



TEST PROJECT

FOR

**ENGINEERING RESEARCH / APPLIED
MATHEMATICS DEPARTMENT**

January 2018

Problems for Scientific Computing Level 2

1. Implement a numerical differentiation method for a vector function
2. Using the numerical differentiation written above, implement newton Raphson algorithm for the solution of system of non-linear equations (Please feel free to use octave's mldivide function)
3. Using your algorithm above solve for x the equation below using initial guess of $x = [0.1, 0.1, -0.1]^T$

$$\begin{aligned} 3x_1 - \cos(x_2x_3) - \frac{1}{2} &= 0 \\ x_1^2 - 81(x_2 + 0.1)^2 + \sin(x_3) + 1.06 &= 0 \\ e^{-x_1x_2} + 20x_3 + \frac{10\pi - 3}{3} &= 0 \end{aligned}$$

4. Using the newton Raphson method implemented above, implement Trapezoidal Method for numerical solution of system of differential equation.

$$y_{n+1} = y_n + \frac{\Delta x}{2} \left\{ \frac{dy}{dx}(x_n, y_n) + \frac{dy}{dx}(x_{n+1}, y_{n+1}) \right\}$$

5. Using your differential equation solver above, solve the following Van der pol equation below for range $x = [0, 300]$ and initial values of $y(0) = 2, y'(0) = 0$;

$$y'' - \mu(1 - y^2)y' + y = 0, \text{ where } \mu = 10$$

6. Plot the graph of y versus x