# L.E.COLLEGE-MORBI

# TUTORIAL:-1

SUBJECT NAME:- NUMERICAL METHODS IN CHEMICAL ENGINEERING    COURSE OUTCOME:-3140510.1

SUBJECT CODE:- 3140510    SEMESTER:- IV

CHAPTER:-1. APPROXIMATION & ERRORS    BRANCH:-CHEMICAL ENGINEERING

1) **Evaluate the sum S=$\sqrt{3} + \sqrt{5} + \sqrt{7}$ to significant digit and find its absolute and relative error.**
2) **Find Relative Error of the number 8.6. If both of its digits are correct. Here absolute error is 0.05.**
3) **Round the numbers 3.645 and 3.655 to three significant figure.**
4) **Describe different types of errors**
5) **Describe the term error propagation with example.**
6) **Round off the number 865250 and 3746235 to four significant figures and compute absolute error, relative error and percentage error in each case.**
7) **Evaluate the sum $\sqrt{6} + \sqrt{7} + \sqrt{8}$ and find its percentage relative error.**
8) **Define: (a) Accuracy (b) precision.**
9) **Find the difference $\sqrt{6.37}$- $\sqrt{6.36}$ to three significant digits.**
10) **If 0.333 is approximate value of 1/3, find absolute and relative error.**
11) **The height of an observation tower was estimated to be 47 m, whereas its actual height was 45 m. calculates the percentage relative error in the measurement.**
12) **Given a value of x=2.5 with an error of $\Delta$x=0.01, estimate the resulting error in the Function, F(x) = $x^3$.**

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# TUTORIAL:-2(A)

**SUBJECT NAME:- NUMERICAL METHODS IN CHEMICAL ENGINEERING** **COURSE OUTCOME:-3140510.4**

**SUBJECT CODE:- 3140510** **SEMESTER:- IV**

**CHAPTER:- 5. FINITE DIFFERENCES & INTERPOLATION** **BRANCH:-CHEMICAL ENGINEERING**

1) **From the following table, estimate the number of students who obtained marks between 40 and 45.**

| Marks | 30-40 | 40-50 | 50-60 | 60-70 | 70-80 |
|---|---|---|---|---|---|
| No. of Students | 31 | 42 | 51 | 35 | 31 |

2) **Find the cubic polynomial which takes the following values :**

| x | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| f(x) | 1 | 2 | 1 | 10 |

3) **The table gives the distance in nautical miles of the visible horizon for the given heights in feet above the earth's surface:**

| X(height) | 100 | 150 | 200 | 250 | 300 | 350 | 400 |
|---|---|---|---|---|---|---|---|
| Y(distance) | 10.63 | 13.03 | 15.04 | 16.81 | 18.42 | 19.90 | 21.27 |

**Find the value of y when (a) x=218 ft (b) x=410 ft.**

4) **Using Lagrange's interpolation formula, find the interpolating polynomial for the following table:**

| X | 0 | 1 | 2 | 5 |
|---|---|---|---|---|
| F(x) | 2 | 3 | 12 | 147 |

5) **Using Lagrange's interpolation formula, find the interpolating polynomial for the following table:**

| X | 0 | 1 | 3 | 4 |
|---|---|---|---|---|
| y | -12 | 0 | 12 | 24 |

6) **The following table gives the value of density(d) of a saturated water for various temperature (T) of saturated stream.**

| Temp(T),˚C | 100 | 150 | 200 | 250 | 300 |
|---|---|---|---|---|---|
| Density(d),kg/m$^3$ | 958 | 917 | 586 | 799 | 712 |

**Use Newton's forward interpolation formula to find the density when the temperature is 130˚C and 270˚C.**

7) **Determine the interpolating polynomial of degree three using Lagrange's interpolation formula for the table below:**

| X | -1 | 0 | 1 | 3 |
|---|---|---|---|---|
| f(x) | 2 | 1 | 0 | -1 |

8) **From the following data, Estimate number of persons getting wages between Rs. 10 and 15.**

| Wages in Rs. : | 0-10 | 10-20 | 20-30 | 30-40 |
|---|---|---|---|---|
| Frequency: | 9 | 30 | 35 | 42 |

9) **The following table gives the values of x and y: Obtain the values of x corresponding to y=12 using Lagrange's technique.**

| X | 1.2 | 2.1 | 2.8 | 4.1 | 4.9 | 6.2 |
|---|---|---|---|---|---|---|
| y | 4.2 | 6.8 | 9.8 | 13.4 | 15.5 | 19.6 |

