

ASSIGNMENT:-4

EECE:-212

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Level: 2

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Here are some mathematical problem are solved by MATLAB 2020a. according to the questions. The answers are given bellow:

1. For a system, following values of x and corresponding values of y are given: (1,1),(2,28),(3,64),(4,43),(5,70),(6,95),(7,127),(8,149) . Find the value of y when x=2.8 and x=7.7 using Newton's Forward and Backward Difference Interpolation Formula in Matlab.

Solution:

Here wanted to about the value of y when x=2.8 & x=7.7 using Newton's Forward and Backward Difference Interpolation Formula in Matlab.

Now using,

Forward method for x=2.8.

```

1 - close all
2 - clear all
3 - clc
4 - format long
5 - x=[1 :8];
6 - xx= 2.8;
7 - y=[1 28 64 43 70 95 127 149];
8 - d=length(x);
9 - table=zeros(d,d+1);
10 - table(:,1)=x;
11 - table(:,2)=y;
12 - table;
13 - dd=d-1;
14 - for i=3:d+1
15 -     for j=1:dd
16 -         table(j,i)=table(j+1,i-1)-table(j,i-1);
17 -     end
18 -     dd=dd-1;
19 - end
20 - table
21 - h=x(2)-x(1);
22 - p=(xx-x(1))/h;
23 - Y=y(1);
24 - for i=1:dd-1
25 -     prod=1;
26 -     for j=1:i
27 -         prod=prod*(p-(j-1));
28 -     end
29 -     Y=Y+prod*table(1,i+2)/factorial(i);
30 - end
31 - Y
32 -

```

Command Window:

```

New to MATLAB? See resources for Getting Started.

table =

     1     1    27     9   -66   171  -326   540  -839
     2    28    36   -57   105  -155   214  -299     0
     3    64   -21    48   -50    59   -85     0     0
     4    43    27    -2     9   -26     0     0     0
     5    70    25     7   -17     0     0     0     0
     6    95    32   -10     0     0     0     0     0
     7   127    22     0     0     0     0     0     0
     8   149     0     0     0     0     0     0     0

f =

67.301793279999998

fx >>

```

Workspace:

Name	Value
d	8
dd	0
f	67.3018
h	1
i	7
j	7
p	1.8000
prod	-10.2187
table	8x9 double
x	[1,2,3,4,5,6,7,8]
xx	2.8000
y	[1,28,64,43,70,95,127,...]

Backward method for x=7.7:

The screenshot shows the MATLAB environment with the Editor, Command Window, and Workspace. The Editor displays the script 'prac19.m' with the following code:

```
1 close all
2 clear all
3 clc
4 format long
5 x=[1:8];
6 Xinput= 7.7;
7 y=[1; 28; 64; 43; 70; 95; 127; 149];
8 d=length(x);
9 table=zeros(d,d+1);
10 table(:,1)=x;
11 table(:,2)=y;
12 table;
13
14 for i=3:d+1
15     for j=d:-1:i-1
16         table(j,i)=table(j,i-1)-table(j-1,i-1);
17     end
18 end
19 table
20
21 h=x(2)-x(1);
22 p=(Xinput-x(d))/h;
23 Y=y(d);
24 for i=1:d-1
25     prod=1;
26     for j=1:i
27         prod=prod*(p+(j-1));
28     end
29     Y=Y+prod*table(d,i+2)/factorial(i);
30 end
31 Y
32
```

The Command Window shows the output of the 'table' variable as an 8x9 double matrix:

```
table =
    1    1    0    0    0    0    0    0    0
    2   28   27    0    0    0    0    0    0
    3   64   36    9    0    0    0    0    0
    4   43  -21  -57  -66    0    0    0    0
    5   70   27   48  105  171    0    0    0
    6   95   25   -2  -50 -155 -326    0    0
    7  127   32    7    9   59  214  540    0
    8  149   22  -10  -17  -26  -85 -299 -839
```

The Command Window also shows the output of the 'Y' variable as a scalar value:

```
Y =
1.708980768137500e+02
```

The Command Window prompt is `fx >>`.

The Workspace shows the following variables and their values:

Name	Value
d	8
h	1
i	7
j	7
p	-0.3000
prod	-95.5447
table	8x9 double
x	[1,2,3,4,5,6,7,8]
Xinput	7.7000
y	[1;28;64;43;70;95;127;149]
Y	170.8981

The value,

Y= 67.301793279999998; [when X=2.8]

Y= 1.708980768137500e+02; [when x=7.7]

2. Solve the above problem by hand calculation.

Solution:

Here have to write down the hand calculation of the following function equation. First its done by **newton forward method**. When **x=2.8**.

