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NUMERICAL METHODS & OPTIMISATION

Roots of Equation Tutorial

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Roots of Equation: Tutorial
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http://ocw.ump.edu.my/course/view.php?id=608&notifyeditingon=1

Chapter Description

- Aims
  - Apply numerical methods in solving engineering problem and optimisation
- Expected Outcomes
  - Apply bracketing method in finding the roots of equation for engineering problems
- References
  - Steven C. Chapra and Raymond P. Canale (2009), Numerical Methods for Engineers, McGraw-Hill, 6th Edition

Application in engineering problem: Class activity

Water is flowing in a trapezoidal channel at a rate of Q = 20 m³/s. the critical depth, y for such channel must satisfy the following equation:

$$0 = 1 - \frac{Q^2}{gA_C^3}B$$

Where g = 9.81 m/s2 , A_C – the cross sectional area (m²) and B = the width of the channel at the surface (m). For this case, B and A_C can be related to y by

$$B = 3 + y \qquad A_C = 3y + \frac{y^2}{2}$$

Solve for the critical depth using (a) the graphical method (b) bisection method and (c) false-position. For (b) and (c) use initial guesses of x_l = 0.5 and x_u = 2.5 and perform the iteration until the approximate error falls below 1% or the number of iteration exceeds 10.

Ans: (a) 1.35 (b) 1.3274 i=10th (c) 1.3516 i=8th

Application in engineering problem: Class activity

The position of a ball, thrown down with a given initial velocity, v_o, and initial position x_o, is subjected to the air resistance that is proportional to its velocity, is given by:

$$x(t) = \rho^{-1}(v_0 + v_r)(1 - e^{-\rho t}) - v_r t + x_0$$

Where **ρ** is the drag coefficient, g is gravity, $v_r = \frac{g}{\rho} = \frac{mg}{k}$ is the terminal velocity. Find the time when the ball hits the ground if x_o = 5m and v_o =20 m/s, **ρ** = 0.35, g = 9.81 m/s² by using open methods

Ans: (a) Newton Raphson: 3.765306 i=3rd (b) Secant: 3.7653306 i=3rd (c) Fixed-point iteration: 3.764103 i=15th

Conclusion

- The open methods can be applied to engineering problems in order to find the roots of equations

Main Reference

Steven C. Chapra and Raymond P. Canale (2009), Numerical Methods for Engineers, McGraw-Hill, 6th Edition

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