NANYANG TECHNOLOGICAL UNIVERSITY
SCHOOL OF CIVIL AND STRUCTURAL ENGINEERING

CV272- NUMERICAL METHODS

Tutorial 5: Numerical Integration

1. Figure Q1 shows an idealised stress-strain curve for concrete subjected to compression load. Numerical values of stress (s) and strain (e) are given in Table Q1.

   (a) Form a difference table for all the data in Table Q1, expressing s as a function of e. Obtain up to and include 4th order differences.

   (b) Using the Newton-Gregory forward polynomial, fit a polynomial of quartic order (n=4) to the recorded points for e at the interval between e = 0 and e = 0.0012. Express the polynomial in the form of

$$s = a_o + a_1 s + a_2 s^2 + a_3 s^3 + a_4 s^4$$

   where $s = \dfrac{(e - e_o)}{0.0003}$ and a_o, a_1, a_2, a_3, a_4 are constants.

   (Ans. $P_4(x) = 0.0167s^4 + 0.0333s^3 - 1.5167s^2 + 7.8667s$)

Table Q1

e	0	3×10^{-4}	6×10^{-4}	9×10^{-4}	1.2×10^{-3}	1.5×10^{-3}	1.8×10^{-3}
s (N/mm^2)	0	6.4	10.2	12.2	13.6	14.2	14.2

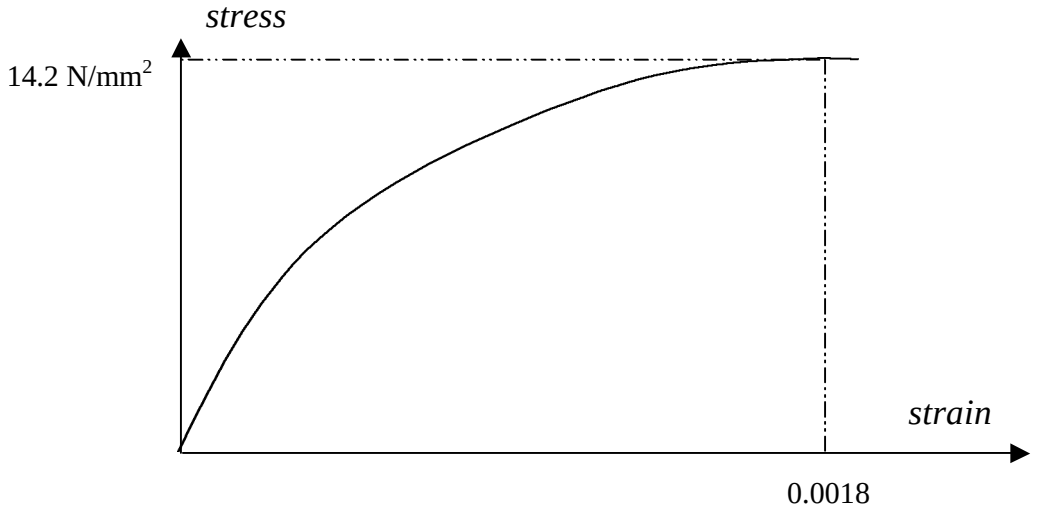

Figure Q1: Idealized Concrete Stress-strain Curve

2. Calculate the area of a quandrant of an ellipse whose semi-axes are a and b ($a = 2b$) by the following methods and compare with the exact result of $\frac{\pi b^2}{2}$.

(a)	Mid-point rule	(Ans. 1.732 b^2)
(b)	Trapezium rule	(Ans. b^2)
(c)	Simpson's rule	(Ans. 1.488b^2)
(d)	Gauss's two-point rule	(Ans. 1.592b^2)

3. Estimate the triple integral:-

$$\int_{o}^{1}\int_{1}^{2}\int_{0}^{0.5} e^{xyz}\,dx\,dy\,dz$$

using

(a)	Simpson's rule	(Ans. 0.6128)
(b)	Guass's two point rule	(Ans. 0.6127)

4. Estimate the double integral using 2-point Gaussian integration:

$$\int_{1}^{2}\int_{3}^{4} f(x,y)\,dy\,dx$$

where $f(x,y)$ =

(a)	$x\,y$	(Ans. 5.250)
(b)	$x^2\,y$	(Ans. 8.167)
(c)	$x^3\,y$	(Ans. 13.125)
(d)	$x^4\,y$	(Ans. 21.681)

By checking your estimates against the analytical solutions, what conclusions can you reach regarding the accuracy of the method?

TKH/jam
12 July 1999