Chapter - 5.

Numerical Method

Aim to find approximate values.

2 - variable

f(x)=y, next term add h with x.

ナスナト

1 = Del.

 ∇ = Tel (nelpha).

E = Shifting operator

Forward Diff . operator.

(FDO) ⇒ ∆

Dyn = Ynti - Yn

fruit Diff = a'

eg: 040=4, -40

(2) f(x)= f(x+1)- f(x)

Him) s: 4: DC=0, +11 ((;Cx)) = C - Of(x)).

* 5m 5n f(x)= 2 m+n f(x).

* & (f(x) g(x)) = f(x) & g(x) + g(x) & f(x).

* $\Delta \frac{f(\alpha)}{g(\alpha)} = \frac{g(\alpha) \cdot g(\alpha) - f(\alpha) \cdot a \cdot g(\alpha)}{g(\alpha) \cdot g(\alpha+h)}$

 $\Delta^2 y_n = \Delta y_{n+1} - \Delta y_n$

 $\Delta^3 Y_n = \Delta^2 Y_{n+1} - \Delta^2 Y_n.$

DK+1 Gn = D Ynt1 - DK

A LOCAL DESIGNATION OF THE PARTY OF THE PART	-		. 5
χ	y f(a)	Δy	23, 234, 24y 25y
20	40		ENIM Li FAMIN
24	y,	OYO	Δ ² γο 3
72	42	۵4,	A 40
λ_3	43	ΔY_2	3y,
24	y ₄	Δ43	Δ ³ γ, Δ ⁴ γ,
75	45	044	16
			(39 N

Backward diff operation.

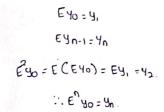
 $\nabla f(\alpha + \eta h) = \nabla^{n} f(x)$.

Shifting operator: E'Con

Displacement operator: E(f(xo) = f(xoth) E f(a) = f(x+h)

$$\stackrel{\text{Eh}}{\text{f(x)}} = f(x+nb).$$

$$\stackrel{\text{Eh}}{\text{f(x)}} = f(x-nb).$$



1) 'A = E-1

ir) ED=DE.

·iii) 저를 탈.

Eg : 5.1

FDO Table

$$\frac{1}{20}$$
 $\frac{1}{20}$ $\frac{1}{20}$

Eq: 542:

$$y = f(x) = x^3 + 2x + 1$$
. $x = 1, 2, 3, 4, 5$.
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To : 5 2	
Eg : 5.3	
x y Dy Dy By By	Δ ⁵ γ,
1 8	
2 12 3	
7 0	1
3 19 3	
4 29 3	
5 42 K-55	
K-42	
Gn 2nd Ps Constant.	
K = 28 · K - 22 = 3 ·	

1.
$$\Delta (\log \alpha x)$$
.
 $\Delta f(x) = f(x+h) - f(x)$.
 $\Delta (\log \alpha x) = \log (\alpha x+h) - \log f(\alpha x)$.
 $= \log \frac{\alpha x+h}{\alpha x}$.
 $= \log \left(\frac{\alpha x}{\alpha x} + \frac{h}{\alpha x}\right)$

: 6th + mm is 58.

=
$$\log \left(1 + \frac{h}{ax}\right)$$
.

