15-11-13-DTP7-RM-22

SE Clemical (RSEm III (CBSGS) 4/12/13

Con. 8625-13.

CPNM

Computer Programming & Numerical Methods

GX-12125

(3 Hours)

25

[Total Marks : 80

N.B. : (1) Question No. 1 is **compulsory**.
(2) Answer any **three** questions from **remaining** questions.
(3) Assume data if **necessary** and specify the assumptions **clearly**.
(4) Answer to the **sub-questions** of a question should be written **together** i.e. one after another.

1. (a) Explain the use of 'for' loop in ~~Sai~~ Sci Lab with appropriate example. 5

(b) Solve the following system using Gaussian Elimination method :— 5

$10x + 2y + z = 9$

$2x + 20y - 2z = -44$

$-2x + 3y + 10z = 22$

(c) Solve $\frac{\partial p}{\partial t} = \frac{\partial^2 p}{\partial y^2}$ subject to the conditions $p(y,0) = 0$, $p(0,t) = 0$, $p(1, t) = 100t$ 5

with $k = \frac{1}{4}$, $h = \frac{1}{2}$ for a time step using Crank-Nicholson method.

(d) A chemical reaction is carried out in batch reactor and it has been found that concentration of reactant changes as per the equation given below :- 5

$$\frac{dc_A}{dt} = \frac{C_A}{1+0.5C_A^{1.8}}$$

If initial concentration (at t= 0) is 0.8 then find concentration of reactant at t = 1 with step size, h = 0.5 using Euler's equation.

(a) Solve the the following system by the Gauss-Siedel Method, and Gauss-Jordon Method. Comment on result. 10

$2x + 2y + z + 2u = 7$

$x - 2y - u = 2$

$3x - y - 2z - u = 3$

$x - 2u = 0$

(b) Solve the following set of equations using Newton Method :- 10

$x_1^2 + x_2^2 - 17 = 0$

$2x_1^{\frac{1}{3}} + x_2^{\frac{1}{2}} - 4 = 0$

start at a value of $X^0 = [2.5 \;\; 0.2]^T$ and show two iterations.

[TURN OVER

SE chemical Sem III (CBSGS)
CPNM

Con. 8625-GX-12125-13.

3. (a) A thin rectangular steel plate is 10 cm x 20 cm in dimensions, whose 10cm right edge is held at 100^0C and the other edges are held at 0^0C. For steel k = 45 w/m-k. Assuming that heat flows only in the x and y direction, determine the steady-state temperature profile. **10**

$$\frac{\partial^2 T}{\partial x^2}+\frac{\partial^2 T}{\partial y^2}=0$$

(b) Find a root of the following equation in the interval [0, 1] using Regula-Falsi method correct upto four decimal places. **10**

$$f(x) = 3x + \sin(x) - e^x = 0$$

4. (a) Lee and Duffy relate the friction factor(f) for flow of suspension of fibrous particles to the Reynolds Number (N_{Re}) by the following expression :- **10**

$$\frac{1}{\sqrt{f}}=\frac{1}{k}\ell n\left(N_{Re}\sqrt{f}\right)+\left(14-\frac{5.6}{k}\right)$$

For suspension with 0.08% concentration, k = 0.28. What is the value of 'f' if N_{Re} = 3750 ? Use Newton-Raphson method to obtain the friction factor accurate to five decimal places.

(b) In a particular reaction equilibrium problem the following expressions are obtained:- **10**

$C_A = 40\text{-}30x_1\text{-}10x_2$

$C_B = 15\text{-}15x_1$

$C_C = 15x_1 - 10x_2$

$CD = 10 - 10\ x_2$

To calculate the equilibrium composition, we need to solve the following equations :-

$$f_1=\frac{C_C}{C_A^2 C_B}-5\times10^{-4}=0$$

$$f2=\frac{C_C}{C_A C_D}-4\times10^{-2}=0$$

Use appropriate numerical method to calculate the equilibrium composition.

5. Consider a tank into which an incompressible fluid is pumped at a variable rate, qi $m^3/5$. This flow rate can vary with time because of changes in operation upstream. The height of the liquid in the tank is h. Liquid leaves the base of the tank via a long horizontal pipe and discharge in to the atmosphere. A force balance on the outlet line is given by : **20**

$$\frac{dv}{dt}=\frac{g}{L}h-\frac{Kf}{\varrho Ap}v^2$$

The continuity equation on the liquid in the tank is given by :

$$A_T\frac{dh}{dt}=q_i-q\ .$$

where Ap = Cross section area of pipe, m^2
AT = Area of tank, m^2
Kf = 2.81×10^{-2}
L = Length of the pipe, m
g = Acceleration due to gravity, m/s^2
ϱ = Density of fluid, Kg/m^3
v = Velocity of fluid in pipe, m/s
q = Flow from pipe, $m^3/s = A_p v$

Data :-

Pipe ID = 0.9144m, L = 914.4m,
Tank ID = 3.6576 m, Tank height = 2.1336 m,
qi = 59431 ℓpm ~~ϱ~~ = 1000 Kg/m^3 rho = 1000 kg/m3
Find liquid height after one minute using Runge-Kutta 4th order method with step size of 30 sec.

6. (a) Discuss the convergence of secant method.
(b) Find the value of y(4) and y(5) using finite differences for following equation :- 6 7

$$\frac{d^2y}{dt^2}=0$$

where, y(2) = 0.33 and y(3) = 0.48

(c) Use the method of iteration to find a positive root, between 0 and 1, of the equation $xe^x = 1$. 7