# L.E.COLLEGE-MORBI

# TUTORIAL:-2(B)

**SUBJECT NAME:- NUMERICAL METHODS IN CHEMICAL ENGINEERING** **COURSE OUTCOME:-3140510.4**

**SUBJECT CODE:- 3140510** **SEMESTER:- IV**

**CHAPTER:- 5. FINITE DIFFERENCES & INTERPOLATION** **BRANCH:-CHEMICAL ENGINEERING**

1) **Using Newton's divided difference interpolation evaluate f(9.2) for the following data:**

| x | 8 | 9 | 8.5 | 11 |
|---|---|---|---|---|
| f(x) | 2.079442 | 2.197225 | 2.251219 | 2.397595 |

2) **Obtain the density of a 26% solution of phosphoric acid in water at 20˚C, using Lagrange's interpolation formula. Can we perform the same calculation using Newton's forward difference interpolation formula? Yes OR No.?**

| Y, Density | 1.0764 | 1.1134 | 1.2160 | 1.3350 |
|---|---|---|---|---|
| X, % $H_3PO_4$ | 14 | 20 | 35 | 50 |

3) **For certain component following data are available:**

| Kinematic viscosity, $cm^2/s$ | 0.0179 | 0.0156 | 0.0138 | 0.0124 | 0.0112 |
|---|---|---|---|---|---|
| Temperature, ˚C | 0 | 4 | 8 | 12 | 16 |

**Using Newton's forward difference interpolation method, predict the kinematic viscosity at 2.5˚C .**

4) **Using Newton's backward difference interpolation formula ,find f(0.40) from the following table:**

| X | 0.10 | 0.15 | 0.20 | 0.25 | 0.30 |
|---|---|---|---|---|---|
| f(x) | 0.1003 | 0.1511 | 0.2027 | 0.2553 | 0.3093 |

5) **Write the formula for divided differences [$x_0$, $x_1$] and [$x_0$, $x_1$, $x_2$]. Using Newton's divided difference formula find f(9) from the following table:**

| X | 5 | 7 | 11 | 13 | 17 |
|---|---|---|---|---|---|
| f(x) | 150 | 392 | 1452 | 2366 | 5202 |

6) **Using Newton's Divided difference formula, evaluate f(8) and f(15) from below table:**

| x | 4 | 5 | 7 | 10 | 11 | 13 |
|---|---|---|---|---|---|---|
| f(x) | 48 | 100 | 294 | 900 | 1210 | 2028 |

7) **Using Newton's forward differences formula, estimate vapor pressure of ammonia vapor at 23˚C. The latent heat of ammonia is 1265 kJ/kg. Data given in the table below:**

| Temperature, ˚C | 20 | 25 | 30 | 35 |
|---|---|---|---|---|
| Pressure, $kN/m^2$ | 810 | 985 | 1170 | 1365 |

8) **Values of x(in degree) and $sinx$ are given in the following table :**

| X | 15 | 20 | 25 | 30 | 35 | 40 |
|---|---|---|---|---|---|---|
| $sinx$ | 0.2588190 | 0.3420201 | 0.4226183 | 0.5 | 0.5735764 | 0.6427876 |

**Using Newton's backward difference formula find the value of sin 38˚.**

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# TUTORIAL:-3

**SUBJECT NAME:- NUMERICAL METHODS IN CHEMICAL ENGINEERING** **COURSE OUTCOME:-3140510.4**

**SUBJECT CODE:- 3140510** **SEMESTER:- IV**

**CHAPTER:- 6. NUMERICAL DIFFERENTIATION & INTEGRATION** **BRANCH:-CHEMICAL ENGINEERING**

1) **Find $\frac{dy}{dx}$ at x=1.1 using following data:**

| X | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.6 |
|---|---|---|---|---|---|---|---|
| y | 7.989 | 8.403 | 8.781 | 9.129 | 9.451 | 9.750 | 10.031 |

2) **Find $\frac{dy}{dx}$ at x=1.30 from following data:**

| X | 1.00 | 1.05 | 1.10 | 1.15 | 1.20 | 1.25 | 1.30 |
|---|---|---|---|---|---|---|---|
| y | 1.0000 | 1.0247 | 1.0488 | 1.0723 | 1.0954 | 1.1180 | 1.1401 |

3) **The following data gives pressure and volume of super heated steam:**

| Volume(V) | 2 | 4 | 6 | 8 | 10 |
|---|---|---|---|---|---|
| Pressure(P) | 105 | 42.7 | 25.3 | 16.7 | 13 |

