ASSIGNMENT - 1

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Subject : Numerical Methods for Engineers

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Que 1 The flow rate, Q in a pipe system connecting two reservoirs is described by the equation $Qe^Q - 1 = 0$. Approximate the real root of the eq? in the interval $0 \le Q \le 1$

Soln Let $Q_0 = 1$

$$f'(Q) = [Qe^Q + e^Q] - 0$$
$$= Qe^Q + e^Q$$

$$f'(Q_0) = 1 \cdot e^1 + e^1 = 2e^1 = 2 \times (2.7182)$$
$$= 5.43656$$

First iteration $Q_1 = Q_0 - \frac{f(Q_0)}{f'(Q_0)}$

$$= 1 - \frac{(2.7182 - 1)}{5.43656}$$

$$= 0.6839$$

Second iteration $Q_2 = Q_1 - \frac{f(Q_1)}{f'(Q_1)}$

$$= 0.6839 - \frac{(e^{0.6839} \times (0.6839) - 1)}{2 \times e^{0.6839}}$$

$$= 0.6839 - \frac{1.7104}{3.9632}$$

$$= 0.2523$$

Third iteration: $q_3 = q_2 - \frac{f(q_2)}{f'(q_2)}$

$= 0.2523 - \frac{(e^{0.2523} \times 0.2523 - 1)}{2 \times e^{0.2523}}$

$= 0.2523 - \frac{(-0.0753)}{(2.57396)}$

$= 0.51466$

Fourth iteration: $q_4 = q_3 - \frac{f(q_3)}{f'(q_3)}$

$= 0.5147 - \frac{(e^{0.5147} \times 0.5147 - 1)}{2 \times e^{0.5147}}$

$= 0.5147 - \left[\frac{-0.00386}{3.3462}\right]$

$= 0.5147 + \frac{0.1388}{3.3462}$

$= 0.55618$

Approx real root can be $\approx$ 0.55618

2. Estimate the minimum weight of a bib taps when bore is 20 mm using:

Bore (in mm)	8	10	15	25	32	40	50
Weight (in kg)	0.25	0.30	0.40	1.25	1.70	2.15	3.65

x	y	Δ	Δ^2	Δ^3	Δ^4	Δ^5
8	0.25					
		0.025				
10	0.30		−0.000102	2.60×10^{-4}		
		0.02		2.60×10^{-4}		
15	0.40		0.00433		4.16×10^{-7}	
		0.085		2.52×10^{-4}		1.028×10^{-7}
25	1.25		−0.00121		3.73×10^{-6}	
		0.0643		1.377×10^{-3}		-0.185×10^{-5}
32	1.70		0.03321		-3.4×10^{-4}	
		0.5625		−0.01049		
40	2.15		−0.2292			
		0.15				
50	3.65					

Using Newton's divided difference formula eg.

$$f[x_1, x_2] = \frac{f_2 - f_1}{x_2 - x_1}$$

And finally

$$\Delta^6 = \frac{(-0.[illegible]5\times10^{-5} - 1.028\times10^{-7})}{(50-8)} = -2.75\times10^{-7}$$

Using Newton's Divided formula.

$$f(20) = f(x_0) + f(x - x_0)\, f[x_0, x_1] + f(x-x_0) f(x - x_1)\, f[x_0, x_1, x_2] + \cdots$$

$$= 0.25 + (20-8)(0.025) + (12)(20-10)(-0.000702) +$$
$$12\times10\times(20-15)(2.6\times10^{-4}) +$$
$$12\times10\times5\times(20-25)\times(4.16\times10^{-7}) +$$
$$12\times10\times5\times(-5)\times(20-32)\times(1.028\times10^{-7}) +$$
$$12\times10\times5\times(-5)\times(-12)\times(20-40)\times(-[illegible])$$

$$= 0.25 + 0.3 + (-0.01229) + 0.0156 - (1.243\times10^{-3})$$
$$+ (3.7008\times10^{-3}) + 0.198$$

$$= 0.89088708$$

Hence when bore size is 20mm the weight is approximately 0.89088708 kg