4.
$$f(x) : x^{2} + 3x$$
 .57 $: \Delta f(x) = 2x + 4$

$$f(x) : x^{2} + 3x$$

$$\Delta f(x) : \Delta (x^{2} + 3x)$$

$$\vdots \left[\Delta f(x) = f(x + h) - f(x) \right].$$

$$= (x + h)^{2} + 3(x + h) - (x^{2} + 3x)$$

$$= x^{2} + h^{2} + 2xh + 3x + 3h - x^{2} - 3x$$

$$= h^{2} + 2xh + 3h$$

$$\vdots \left[h = 1 \right]$$

$$= 1 + 2x + 3(1)$$

$$= 2x + 4$$

$$\vdots \left[\text{Nence Braned} \right].$$

$$f(x) : \Delta f(x + h)$$

$$f(x) : \Delta f(x + h)$$

$$= (x - 1 + 1) - (x - 1)^{3}$$

$$= x^{3} - (1x^{3} - 3x^{2} + 3x - 1)$$

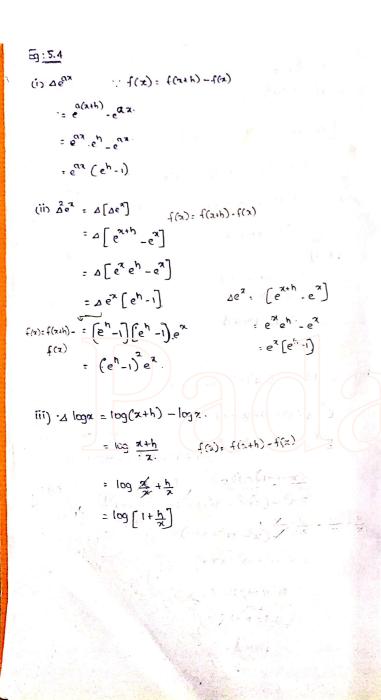
$$= 3^{3} - (x^{3} - 3x^{2} + 3x - 1)$$

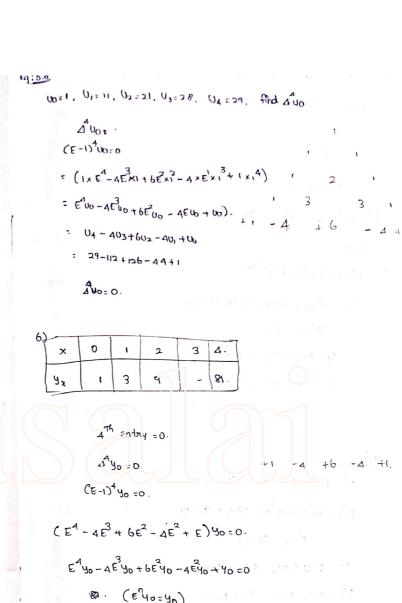
 $= x^3 - x^3 + 3x^2 - 3x + 1$

= 3x2-3x+1.

... L.H.S = R.H.S

Browd.





44 - 443+ 642-441, +40=0 81 - 443+ (6×9) "-(4×3)+1=0

+4 43 = + 124

430.

```
y, = 3.
8.
                           15 35
                                                                       (D=> 44-44,=12
    y=f(x)
                                                                            44 - 4(3)=12
                                                                                4-12=12
        . A44 = 0.
                                                                                    y4 = 24.
        (E-1) 4K=0.
 (E4-4E3+6E2-4E+1) 4K=0.00
                                                                    터:<u>5</u>...
                                                                                                                           1967
    (E-4E3+6E-4E+1)40=0
                                                                                                                    1966
                                                                                                     1964
                                                                                              1963
                                                                                1961
                                                                                       1962
                                                                     year a
      EAY0-4E40+6E40-4E40 +40=0
                                                                                                             350
                                                                    Production
                                                                       C4)
            (E'yo = yn)
           74-443 1642 - 44, +40=0.
                                                                                           = en nies =0.
            (15×4) (6:8).
4., -60+ 48-44, +0=0
                 ya - 44, =12. . . (1).
                                                                                  (E-1) 4K=0.
                                                                         (E' - 5E"+10E3 - 10E7+5E1-1)41x=0.
       K=1
        (E4-4E3+6E2-4E+1)41=0.
                                                                        (E40- 5E40+10E40 - 10E40+5E140-40)=0
          E4, -484, +684, -484, +14, =0
                                                                                45-544 + 1043 - 1042 + 541 - 40 =0 .
                 (Ey, = 4n+1) -01/3 + 3A
                                                                                45 - 5(350) + 1043 - 10(260) + 5(220) -20020
            45 - 4 44 + 643 - 442 + 4+=0 + - ar 30 + al
                                                                                     45 + 1043 = 3450 .. 4. (1) . . . . .
            35 - 44 +90 - 32+41=0 ( 0 0)
                  -444 +41 = -93 2 .. (2) - 1 - + 21 - 11
                                                                         (E 41 - 5E 41 + 10E 41 - 10E 41 + 5E 41 - 41)=0
                             (-11-(1×A)-(P+0)+ + +++
                                                                                46 - 545 +1044 - 1043+542 -41 =0
        (a) -> -444 + 441 =93
  4×(2) -> 44-164, =48
                                                                                   430-545+10(350)-1043+5(260)-220=0
                  -1541 = -45 4 st
                                                                                         - 545 - 1043 = -5010 . . . (2)
```