**Find the rate of change of pressure with respect to volume when (i)V=2 and (ii) V=8.**

4) **From the table below, for what value of x; y is Minimum? Also find the value of y.**

| X | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|
| y | 0.205 | 0.240 | 0.259 | 0.262 | 0.250 | 0.224 |

5) **Find $f'(10)$ from the following data:**

| $x$ | 3 | 5 | 11 | 17 | 34 |
|---|---|---|---|---|---|
| $f(x)$ | -13 | 23 | 899 | 17315 | 35606 |

6) **From the following table of values of x and y, obtain $\frac{dy}{dx}$ for x=1.2.**

| X | 1 | 1.2 | 1.4 | 1.6 | 1.8 | 2 | 2.2 |
|---|---|---|---|---|---|---|---|
| y | 2.7183 | 3.3201 | 4.0552 | 4.9530 | 6.0496 | 7.3891 | 9.0250 |

7) **If f(0)=1, f(0.5)=0.8, f(1)=0.5, Find the value of $\int_0^1 f(x)dx$ using trapezoidal rule.**

8) **Apply Simpson's rule to evaluate $\int_0^1 \sqrt{1-x^2}\, dx$, using (i) h=0.1 (ii) h=10.**

9) **Calculate the approximate value of $\int_0^{\frac{\pi}{2}} sinx\, dx$ by Simpson's 1/3 rule using 11 ordinates.**

10) **Using Trapezoidal Rule evaluate the integral $\int_0^6 x^2 e^x\, dx$ with h=1.**

11) **Evaluate $\int_0^1 \frac{dx}{1+x^2}$ using trapezoidal rule with h=0.2.**

12) **Evaluate $\int_4^{5.2} lnx\, dx$ using the trapezoidal rule and Simpson's 3/8 rule, taking h=0.2.**

13) **Integration provides a means to compute how much mass enters or leaves a reactor over a specified time period as M = $\int_{t1}^{t2} Qc\, dt$. Where, t1 and t2= the initial and final times respectively. The integral represents the summation of product of flow times concentration to give the total mass entering or leaving from time $t_1$ to $t_2$. For a constant flow rate of Q=4 $m^3$/mm, Use**

Simpson's rule to evaluate this equation for data listed below:

| X | 0 | 10 | 20 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|---|
| y | 10 | 35 | 55 | 52 | 40 | 37 | 32 |

14) Given the data below, find the isothermal work done on the gas as it is compressed from $V_1$ = 22 L to $V_2$ = 2 L. Use $W= -\int_{V1}^{V2} P\, dv$ . Use Trapezoidal Rule.

| V(L) | 2 | 7 | 12 | 17 | 22 |
|---|---|---|---|---|---|
| P(atm) | 12.20 | 3.49 | 2.04 | 1.44 | 1.11 |

15) Water is flowing through a pipeline 6 cm in diameter. The local velocities (u) at various radial positions (r) are given below:

| u, cm/s | 2 | 1.94 | 1.78 | 1.5 | 1.11 | 0.61 | 0 |
|---|---|---|---|---|---|---|---|
| r, cm | 0 | 0.5 | 1 | 1.5 | 2 | 2.5 | 3 |

Estimate the average velocity ū, using Simpson's 1/3 rule. The average velocity is given by:

$$\bar{u} = \frac{2}{R^2}\int_0^R u\, r\, dr \text{ , where R= 3 cm.}$$

16) The variation of the specific heat $C_P$ with temperature T for a substance is tabulated below:

| T,˚C | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $C_p$, $\frac{KJ}{kg\ K}$ | 2.11 | 2.25 | 2.39 | 2.54 | 2.69 | 2.83 | 2.95 | 3.08 | 3.22 | 3.38 | 3.52 |

Estimate the heat required to raise the temperature of 1 kg of substance from 30˚C to 90˚C using Simpson's 1/3 Rule.

17) The below table shows the temperature $f(t)$ as a function of time t :

| t | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| $f(t)$ | 81 | 75 | 80 | 83 | 78 | 70 | 60 |

By using Simpson's 1/3 rule, evaluate $\int_1^7 f(t)dt$.

18) The out flow chemical concentration (c) from a completely mixed reactor is measured at various time (t) as shown in table:

| t(min) | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 |
|---|---|---|---|---|---|---|---|---|
| c(mg/m³) | 12 | 22 | 32 | 45 | 58 | 70 | 75 | 78 |

For an out flow of Q=0.3 $m^3/s$, estimate the mass of chemical in grams by using the formula M = $Q\int_{t=0}^{t=14} c\, dt$.

