General Sir John Kotelawala Defence University
Faculty of Engineering
Department of Mathematics
Mathematical Software - MA 1232

Learning Outcomes Covered: LO3, LO4, LO5
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Intake 39 - Semester 2 Tutorial 06 03.10.2022

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1. Cubic polynomial with three closely spaced real roots is given by:

$$p(x) = 816x^3 - 3835x^2 + 6000x - 3125$$

What are the exact roots of p?

2. The polynomial

$$p(x) = x^3 - 2x - 5$$

has one real root, between x = 2 and x = 3, and a pair of complex conjugate roots. Use the roots function in MATLAB to find numerical values for all three roots.

3. Solve the following system of equations.

$$3x - 0.1y - 0.2z = 1$$
$$0.1x7y - 0.3z = 0$$
$$0.3x - 0.2y10z = 5$$

   (a) Using the inbuilt function for inverse matrix.
   (b) Using the method of LU factorization.

4. Evaluate the following integral:

$$\int_{-2}^{4} (1 - x - 4x^3 + 2x^5)dx$$

   (a) analytically.
   (b) using trapezoidal rule.

5. Write a function file euler.m

```
function [t,y]=euler(dydt,yo,h,tspan)
%[t,y]=euler(dydt,tspan,y0,h):
%uses Euler's method to the ODe
%input:
%dydt=function handle of the ODE,f(t,y)
%tspan=[]of independent variable
%y0=initial value of dependent variabale
%h=step size
%output:
%t=vector of independent variable
%y=vector of solution for dependent variable
```

6. Numerically approximate the solution of the following Initial Value Problems using the Euler method.

   (a) $y' = ty \quad y(0) = 1 \quad t \in [0, 1]$
   (b) $y' = y^2 \quad y(1) = -1.5 \quad x \in [1, 20]$

7. Numerically approximate the solution of the following Initial Value Problem.

$$y' = x + y \quad y(0) = 2 \quad x \in [0, 1]$$

by using the Euler method for $h = 0.05, 0.1, 0.2, 0.5$. If the exact solution is given by $y(x) = 3e^x - x - 1$, plot the exact solution and the numerical solutions for $h = 0.05, 0.1, 0.2, 0.5$ in one figure.(label the axis and the graphs).

8. Write a function file ode_RK4.m for the fourth order Runge-Kutta method to solve vector differential equation y'(t)=f(t,y(t)) for tspan=[t0, tf] and with the initial value y0 and N time steps

```
function [t,y]=ode_RK4(func,tspan,y0,N)
%func=function handle of the ODE,f(t,y)
%tspan=[]of independent variable
%y0=initial value of dependent varibale
%N=time steps
%output:
%t=vector of independent variable
%y=vector of solution for dependent variable
```

9. Numerically approximate the solutions of the following Initial Value Problem.

   (a) $y' = x + y \quad y(0) = 2 \quad x \in [0, 1]$
   (b) $y' = -y + 1 \quad y(0) = 0 \quad t \in [0, 2]$

   by using the Runge-Kutta method for $N = 4, N = 10$.

10. Numerically approximate the solutions of the following Initial Value Problem using ode45 inbuilt function.

   (a) $y' = x + y \quad y(0) = 2 \quad x \in [0, 1]$
   (b) $y' = -y + 1 \quad y(0) = 0 \quad t \in [0, 2]$
   (c) $y' = ty \quad y(0) = 1 \quad t \in [0, 1]$
   (d) $y' = y^2 \quad y(1) = -1.5 \quad x \in [1, 20]$