$$\begin{array}{lll}
& 2(n^{2}+47+3)-1(n^{2}+52+6)-1(n^{2}+97+2) \\
& (2n1)(2n2)(2n3) \\
& = 2n^{2}+85+6-2-5x-6-2^{2}-3x-2 \\
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& = -2 \\
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$$G_{1} = G_{1} + A_{1}(G_{1}) + A_{2}^{2} G_{1}(G_{1}) + A_{3}^{2} G_{1}(G_{1})$$

$$A_{1}(G_{1}) = A_{1}(G_{1}) + A_{2}^{2} G_{2}(G_{1})$$

$$f(G_{1}) = f(G_{1}) + A_{3}^{2} G_{2}(G_{1})$$

$$f(G_{1}) = f(G_{1}) + A_{3}^{2} G_{2}(G_{2})$$

$$= f(G_{2}) + A_{3}^{2} G_{2}(G_{2}) + A_{3}^{2} G_$$

=
$$-2(x^2+122+7x)-(x^2+82+6x)+3(x^2+62+5x)$$
.

$$= -2x^{2} - 24 - 14x - x^{2} - 8 - 6x + 3x^{2} + 18 + 15x$$

$$(x+2)(x+3)(x+4)$$



Newton's Newton's Backward. forward

$$f(20+nh) = f(0) + \frac{n}{1!} \Delta f(20) + \frac{n(n-1)}{2!} \Delta^2 f(20) + \cdots$$

$$n=\frac{2-i0}{h}$$

Backward:

$$f(x_n+nh)=f(x_n)+\frac{n}{1!} of(x_n)+\frac{n(n+1)}{2!}.o^2f(x_n)+.$$

$$y(x_n+h) = y_n + \frac{n}{1!} dy_n + \frac{n(n+1)}{2!} d^2y_n + \dots$$

lagrango's Interpolation formula:

$$y = f(x) = \frac{(x - x_1)(x - x_2)(x - x_1, \dots, (x - x_n))}{(x_0 - x_1)(x - x_2) \dots (x_0 - x_n)} e_{0} + \frac{(x - x_0)(x - x_2) \dots (x - x_n)}{(x_1 - x_0)(x_1 - x_2) \dots (x_n - x_n)}$$

$$\frac{(x-x_0)(x-x_1)...(x-x_{n-1})}{(x_n-x_0)(x_n-x_1)...(x_n-x_{n-1})}...y_n$$

```
12.
 E(x)
  20 = 3 , x1=7, x2=11, x3=19
  40 =42. 41=43, 42=47, 44 = 60
    lagranges:
   =\frac{(x-x_1)(x-x_2)(x-x_3)}{(x_0-x_1)(x_0-x_2)(x_0-x_3)}y_0+\frac{(x-x_0)(x-x_2)(x-x_3)}{(x_1-x_2)(x_1-x_3)}y_1
      + \frac{(x-x_0)(x-x_1)(x-x_3)}{(x_2-x_0)(x_2-x_1)(x_2-x_3)} y_2 + \frac{(x-x_0)(x_2-x_1)(x_2-x_2)}{(x_3-x_0)(x_3-x_1)(x_2-x_2)} y_3 = \frac{(x_1-x_0)(x_2-x_1)(x_2-x_2)}{(x_3-x_0)(x_3-x_1)(x_2-x_2)}
       = (8)(4)(+A)
(42) + (12)(4)(-4)(43)+
(A)(-8)(-12)
           (2) (8) (AT) + (12) (8) (A) (66).
           = + 10.5 043 +70.5+15
                    when 2=15, Y=53.
                          19837 1984 1985
               1982
    f(\alpha)
                          235 , d 365 , 525 , log 1 = 10 1
              CF-F ((or x) , (or x) , x x/ 18 Gn = (x)), , ;
(12 30 = 1982 ) XIF 1983, X22 1984, M3= 1986. (18). Z= 1985.
    40 = 150 , 41=235, 43=365, 44=525.
```

```
lagrange: (5) (3)(3)(4)(6)
     \frac{(\chi_{a}-\chi_{0})(\chi_{a}-\chi_{1})(\chi_{1}-\chi_{2})}{(\chi_{0}-\chi_{0})(\chi_{2}-\chi_{1})(\chi_{2}-\chi_{2})}(\chi_{a}) + \frac{(\chi_{a}-\chi_{0})(\chi_{2}-\chi_{1})(\chi_{2}-\chi_{2})}{(\chi_{0}-\chi_{0})(\chi_{3}-\chi_{1})(\chi_{2}-\chi_{2})}(\chi_{2})}(\chi_{2})
      =\frac{(3)(1)(-1)}{(4)(-1)(-1)}(150) + \frac{(3)(1)(-1)}{(1)(-1)(-3)}(235) + \frac{(3)(3)(-1)}{(2)(2)(-2)}(365)
           +\frac{(3)(2)(1)}{(4)(3)(2)} (525).
         = 593.75
10. x=26, x0=15, x1=25, x2=30, x3=35.
                           40= 30 . 41=40, 40=45. 43=48.
    Lagrancie:
    = \frac{(x-x_1)(x-x_2)(x-x_3)}{(x-x_1)(x-x_2)(x-x_3)} (y_0) + \frac{(x_1-x_0)(x-x_2)(x-x_3)}{(x_1-x_0)(x-x_2)(x-x_3)} (y_1).
      (20-24)(20-22)
                                                                          25 - 15 26 - 30 26 - 35
      \frac{(x_0 - x_1)(x_0 - x_2)(x_0 - x_3)}{(x_1 - x_1)(x_1 - x_3)} + \frac{(x_1 - x_2)(x_1 - x_1)(x_2 - x_3)}{(x_2 - x_0)(x_2 - x_1)(x_2 - x_3)} 
 \frac{(x_2 - x_0)(x_2 - x_1)(x_2 - x_3)}{(x_1 - x_1)(x_2 - x_3)} + \frac{(x_1 - x_0)(x_2 - x_1)(x_2 - x_2)}{(x_2 - x_0)(x_3 - x_1)(x_3 - x_2)} 
 \frac{(x_1 - x_0)(x_2 - x_1)(x_2 - x_3)}{(x_1 - x_0)(x_2 - x_1)(x_3 - x_3)} = \frac{(x_1 - x_0)(x_1 - x_1)(x_2 - x_2)}{(x_1 - x_0)(x_2 - x_1)(x_3 - x_2)} 
                                                            \frac{(21)(-4)(-9)}{(10)(-5)(-10)}(40) + \frac{(11)(1)(-4)}{(15)(5)(-5)}(45)
          = (1)(-4)(-9) (36)+
                                                                                                + (11)(1)(-4) (48).
```