19) A resistor is being used to dissipate energy from a variable D.C. supply. A calculation is needed of how much energy has been dissipated over a period of time. Table below contains values of current I, through the resistor and voltage V, across the resistor for the first 100 seconds since electrical power was first applied. Calculate the energy dissipation during this time period using Simpson's 1/3 rule with a step interval of 10 seconds.

| Time(s) | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Voltage(V) | 50 | 99 | 67 | 80 | 92 | 96 | 78 | 82 | 90 | 107 | 86 |
| Current(A) | 10 | 20 | 13 | 16 | 18 | 22 | 14 | 15 | 18 | 19 | 17 |

# L.E.COLLEGE-MORBI

# TUTORIAL: 4

SUBJECT NAME:- NUMERICAL METHODS IN CHEMICAL ENGINEERING COURSE OUTCOME:-3140510.3

SUBJECT CODE:- 3140510 SEMESTER:- IV

CHAPTER:-2. SOLUTION OF ALGEBRAIC & TRANSCENDENTAL EQUATIONS BRANCH:-CHEMICAL ENGINEERING

1) (a) Find the value of 1st approximation for $x^3 - x - 1 = 0$ using bisection method.
   (b) The sum of the roots of an equation $x^3 - 2x^2 + x - 1 = 0$ is…………..
2) Find the root of the equation $2x - log\ x - 7 = 0$ using false Position Method correct upto three decimal places.
3) Find the root of the equation $x^3 + x - 1 = 0$ using the bisection method correct upto three decimal places.
4) Using Bisection method, find a real root of the equation $x^3 - 2x - 5 = 0$ correct to 3 decimal places.
5) Find the real root of the equation $x^3 + x^2 - 1 = 0$ using the bisection method correct upto three decimal places.
6) Find a real root of the equation $e^x - 3x = 0$ upto two decimal places using Newton-Raphson method. Take $x_0 = 0$.
7) Find a real root of the equation $x^3 - 9x + 1 = 0$ in the interval [2,3] by the regula falsi method.
8) Find the root of the equation $cosx = xe^x$ using the (a) secant method (b) false position method correct upto four decimal places.
9) Find the root of the equation $e^{-x} - tanx = 0$ using secant method correct upto three decimal places. Take $x_0 = 1,\ x_1 = 0.7$.
10) Find real root of the equation $x\ log_{10}x = 1.2$ by the regula falsi method.
11) Solve the equation $x^3 - 7x^2 + 36 = 0$, given that one root is double of another, by using the relations of roots.
12) Using multiple equation Newton Raphson method determine the roots of following equations. Initiate computations with guesses of $x = 1.5\ and\ y = 3.5$.
    $u_{(x,y)} = x^2 + xy - 10 = 0$
    $u_{(x,y)} = y + 3xy^2 - 57 = 0$
13) Use Descartes rule of sign to find numbers of positive, negative and imaginary roots of the function $x^6 - x^5 - 10x + 7 = 0$.
14) Find numbers of positive, negative and imaginary roots of the equation: $2x^7 - x^5 + 4x^3 - 5 = 0$.
15) Transform the equation $x^3 - 6x^2 + 5x + 8 = 0$, into another in which the second term is missing, by using synthetic division.
16) Solve the non-linear equations $x^2 - y^2 = 4$ and $x^2 + y^2 = 16$ numerically with $x_0 = y_0 = 2.828$ using Newton-Raphson method. (Carry out two iterations)

**17) Solve following equations using Newton Raphson technique starting with $x_0 = [0.5 \quad 0.5]$ Perform two iterations.**

$$f_1(x_1, x_2) = 4 - 8x_1 + 4x_2 - 2x_1^3 = 0$$
$$f_2(x_1, x_2) = 1 - 4x_1 + 3x_2 + x_2^2 = 0.$$

**18) Calculate the bubble point temperature for binary mixture benzene (1) and toluene (2) at 1 atm pressure and $x_1$=0.4, Using Secant method. Carry out one iteration.**

**<u>Data Given:</u>** **Two initial guess temperatures are: $T_1$ = 353 K and $T_{i-1}$ =360 K.**

**$f_t = x_1 P_1^{sat} + x_2 P_2^{sat} - P = 0$.**

**Antoine equation: $\ln P^{sat} = A - \frac{B}{T+C}$, P is in kPa and T is in K.**

| | A | B | C |
|---|---|---|---|
| **Antoine constants:** | **14.1603** | **2948.78** | **-44.5633** |
| | **14.2515** | **3242.38** | **-47.1806** |

**19) For turbulent flow of a fluid in a hydraulically smooth pipe. Prandtl's universal resistance law relates the friction factor f, and the Reynolds number (Re), according to following relationship:** $\frac{1}{\sqrt{f}} = -0.4 + 4\,log_{10}(Re\sqrt{f})$

