1T00534 - S.E.(Chemical Engineering)(SEM-IV)(Choice Based)(R- 20-21) (C Scheme) / 40323 - Numerical Method in Chemical Engineering

QP CODE: 10029343 DATE : 15/05/2023

Time : 3 Hrs. **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 assumptions clearly

Q.1 a) Solve the following using gauss elimination method **[5 marks]**

$8x + 4y - z = 11 \quad -2x + 5y + z = 4 \quad 2x - y + 6z = 7$

b) Derive Newton Raphson's formula by using Taylor series expansion. **[5 marks]**

c) Explain different types of errors in detail **[5 marks]**

d) Solve the boundary value problem $u_t = u_{xx}$ under the conditions $u(0,t) = u(1,t) = 0$ and $u(x,0) = \sin\pi x$, $0 \le x \le 1$ using Bender Schmidt Method for two time steps. (Take h=0.2) **[5 marks]**

Q.2 a) Consider a reaction A ⟶ B carried out in a batch reactor governed by **[10 marks]**

$$\frac{dCa}{dt} = -kCa$$

The initial conditions are: at t=0, Ca= 1 mol/m^3. The rate constant (k) is 1 s^{-1}. Using Runge-Kutta forth order method, determine the concentration of A at 2 s.(take step size as 1).

b) i) Find the root of the equation $x^2 - 4x - 10 = 0$ using Secant method up to two iterations. **[5 marks]**

ii) Solve using Runge-kutta second order method **[5 marks]**

$$\frac{dy}{dx} = 1 - 2xy$$

y(0)= 0 , Take step size h=0.2 find y(0.4)

Q.3 a) The spherical storage tank containing oil has a diameter of 6 ft. Calculate the height h to which a dipstick 8 ft long would be wet with oil when immersed in the tank when it contains 4 ft3 of oil. The equation that gives the height, h, of the liquid in the spherical tank for the given volume and radius is given by $V = \frac{3\pi h^2(3r-h)}{9}$, Use the Bisection Method to find the height (h), to which the dipstick is wet with oil. **[10 marks]**

b) Find by Newton Raphson's method, the real root of the equation $3x = \cos x + 1$ by taking initial guess 0.5 **[10 marks]**

Q.4 a) The temperature of a metal strip was measured at various time intervals during heating and the values are given in the table. If the relationship between temperature T and time t is of the form **[10 marks]**

$T = be^{t/4} + a$

Time t (min)	Temperature T (^{0}C)
1	70
2	83
3	100
4	124

Find the temperature at t = 6 minute.

b) Solve the following equations using Gauss-Jordan Method **[10 marks]**

x + y + z = 9 ; 2x – 3y + 4z = 13; 3x + 4y + 5z = 40

Q.5 a) **[10 marks]**

Evaluate $\int_0^1 \frac{dx}{1+x}$ by applying

1. Trapezoidal rule
2. Simpson's (1/3)rd rule
3. Simpson's (3/8)th rule

b) Find the value of y(4) and y(5) using finite differences for following equation: **[10 marks]**

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

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

Q.6 a) Solve the following by Gauss-Seidel method **[10 marks]**

10x + y + z =12

2x1 + 10y +z = 13

2x + 2y + 10z = 14

b) The change in velocity of a moving particle is given by the following equation **[10 marks]**

$$\frac{dv}{dt} = 0.025v^2 - 5t$$

Where v is in m/s and t is in seconds. If at t=0, v= 5 m/s. by using Euler's method find v(1.5). (take step size as 0.25)