X=1986, X0=1974, X1=1978, X2=1982, X3=1990 9. 40= 25, 41=60, 42=80, 43=170.

$$\frac{(4\chi_{1})(4)}{(4\chi_{1}+4\chi_{2})}(12)+\frac{(2\chi_{1})(4)}{(4\chi_{2})(2\chi_{2})}(13)+\frac{(2\chi_{1})(4\chi_{2})}{(4\chi_{2})(2\chi_{2})}(14)+\frac{(2\chi_{1})(4\chi_{2})}{(4\chi_{2})(2\chi_{2})}(16)$$

=2-4.33+11.67+5.33

= 14.67.

5 (x)

: sprange

$$=\frac{(8)(4)(-4)}{(4)(-4)(-4)}(25)+\frac{(12)(4)(-4)}{(4)(-4)(-4)}(60)+\frac{(12)(8)(-4)}{(8)(4)(-8)}(80)$$

= 127.5

9(11) = 40+ 11 240 + 1 (1-1) 240 + 1 (1-1) 2310+

Eg: 5.22

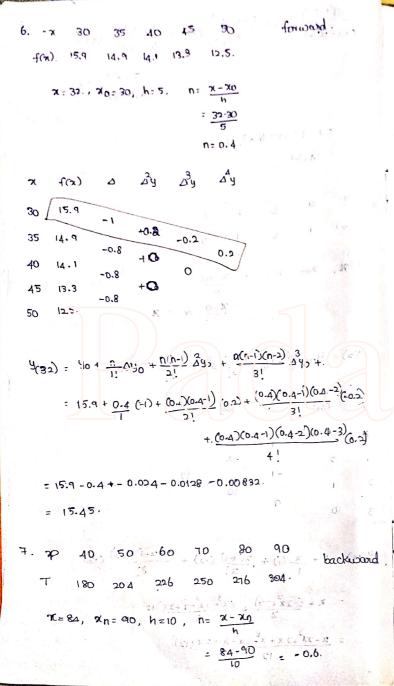
=
$$\frac{(x-x_1)(x-x_2)(x-x_3)}{(x_0-x_1)(x_0-x_2)(x_0-x_3)}$$
 (40) + $\frac{(x-x_0)(x-x_2)(x_0-x_3)}{(x_1-x_0)(x_1-x_2)(x_1-x_3)}$ (4)

$$\frac{+(x-x_0)(x-n_1)(x-x_3)}{(x_2-x_0)(x_2-x_1)(x_2-x_3)}(42)+\frac{(x-x_0)(x-x_1)(x-x_2)}{(x_3-x_0)(x_3-x_1)(x_3-x_2)}$$

$$y(x) = 1 + \frac{\pi}{2}(1) + \frac{\pi(x-1)(x-2)}{2!}(-2) + \frac{\pi(x-1)(x-2)}{3!}(-2) = \frac{\pi(x-1)(x-2)}{3!}(-$$