**Compute f for Re=1000, using Newton-Raphson method with initial $f_0$= 0.01. Perform one iteration.**

**20) You are designing a spherical tank (figure 1) to hold water for a small village in a developing country. The volume of liquid it can hold can be computed as**

$$V = 2\pi h^2 \frac{[3R-h]}{3}.$$

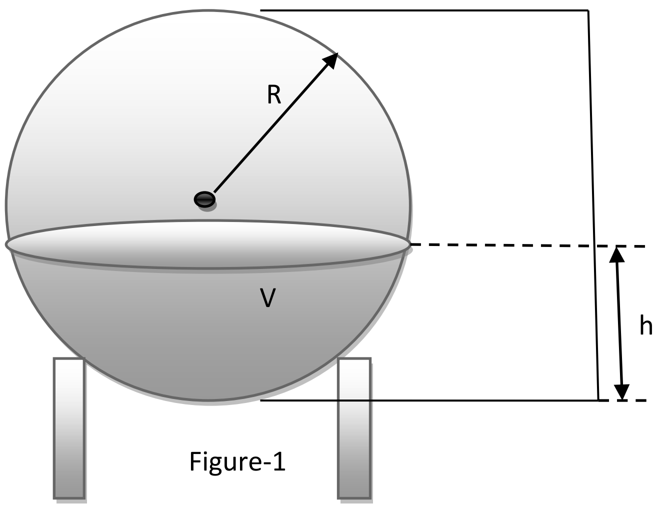


Figure-1

**Where V=volume [m³], h=depth of water in tank [m], and R= tank radius [m]. If R=3 m, to what depth must the tank be filled so that it holds 30 m³. Use three iterations of bisection method to determine your answer.**

**[ <u>HINT</u> : from the physics of the problem, the depth(h) would be between h=0 and h=2R and hence the this becomes the lower and upper limits of depths to initiate the computation ]**

# L.E.COLLEGE-MORBI

# TUTORIAL: 5

**SUBJECT NAME:- NUMERICAL METHODS IN CHEMICAL ENGINEERING** **COURSE OUTCOME:-3140510.3**

**SUBJECT CODE:- 3140510** **SEMESTER:- IV**

**CHAPTER:-3. SOLUTION OF LINEAR EQUATIONS** **BRANCH:-CHEMICAL ENGINEERING**

1) **It takes three different ingredients A, B, C to produce a certain chemical substance. A, B, C have to be dissolved in water separately before they interact to form the chemical. Suppose that the solution containing A at 1.5 combined with the solution containing B at 3.6 combined with the solution containing C at 5.3 makes 25.07g of the chemical. If the proportion for A, B, C in this solution are changed to 2.5, 4.3, 2.4 respectively then 22.36g of the chemical is produced. Finally if the proportions are 2.7, 5.5, 3.2 respectively, then 28.14g of the chemical is produced. What are the volumes of the Solutions containing A, B, C?**
2) **Find numerically the largest Eigen value and corresponding Eigen Vector of the following matrix.**

$$A=\begin{bmatrix} 1 & -3 & 2 \\ 4 & 4 & -1 \\ 6 & 3 & 5 \end{bmatrix}$$

3) **Find the solution to three decimal, of the system by Matrix Inversion Method.**

$$5x + y + 2z = 19$$
$$x + 4y - 2z = -2$$
$$2x + 3y + 8z = 39$$

4) **Solve the following three equations for $P_1$, $P_2$ and $P_3$ using Gauss Elimination method.**

$$\begin{bmatrix} 0.01 & 0.95 & 0.10 \\ 0.99 & 0.05 & 0 \\ 0 & 0 & 0.90 \end{bmatrix} \begin{matrix} P1 \\ P2 \\ P3 \end{matrix} = \begin{matrix} 400 \\ 400 \\ 200 \end{matrix}$$

5) **Solve** $\begin{bmatrix} 2 & 1 & 0 \\ 1 & 2 & 1 \\ 0 & 1 & 1 \end{bmatrix} \begin{matrix} X1 \\ X2 \\ X3 \end{matrix} = \begin{matrix} 1 \\ 2 \\ 4 \end{matrix}$ **using Gauss-Seidel Technique. Carry out two iteration, starting with $x^{(1)} = [\,1 \quad 2 \quad 1\,]^T$.**
6) **Use Gauss-Seidel method to obtain the solution of the system of equations:** $3x - 0.1y - 0.2z = 7.85$

$$0.1x + 7y - 0.3z = -19.3$$
$$0.3x - 0.2y + 10z = 71.4$$

7) **Solve the following system of equations by Gauss elimination method.**

$$8y + 2z = -7$$
$$3x + 5y + 2z = 8$$
$$6x + 2y + 8z = 26$$

8) **Find the Inverse of matrix A=** $\begin{bmatrix} 5 & -2 & 4 \\ -2 & 1 & 1 \\ 4 & 1 & 0 \end{bmatrix}$

