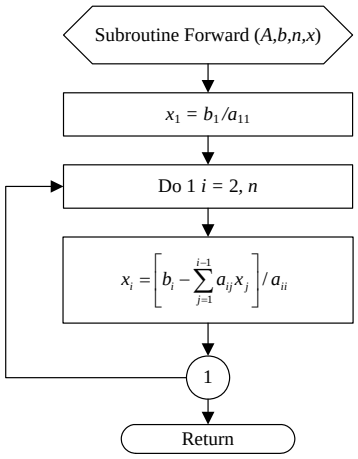
King Saud University
College of Engineering
Chemical Engineering Dept.

CHE401: Exam 2

Problem #1

(a) Convert the following flow chart into a FORTRAN program:



(b) In the Bisection method the search interval is reduced to half each iteration, this means that the solution progress as follows:

$$\frac{L^k}{L^0} = 2^{-k} \qquad \text{where} \quad L^k = b^k - a^k$$

How many steps does Bisection method takes to reach to a confidence limit of 1e-3 as a percent of the current interval to the initial interval?

Problem#2

In a chemical reaction, the molar concentration of the reactant is described by the following differential equation:

$$\frac{dC_A}{dt} = F(C_{Af} - C_A) - \frac{0.05C_A}{0.1 + C_A},$$

The feed concentration C_{Af} is 1 mol/L. At the nominal conditions, F = 1 L/s and C_A is 0.955 mole/L. Assume a step change in the feed flow by 10%, using a step size of 0.5 sec, evaluate the concentration and conversion at t = 1 sec using a modified Euler method which is defined as follows:

$$x_{i+1/2} = x_i + hf(t_i, x_i)$$
$$\bar{x}_{i+1/2} = f(t_i + \frac{h}{2}, x_{i+1/2})$$
$$x_{i+1} = x_i + h\bar{x}_{i+1/2}$$

Problem #3
Given the following equation:

$$\frac{d^2x}{dz^2} + 3\frac{dx}{dz} - 10x = 0; \quad x(z = 0) = 3; x(z = 6) = 1;$$

(a) What is the type of this equation and why?
(b) Transform the above equation into a set of first-order differential equations.
(c) Find the value of x at the interior points $z = 2$ and $z = 4$ by applying the following forward finite difference on the original equation:

$$\frac{dx}{dz} = \frac{1}{h}(x_{i+1} - x_i)$$

$$\frac{d^2x}{dz^2} = \frac{1}{h^2}(x_{i+2} - 2x_{i+1} + x_i)$$