=
$$\frac{x + (-2x^{2} + 2x)}{2} + (\frac{x^{3} - 2x^{2} - x^{2} + 2x}{2}) = \frac{1 + x - 2 + x}{2}$$

= $\frac{x - 2x^{2} + 2x + x^{3} - 2x^{2} - x + 2x}{12}$ = $\frac{x - 2x^{2} + 2x + x^{3} - 2x^{2} - x + 2x}{12}$ = $\frac{x - 2x^{2} + 2x + x^{3} - 2x^{2} - x + 2x}{12}$



```
fai
      180
40
            24.
      204
50
           23
60
           124
70
           26
     276
80
    304
n(n+1)(n+2)(n+3) + +
    = 30.4 + 28(-0.5)(28) + \frac{(-0.6)(-0.61)}{2!}(2) + 0 + 0 + .
                         (-0.6)(-0.6+)(-0.6+2)(-0.6+3)(-0.6+4) (A)
   = 304 - 16.8 - 0.24 - 0.0914.
   = 286.86.
```

$$x = f(x)$$
 $\Delta = \Delta y = \Delta y$
 $0 = 1$
 $1 = 2$
 $2 = 11$
 $3 = 34$

$$y(5.8) = y_0 + \frac{n}{1!} \Delta y_0 + \frac{n(n+1)}{2!} \Delta y_0 + \frac{n(n+1)(n+2)}{3!} \Delta^3 y_0.$$

$$= 34 + (-0.2)(23) + \frac{(-0.2)(-0.2+1)(-0.2+2)}{2!} (14) + \frac{(-0.2)(-0.2+1)(-0.2+2)}{3!} (6)$$

$$x=3:2$$
, $x_0=3$, $h=1$, $h=\frac{x-x_0}{h}=\frac{3.2-3}{3}$

$$y_{(3,2)} = y_0 + \frac{n}{1!} gy_n + \frac{n(n-1)}{2!} gy_n + \frac{n(n-1)(n-2)}{3!} gy_n + \frac{3!}{3!}$$

$$= 16 + \frac{0.2}{1!} (4) + 0 + \frac{(0.2 \times 0.2 - 1)(0.2 - 2)}{3!} (10)$$

$$= 16 + 0.8 + 0.48$$

$$= 17.28$$

$$x=45$$
, $x_0=40$, $h=10$, $n=\frac{x-x_0}{h}$

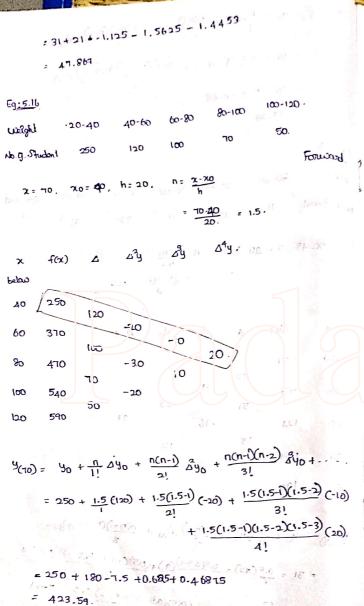
$$=\frac{45-40}{10}=$$

$$y_{(A5)} = y_0 + \frac{n}{1!} (Ay_0) + \frac{n(n-1)}{2!} A_{y_0}^2 + \frac{n(n-1)(n-2)}{3!} A_{y_0}^3 + \dots$$

$$= 31 + \frac{0.5}{2} (42) + \frac{0.5(0.5-1)}{2} (9) + \frac{(0.5)(0.5-1)(0.5-2)}{3!} (0.5) (0.5-2) (0.5-3) (33).$$