9) **Solve the following system of equations by Gauss Elimination method:**
$\mathbf{2x + 2y - 2i = 8; \quad -4x - 2y + 2z = -14; \quad -2x + 3y + 9z = 9}$

10) **Use Gauss-Seidel method to solve the system of equations up to three decimal places:**

$$2x + 15y + 6z = 72; \quad 54x + y + z = 110; \quad -x + 6y + 27z = 85.$$

11) **Check whether the following system of equations is diagonally dominant or not? Solve the system by using Gauss- Siedel iterative method(upto 3 iterations)**

$$20x + y - 2z = 17$$
$$3x + 20y - z = -18$$
$$2x - 3y + 20z = 25$$

12) **Find the Inverse of the matrix A=** $\begin{bmatrix} 2 & 1 & 1 \\ 0 & 1 & 0 \\ 1 & 1 & 2 \end{bmatrix}$

13) **Use Gauss elimination to solve the system :**

$$2X_1+X_2 -X_3 =-1$$
$$X_1-2X_2 +3X_3=9$$
$$3X_1-X_2 +5X_3 =14$$

14) **Find the largest Eigen value and corresponding Eigen vector of the matrix** $\begin{bmatrix} 25 & 1 & 2 \\ 1 & 3 & 0 \\ 2 & 0 & -4 \end{bmatrix}$**, taking** $[\,1 \quad 0 \quad 0\,]^T$ **as initial Eigen vector.**

15) **Solve the following system of equations by Gauss Elimination method:**
$\mathbf{x + 4y - z = -5; \quad x + y - 6z = -12; \quad 3x - y - z = 4.}$

16) **Using Jacobi method solve the system of equations:**
$\mathbf{10x + 2y + z = 9; \quad 2x + 20y - 2z = -44; \quad -2x + 3y + 10z = 22.}$

17) **Find the Inverse of the matrix A=** $\begin{bmatrix} 3 & 1 & 2 \\ 2 & -3 & -1 \\ 1 & 2 & 1 \end{bmatrix}$.

18) **Use Gauss-Seidel method to solve the system of equations up to three decimal places:**

$$83x + 11y - 4z = 95; \quad 7x + 52y + 13z = 104; \quad 3x + 8y + 29z = 71.$$

19) **Find the Eigen value and Eigen vectors of the matrix** $\begin{bmatrix} 5 & 0 & 1 \\ 0 & -2 & 0 \\ 1 & 0 & 5 \end{bmatrix}$.

20) **Using Iterative power method, Find the largest Eigen value and corresponding Eigen vector of the matrix** $\begin{bmatrix} 1 & 6 & 1 \\ 1 & 2 & 0 \\ 0 & 0 & 3 \end{bmatrix}$

21) **Use Jacobi's method to solve the following three equations with initial values** $X_1=X_2=X_3=X_4=0$**. Carry out three iterations.**

$$10X_1-2X_2 -X_3-X_4= 3$$
$$-2X_1+10X_2 -X_3-X_4= 15$$
$$-X_1-X_2 +10X_3-2X_4 = 27$$
$$-X_1-X_2 -2X_3+10X_4 = -9.$$

# L.E.COLLEGE-MORBI

# TUTORIAL: 6

SUBJECT NAME:- NUMERICAL METHODS IN CHEMICAL ENGINEERING COURSE OUTCOME:-3140510.2

SUBJECT CODE:- 3140510 SEMESTER:- IV

CHAPTER:-4. CURVE FITTING BRANCH:-CHEMICAL ENGINEERING

1) **Certain Experimental values of x and y are given below:**
   **(0,-1),(2,5),(5,12),(7,20).**
   **If a straight line Y= $a_0$ + $a_1$x is fitted to the data, find the approximate values of $a_0$ & $a_1$.**
2) **Fit the polynomial of the second degree to the data points (x,y) given by (0,1),(1,6),(2,17).**
3) **Heat transfer co-efficient (h) is related to the velocity (u) of the following fluid through a pipe by $h = a\,u^b$ Determine the values of a and b from the following data using least square technique.**

| u, m/s | 0.305 | 0.914 | 1.524 | 2.134 | 2.743 |
|---|---|---|---|---|---|
| h, W/($m^2$K) | 852 | 2100 | 3208 | 4258 | 5228 |

