UNIVERSITI MALAYSIA PAHANG

NUMERICAL METHODS & OPTIMIZATION (BTP 2412)

Assignment

Question 1

The displacement of a structure is defined by the following equation for a damped ascillation:

$$y = 9e^{-kt}cos\ \omega t$$

where k = 0.7 and ω = 4.

a) Use the graphical method to make an initial estimate of the time required for the displacement to decrease to 3.5
b) Use the Newton – Raphson method to determine the root to ε_s = 0.01%
c) Use the Secant method to determine the root to ε_s = 0.01%

Question 2

The following equation pertains to the concentration of a chemical in a complete mixed reactor:

$$c = c_{in}(1 - e^{-0.04t}) + c_0 e^{-0.04t}$$

If the initial concentration c_o = 5 and the in flow concentration, c_{in} = 12, compute the time required for c to be 85 percent of c_{in}.

Question 3

Use zero- through fourth-order Taylor Series expansions to predict *f(2.5)* for *f(x) = ln x* using a base point at *x = 1*. Compute the true percent relative error for each approximation. Discuss the meaning of the results.

The value of $f(x_{i+1})$ can be approximated by using the following equation:

$$f(x) \cong f(a) + f'(a)(x - a) + \cdots + \frac{f^n(x)}{n!}(x - a)^n$$

Question 4

The following system of equations is designed to determine concentrations of chlorine ('C_i' in g/m3) in a series of reactors as a function of the amount of mass input to each reactor (the right-hand sides in g/day). Calculate the chlorine concentration for each of reactors in a day.

$$3C_1 + C_3 - C_4 = 2$$

$$-C_2 + 3C_3 = -1$$

$$C_1 + 3C_2 + 4C_4 = 4$$

$$3C_1 - 9C_2 + 4C_3 + 5C_4 = 0$$

Question 5

Idealized spring-mass systems have numerous application throughout engineering. The following figure shows an arrangement of four spring in series being depressed with a force of 3000 kg. At equilibrium, force balance equations can be developed defining the interrelationships between the springs:

$$k_2(x_2 - x_1) = k_1 x_1$$

$$k_3(x_3 - x_2) = k_2(x_2 - x_1)$$

$$k_4(x_4 - x_3) = k_3(x_3 - x_2)$$

$$F = k_4(x_4 - x_3)$$

where *k*'s are spring constants. If k_1 through k_4 are 100, 50, 80 and 200 N/m, respectively, compute the *x*'s.

Question 6

Given the equations:

$$10x_1 + 2x_2 - x_3 = 27$$

$$-3x_1 - 6x_2 + 2x_3 = -61.5$$

$$x_1 + x_2 + 5x_3 = -21.5$$

Solve by using *LU* Decomposition method. Show ALL steps of computation

Question 7

An electrical engineer supervises the production of the three types of the electrical components. Three kinds of material – material, plastic and rubber – are required for the production. The amounts needed to produce each component are:

Component	Metal, (g/ component)	Plastic, (g/ component)	Rubber, (g/ component)
1	15	0.30	1.0
2	17	0.40	1.2
3	19	0.55	1.5

If totals of 3.89, 0.095, and 0.282 kg of metal, plastic and rubber, respectively, are available each day, how many components can be produced per day?