Homework #7 (NQe311, Spring, 2020)

KAIST

(Due May 26)

1. The following is a simple reactor kinetics model describing time-dependent behaviors of the neutron population $n(t)$ and the delayed neutron precursor density $C(t)$ under reactivity input $\rho(t)$:

$$\frac{dn}{dt} = \frac{\rho - \beta}{l} n + \lambda C, \; n(0) = n_0$$

$$\frac{dC}{dt} = \frac{\beta}{l} n - \lambda C, \; C(0) = C_0$$

By writing computer programs based on i) explicit Euler method and ii) implicit Euler method, find and compare the numerical solutions with the following data:

$$l = 10^{-4} \text{ sec}, \; \beta = 0.0065, \; \lambda = 0.0769 \text{ sec}^{-1},$$

$$n_0 = 1, \; C_0 = \frac{\beta n_0}{\lambda l} = \frac{0.0065 \times 1}{0.0769 \times 10^{-4}}$$

a) Case 1 for $\rho(t) = \begin{cases} 0.006, & for \;\; 0 \le t \le 5 \text{ sec} \\ 0, & for \;\; t > 5 \text{ sec} \end{cases}$

b) Case 2 for $\rho(t) = \begin{cases} 0.007, & for \;\; 0 \le t \le 1 \text{ sec} \\ 0, & for \;\; t > 1 \text{ sec} \end{cases}$

2. Repeat Problem 1 by calling subroutines available in MATLAB:

   i) a subroutine based on Runge-Kutta methods, e.g., ode45

   ii) a subroutine based on backward differentiation formula, e.g., ode15s