4) **An Experiment gave the following values:**
   **It is known that v and t are connected by the relation $v = a\,t^b$ Find the best possible values of a & b.**

| v (ft/min) | 350 | 400 | 500 | 600 |
|---|---|---|---|---|
| t(min) | 61 | 26 | 7 | 2.6 |

5) **Fit a second degree polynomial $y = a + bx + cx^2$ using least squares method to the following data:**

| X | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| y | 1.7 | 1.8 | 2.3 | 3.2 |

6) **Fit a straight line to the following data:**

| x | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| y | 1 | 1.8 | 3.3 | 4.5 | 6.3 |

7) **Explain the principle of least squares and using it fit an exponential curve $y = ae^{bx}$ to the following data:**

| X | 0 | 2 | 4 | 6 | 8 |
|---|---|---|---|---|---|
| y | 150 | 63 | 28 | 12 | 5.6 |

8) **In an experiment the following values of heat capacity (C) at various temperatures (T) for a gas is obtained:**

| Temp (T) | -50 | -30 | 0 | 60 | 90 | 110 |
|---|---|---|---|---|---|---|
| Heat Capacity (C) | 1270 | 1280 | 1350 | 1480 | 1580 | 1700 |

   **Use linear regression to determine the model to predict the heat capacity(C) as a function of Temperature (T).**
9) **The pressure and volume of a gas are related by the relation $p\,v^{\alpha} = k$, where $\alpha$ and k being constants. Find the relation for the following set of observations:**

| p ($kg/cm^3$) | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 |
|---|---|---|---|---|---|---|
| V (liters) | 1.62 | 1.00 | 0.75 | 0.62 | 0.52 | 0.46 |

**10) If P is the pull required to lift a load by means of a pulley block, find a linear law of the form P=mW + c connecting P and W , Using the following Data. Also compute P when W=150.**

| P | 12 | 15 | 21 | 25 |
|---|---|---|---|---|
| W | 30 | 70 | 100 | 120 |

**11) Fit a function of the form $y = ax^b$ to the following data:**

| X | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Y | 7.1 | 27.8 | 62.1 | 110 | 161 |

**12) Table below gives the Temperature (T) and Length (L) of heated road. If $L = a_0 + a_1T$, find the best values of $a_0$ and $a_1$ using linear regression.**

| T,˚C | 20 | 30 | 40 | 50 | 60 | 70 |
|---|---|---|---|---|---|---|
| L, mm | 800.3 | 800.4 | 800.6 | 800.7 | 800.9 | 801 |

**13) Determine the constants a and b by the method of least square such that $y = ae^{bx}$ fits the following data:**

| X | 2 | 4 | 6 | 8 | 10 |
|---|---|---|---|---|---|
| y | 4.077 | 11.084 | 30.128 | 81.897 | 222.62 |

# L.E.COLLEGE-MORBI

# TUTORIAL:-7

**SUBJECT NAME:- NUMERICAL METHODS IN CHEMICAL ENGINEERING** **COURSE OUTCOME:-3140510.3**

**SUBJECT CODE:- 3140510** **SEMESTER:- IV**

**CHAPTER:- 5 ODE** **BRANCH:-CHEMICAL ENGINEERING**

1.Use second order Runge – Kutta method to solve $dy/dx$= 3x + y, given y = 1.3 when x = 1 to approximate y when x = 1.2 taking step size 0.1.

2.Determine the value of y at x=0.3, given that $dy/dx$= x + y and y(0) =1, using modified Euler's method.

3. Using Taylor's series method, obtain the solution of$dy/dx$= 3x + y2, given that y (0) = 1. Find the value of y for x = 0.1.

4. Use fourth order Runge – Kutta method to find the value of y when x = 0.2, given that y' = x + y2, and y = 1 when x = 0 taking step size 0.1.

5. Explain modified Euler's method.

6 Apply Euler's method and find an approximate value of y corresponding to x = 1, given that y' = x + y and y(0) = 1.

7.Solve y' = x2y – 1, y(0) = 1 by Taylor's series method. Find the values of y at x = 0.1 and x = 0.2.

8.Using modified Euler's method, find an approximate value of y when x =0.3, given that dy/dx =x+y with initial conditiony y(0) =1

9. Using Runge-Kutta method of order 4, solve dy/dx=xy+y2 with initial condition y(0) =1
for x= 0.1,0.2.

10. Discuss brief about milne's predictor correction method.

11.Apply fourth order Runge-Kutta method to find approximate value of y for X= 0.2, given that dy/dc=X+y and y=1 when x=0.

