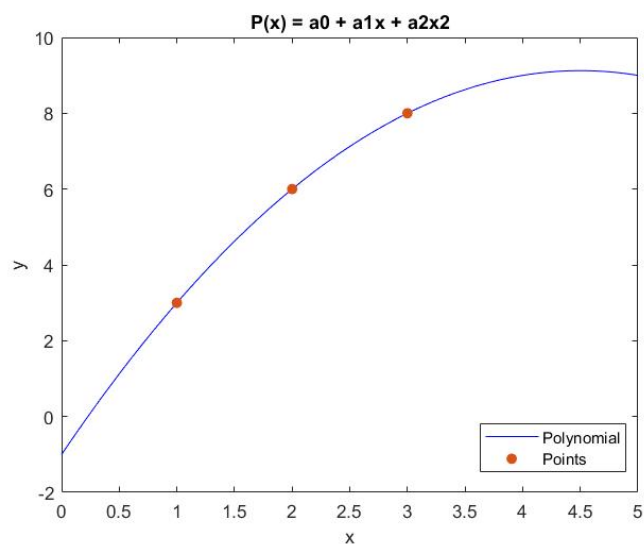
```
% Set points for x-axis and y-axis
x = [1, 2, 3];
y = [3 3 8]; % Last digit of ID: 3

coeffs = polyfit(x,y,2); % Get the coefficients of polynomial function

plot(0:0.1:5,polyval(coeffs,0:0.1:5),'b-'); % Plot the polynomial values in graph

%build the graph with labels, titles etc.
hold on; % Hold to not replace the older plot
scatter(x,y,'filled'); % Create a scatter with filled indicator
xlabel('x'); % Set the label for x-axis
ylabel('y'); % Set the label for y-axis
title('P(x) = a0 + a1x + a2x2'); % Set the title of the plot
legend('Points', 'Polynomial'); % Set legend for indicators
hold off;
```

Plot of the function:



Question 2:

Using suitable command encode the message “ABBREVIATIONS” by using matrix A given below:

$$= \begin{bmatrix} 1 & -1 & 1 \\ 1 & 1 & 0 \\ 1 & 2 & 1 \end{bmatrix}$$

Solution:

Given message “ABBREVIATIONS” with the key $A \begin{bmatrix} 1 & -1 & 1 \\ 1 & 1 & 0 \\ 1 & 2 & 1 \end{bmatrix}$

Where A = 1, B = 2, B = 2, R = 18, E = 5, V = 22, I = 9, A = 1, T = 20, I = 9, O = 15, N = 14, S = 19

Forming matrices with the above numbers,

$$\begin{bmatrix} 1 & 2 & 2 \end{bmatrix} \begin{bmatrix} 18 & 5 & 22 \end{bmatrix} \begin{bmatrix} 9 & 1 & 20 \end{bmatrix} \begin{bmatrix} 9 & 15 & 14 \end{bmatrix} \begin{bmatrix} 19 & 0 & 0 \end{bmatrix}$$

To encrypt

$$\begin{bmatrix} 1 & 2 & 2 \end{bmatrix} \begin{bmatrix} 1 & -1 & 1 \\ 1 & 1 & 0 \\ 1 & 2 & 1 \end{bmatrix} = \begin{bmatrix} 1 + 2 + 2 & -1 + 2 + 4 & 1 + 0 + 2 \end{bmatrix} \\ = \begin{bmatrix} 5 & 5 & 3 \end{bmatrix}$$

$$\begin{bmatrix} 18 & 5 & 22 \end{bmatrix} \begin{bmatrix} 1 & -1 & 1 \\ 1 & 1 & 0 \\ 1 & 2 & 1 \end{bmatrix} = \begin{bmatrix} 18 + 5 + 22 & -18 + 5 + 44 & 18 + 0 + 22 \end{bmatrix} \\ = \begin{bmatrix} 45 & 31 & 40 \end{bmatrix}$$

$$\begin{bmatrix} 9 & 1 & 20 \end{bmatrix} \begin{bmatrix} 1 & -1 & 1 \\ 1 & 1 & 0 \\ 1 & 2 & 1 \end{bmatrix} = \begin{bmatrix} 9 + 1 + 20 & -9 + 1 + 40 & 9 + 0 + 20 \end{bmatrix} \\ = \begin{bmatrix} 30 & 32 & 29 \end{bmatrix}$$

$$\begin{bmatrix} 9 & 15 & 14 \end{bmatrix} \begin{bmatrix} 1 & -1 & 1 \\ 1 & 1 & 0 \\ 1 & 2 & 1 \end{bmatrix} = \begin{bmatrix} 9 + 15 + 14 & -9 + 15 + 28 & 9 + 0 + 14 \end{bmatrix} \\ = \begin{bmatrix} 38 & 34 & 23 \end{bmatrix}$$