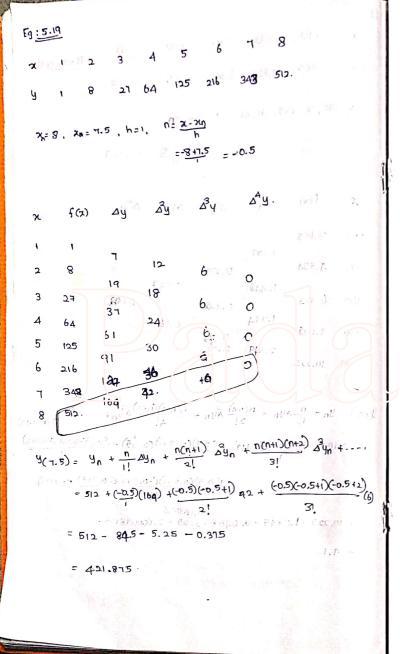
$$(0.5)(0.5-1)(0.5-2) (0.5-3) (33).$$

$$4!$$



Fg:5.13. Round Ä 98752 33533 28 38 190, 1,32,285 -10455 35791 - 81,11 1,62,016 1911 30983 1,95,570 22736 50380 2,16,050 $y_{(1905)} = y_0 + \frac{\eta}{1!} \Delta y_0 + \frac{\eta(\eta-1)}{2!} \Delta y_0 + \frac{\eta(\eta-1)(\eta-2)}{3!} \Delta y_0 + \frac{\eta(\eta-1)(\eta-2)}{$ + 1·4(1·4-1)(1·4-2)(1·4-3) (41438).

				Is		The same of the sa				
Eg : 5.17	1921	1481	Paramay 1991	G: 5.18						/ s.2
× 1941 1951	1961 1971	WR		2	140	150	160	OFI	180	Backward
y 20 24	29 36	46	51	5(0)	3,685	4.854	6.302	8.016	(0,525 -	
7=1946. · x0=194	* አና	λ 180, χ = 175, h = 10 . η = χ = - 20								
4	1 805	= 1946-1	94] = 0.5	o			:	175-180	: -0.5	
		ηE					,		0	
% Y ∆y	$\Delta^{3}y \qquad \Delta^{3}y$	AY	Δ^{5} y.	30	$f(\alpha)$	Δy	$\Delta^2 y$	∆ ³ y	Δ ⁴ y	
1941 20		F 2183	ar en	140	3.685	1.169				
1951 24	eco I		PSC CEIL	, 150	д,854	1.448	0.279	0.043		
1961 29	2	Olives	-9,7,00	19 160	6.302	1.774	0.326.	0.0	0.00)
1971 36	3	-digital	ora, EP.L. In	סרו	8.072	2 189	0 315	04	, 5 H	
1981 46	-5	56336	050048 15	· 190	10.2.15.		0			
(વવા. કા					•		n41) 3.	n(n+i)0	n+2) 3	8-1
took and	1 645 " Office 1	0)17 + nV6.	Crob Vanco	12					1 42 A3 4 .	(0.049)
y(1946)= 40 + 11 24	0 + n(n-1) 2yo	1 (n-1)(r	1-2) 2340 +		10.225+	(-0.5) (2.1				<u>5)(-0.5+1)(</u> -0.5+2)
18.	Ç.,	7		(5) -	o Vincer				-0.5+2)(-0.	<u>5+3</u>) (0.∞2).
	0.5(0.5-1) (1) + 0.5				0.225 - 1.	0745 - 0.	. 0468 -	0.0030625 225 - 0.	000048125.	
Sur 5 6 6 6	A. 282 + 0.5(0.	5-1)(0.5-2)	(co. 5-3) (o.5-4)(co	9).			er.		- M.Jr.	
	_	5!	North Section	=	9.1.				218.15	
= 20+2 + - 6.025										
= 21,691407	•									
	West and									



```
Eg: 5.20
                                                                   backword.
  Age
Promium
                                  δq
            F(X)
           114.84
  45
                       -18.68
          96.16
                      -12.84
                                                       0.68
          83.32
  55
                      . 8.84
          74.48
           58.48
A^{(63)} = AA^{U} + \frac{U}{U} AA^{U} + \frac{U(U+1)}{U(U+1)} A^{A}^{U} + \frac{U(U+1)(U+2)}{3!} A^{A}^{U} + \cdots
                                 + (-0.4)(-0.4+1)(-0.4+2)(0.4+3) (0.68)
       68.48 +2.4 -0.3408 +0.07424 -0.02828
          70. 585
```

