

# MATH 225 Linear Algebra and Differential Equations

## Fall 2007 MATLAB Homework 5

Due date: Friday, December 28, 17:30

In this homework you will solve a constant coefficient linear differential equation analytically and compare the solution with the Matlab's solver. You will also learn more about the ill-posed root finding problem.

1. The characteristic equation of a differential equation is

$$(r+1)(r+2)(r+3)\dots(r+n) = 0.$$

For  $n=20$ ,

- (a) Find the differential equation.  
(b) Find the analytical solution for the initial condition

$$\begin{bmatrix} y(0) \\ y'(0) \\ \vdots \\ y^{(n-1)}(0) \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ \vdots \\ n \end{bmatrix}$$

for  $x = [0 \ 2]$ . To find the coefficients of the exponentials, construct a matrix equation and solve it using '`\`' operator.

- (c) Solve the equation using `ode45` solver.  
(d) Now starting from the differential equation you obtained in (a), find the roots of the characteristic equation in Matlab. Then, solve the initial value problem as in (b). Plot all results on the same figure. Which method is the most accurate one? What is the source of the error? Comment on the results.

**Hints:** Try with different  $n$ 's to find the main source of the error. Use Matlab commands `roots` and `poly`.