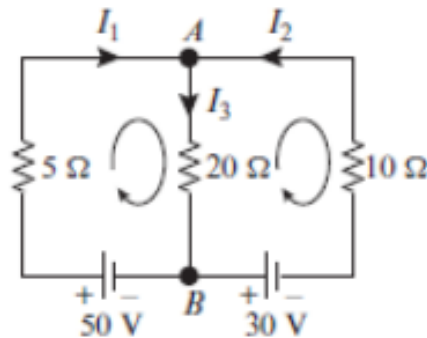
$$\begin{aligned}
 \begin{bmatrix} 19 & 0 & 0 \end{bmatrix} \begin{bmatrix} 1 & -1 & 1 \\ 1 & 1 & 0 \\ 1 & 2 & 1 \end{bmatrix} &= \begin{bmatrix} 19 + 0 + 0 & -19 + 0 + 0 & 19 + 0 + 0 \end{bmatrix} \\
 &= \begin{bmatrix} 19 & -19 & 19 \end{bmatrix}
 \end{aligned}$$

So, we have the following encrypted message:

5 5 3 45 31 40 30 32 29 38 34 23 19 -19 19

Question 3:

Determine the currents for the electrical network shown in the following figure:



Also solve the system by using MATLAB or any other programming language.

Solution:

From Kirchhoff's 1st law,

$$I_1 + I_2 - I_3 = 0$$

From Kirchhoff's 2nd law,

$$5I_1 + 20I_3 = 50$$

$$-10I_2 - 20I_3 = 30$$

So,

$$I_1 + I_2 - I_3 = 0$$

$$5I_1 + 0I_2 + 20I_3 = 50$$

$$0I_1 - 10I_2 - 20I_3 = 30$$

The augmented matrix is :

$$= \left(\begin{array}{ccc|c} 1 & 1 & -1 & 0 \\ 5 & 0 & 20 & 50 \\ 0 & -10 & -20 & 30 \end{array} \right)$$

$$= \left(\begin{array}{ccc|c} 1 & 1 & -1 & 0 \\ 0 & -5 & 25 & 50 \\ 0 & -10 & -20 & 30 \end{array} \right) \quad r_2' = -5r_1 + r_2$$

$$= \left(\begin{array}{ccc|c} 1 & 1 & -1 & 0 \\ 0 & 1 & -5 & -10 \\ 0 & -10 & -20 & 30 \end{array} \right) r_2' = -\frac{1}{5}r_2$$

$$= \left(\begin{array}{ccc|c} 1 & 1 & -1 & 0 \\ 0 & 1 & -5 & -10 \\ 0 & 0 & -70 & -70 \end{array} \right) r_3' = 10r_1 + r_3$$

$$= \left(\begin{array}{ccc|c} 1 & 1 & -1 & 0 \\ 0 & 1 & -5 & -10 \\ 0 & 0 & 1 & 1 \end{array} \right) r_3' = -\frac{1}{70}r_3$$

So, the reduced system is :

$$I_1 + I_2 - I_3 = 0$$

$$I_2 - 5I_3 = -10$$

$$I_3 = 1$$

$$I_2 = -10 + 5 \cdot 1 = -5$$

$$I_1 = 1 - (-5) = 6$$

Therefore,

$$I_1 = -5$$

$$I_2 = 6$$

$$I_3 = 1$$

Solution using MATLAB

```
% Define variables for values of the current
syms I1 I2 I3;

% Set the equations we have got according kirchhoff's law
eqn1 = I1 + I2 - I3 == 0;
eqn2 = 5*I1 + 0*I2 + 20*I3 == 50;
eqn3 = 0*I1 - 10*I2 - 20*I3 == 30;

% Get the solution using solve function for linear system
sol = solve([eqn1, eqn2, eqn3], [I1, I2, I3]);

% Display the solution for values of currents from the struct of sol
disp('The currents in the electronic networks are:');
disp(['I1 = ', char(sol.I1), ', I2 = ', char(sol.I2), ', I3 = ', char(sol.I3)]);
```

The currents in the electronic networks are:

I1 = 6, I2 = -5, I3 = 1