

Solved Example

Example 5.1.1 A slider in a machine moves along a fixed straight rod. Its displacement x cm along the rod is given below at different instant of time in seconds. Find velocity of slider and its acceleration at $t = 0.3$ sec and $t = 0.2$ sec.

t	0	0.1	0.2	0.3	0.4	0.5	0.6
x	30.13	31.62	32.87	33.64	33.95	33.81	33.24

Solution:

The difference table is as shown below

t	x	Δ	Δ^2	Δ^3	Δ^4	Δ^5	Δ^6
0	30.13						
		1.49					
0.1	31.62		-0.24				
		1.25		-0.24			
0.2	32.87		-0.48		0.26		
		0.77		0.02		-0.27	
0.3	33.64		-0.46		-0.01		0.29
		0.31		0.01		0.02	
0.4	33.95		-0.45		0.01		
		-0.14		0.02			
0.5	33.81		-0.43				
		-0.57					
0.6	33.24						

Since the derivative is required near the middle of table we use Stirling's formula;

$$\left(\frac{dy}{dx} \right)_{x_0} = \frac{1}{h} \left[\frac{\Delta y_0 + \Delta y_{-1}}{2} - \frac{1}{6} \frac{\Delta^3 y_{-1} + \Delta^3 y_{-2}}{2} + \frac{1}{30} \frac{\Delta^5 y_{-2} + \Delta^5 y_{-3}}{2} + \dots \right] \quad (1)$$

and