So the equation for newton forward method is:

$$y_n(x) = y_o + p\Delta y_o + \frac{p(p-1)}{2!}\Delta^2 y_o + \frac{p(p-1)(p-2)}{3!}\Delta^3 y_o + \dots + \frac{p(p-1)(p-2)\dots(p-n+1)}{(n)!}\Delta^n y_o$$

Where $x = x_0 + ph$, h=difference between two successive values of x.

$$p = \frac{x-x_0}{h} = 1.8000000000$$

The values of $\Delta y_o, \Delta^2 y_o, \Delta^3 y_o \dots \Delta^n y_o$ Can be found from the following forward difference Table (Table-1).

1	1	27	9	-66	171	-326	540	-839
2	28	36	-57	105	-155	214	-299	0
3	64	-21	48	-50	59	-85	0	0
4	43	27	-2	9	-26	0	0	0
5	70	25	7	-17	0	0	0	0
6	95	32	-10	0	0	0	0	0
7	127	22	0	0	0	0	0	0
8	149	0	0	0	0	0	0	0

$\Delta y_0 = y_1 - y_0; \Delta y_1 = y_2 - y_1; \Delta y_2 = y_3 - y_2; \Delta^2 y_0 = \Delta y_1 - \Delta y_0; \Delta^3 y_0 = \Delta^2 y_1 - \Delta^2 y_0$ And so on.....

The hand calculation is:

y

$$\begin{aligned} &= 1 + 1.800000 * 27 + \frac{1.800 * (1.800 - 1) * 9}{2!} \\ &+ \frac{1.800 * (1.800 - 1)(1.800 - 2) * (-66)}{3!} \\ &+ \frac{1.800 * (1.800 - 1)(1.800 - 2)(1.800 - 3) * (171)}{4!} \\ &+ \frac{1.800 * (1.800 - 1)(1.800 - 2)(1.800 - 3)(1.800 - 4) * (-326)}{5!} \\ &+ \frac{1.800 * (1.800 - 1)(1.800 - 2)(1.800 - 3)(1.800 - 4)(1.800 - 5) * (540)}{6!} \\ &+ \frac{1.800 * (1.800 - 1)(1.800 - 2)(1.800 - 3)(1.800 - 4)(1.800 - 5)(1.800 - 6) * (-839)}{7!} \end{aligned}$$

$$= 67.301793279999998$$

(Answer.)

Now for X=7.7;

It's done with **newton backward** method.

So the equation for newton backward method is:

$$y_n(x) = y_o + p\nabla y_n + \frac{p(p+1)}{2!}\nabla^2 y_n + \frac{p(p+1)(p+2)}{3!}\nabla^3 y_n + \dots + \frac{p(p+1)(p+2)\dots(p+n-1)}{(n!)}\nabla^n y_n$$

Where, $x = x_n + ph$, h=difference between two successive values of x.

$$p = \frac{x-x_0}{h} = -0.300000$$

Values of $\nabla y_n, \nabla^2 y_n, \nabla^3 y_n, \dots, \nabla^n y_n$ Can be found from the following backward difference Table (Table-2).

1	1	0	0	0	0	0	0	0
2	28	27	0	0	0	0	0	0
3	64	36	9	0	0	0	0	0
4	43	-21	-57	-66	0	0	0	0
5	70	27	48	105	171	0	0	0
6	95	25	-2	-50	-155	-326	0	0
7	127	32	7	9	59	214	540	0
8	149	22	-10	-17	-26	-85	-299	-839

$\nabla y_1 = y_1 - y_0; \nabla y_2 = y_2 - y_1; \nabla^2 y_2 = \nabla y_2 - \nabla y_1; \nabla^3 y_3 = \nabla^2 y_3 - \nabla^2 y_2$ and so on.....

The hand calculation is:

$$\begin{aligned}
 y &= 1 + -0.300000 * 22 + \frac{-0.300 * (-0.300 + 1) * -10}{2!} \\
 &+ \frac{-0.300 * (-0.300 + 1)(-0.300 + 2) * (-17)}{3!} \\
 &+ \frac{-0.300 * (-0.300 + 1)(-0.300 + 2)(-0.300 + 3) * (-26)}{4!} \\
 &+ \frac{-0.300 * (-0.300 + 1)(-0.300 + 2)(-0.300 + 3)(-0.300 + 4) * (-85)}{5!} \\
 &+ \frac{-0.300 * (-0.300 + 1)(-0.300 + 2)(-0.300 + 3)(-0.300 + 4)(-0.300 + 5) * (-299)}{6!} \\
 &+ \frac{-0.300 * (-0.300 + 1)(-0.300 + 2)(-0.300 + 3)(-0.300 + 4)(-0.300 + 5)(-0.300 + 6) * (-839)}{7!}
 \end{aligned}$$

$$= 1.708980768137500e+02$$

(Answer.)