12.Solve the following initial value problem $dy/dx$ = $4e0.8x - 0.5y$ ; $y(0)$ = 2From x = 0 to 0.5 taking h = 0.5 using 4th order Runge - Kutta method.

13.Solve $y'$ =y + $x^2$ with y(0) = 1 using Milne's predictor - corrector method & find y(0.8) taking h = 0.2 with values of y(0.2), y(0.4), y(0.6) listed below

| | | | |
|---|---|---|---|
| x : 0 | 0.2 | 0.4 | 0.6 |
| y : 1 | 1.2242 | 1.5155 | 1.9063 |

14.Apply Euler's method to solve the initial value problem dy/dx= x-y/2 , where y(0) = 1over [0, 3] using step size 0.5.

15. Apply fourth order Runge-Kutta method to find approximate value of y for X=0.2, in steps of 0.1, if dx/dy =$X^2$+$Y^2$  y(0) =1

16.Using Euler's method, find y(0.2) given $dy/dx= y - 2x/y$, $y(0) = 1$ with h = 0.1

17.Solve $dy/dx= 2y + 3ex$, $y(0) = 1$ by Taylor's Series method. Find the approximate value of y for x = 0.1 and x = 0.2

18.Solve d C /dt=1 .5 -4 .5 C/3using Runge-Kutta 4th order method.
Data given: Time interval from t = 0 min to t = 1 min, with step size h = 0.5 min. At time t = 0 min, C0= 1 mol/m3.

19.Desceibe the method of finite difference approximation to partial derivative.

20.solve the following set differential equations using fourth Runge-kutta method assuming that at x=0 y1=4  and y2=6  integrate to X=1 with a step size of 0.5

dy1/dx=-0.5y  dy2/dx= 4-0.3y2- o. 1y1

# L.E.COLLEGE-MORBI

## ASSIGNMENT:-1

**SUBJECT NAME:- NUMERICAL METHODS IN CHEMICAL ENGINEERING** **COURSE OUTCOME:-3140510.4**

**SUBJECT CODE:- 3140510** **SEMESTER:- IV**

**BRANCH:-CHEMICAL ENGINEERING**

1. What is the difference between explicit and implicit function? Explain with examples.

2. Find the cubic polynomial which takes following value evaluate f(4.5)

| | | | | |
|---|---|---|---|---|
| X | 0 | 1 | 2 | 3 |
| F(x) | 1 | 2 | 1 | 10 |

3. From the following data estimate the number of persons having income between 2000 and 2500.

| | | | | | |
|---|---|---|---|---|---|
| Income.- | below 500. . | 500 -1000. | 1000-2000. | 2000-3000. | 3000-4000 |
| No. of persons- | 6000 | 4250 | 3600. | 1500. | 650 |

Given the table

| | | | | | | |
|---|---|---|---|---|---|---|
| x. | 310 | 320 | 330 | 340 | 350. | 360 |
| Logx | 2.4916 | 2.50515 | 2.51851 | 2.53148 | 2.54407 | 2.55630 |

Find the value of log 337.5 by Everett's formula

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## ASSIGNMENT:-2

**SUBJECT NAME:- NUMERICAL METHODS IN CHEMICAL ENGINEERING** **COURSE OUTCOME:-3140510.4**

**SUBJECT CODE:- 3140510** **SEMESTER:- IV**

**BRANCH:-CHEMICAL ENGINEERING**

1. Derive Newton's forward difference formula using numerical method
2. Derive Newton's backward difference formula using numerical method
3. Derive Newton's central difference formula using numerical method
4. Derive Bessel's formula using numerical method

**L.E.COLLEGE-MORBI**

**ASSIGNMENT:-3**

**SUBJECT NAME:- NUMERICAL METHODS IN CHEMICAL ENGINEERING** **COURSE OUTCOME:-3140510.2**

**SUBJECT CODE:- 3140510** **SEMESTER:- IV**

**BRANCH:-CHEMICAL ENGINEERING**

1. Fit a second-degree parabola and line to the following data and evaluate the best curve for the given second data:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| X | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |
| Y | 1.1 | 1.3 | 1.6 | 2.0 | 2.7 | 3.4 | 4.1 |

2. Derive formula for Newton cotes numerical integration

3. Derive formula for trapezoidal rule of numerical integration.

4. Derive formula for Simpson 1/3 rule of numerical integration.

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## ASSIGNMENT:-4

**SUBJECT NAME:- NUMERICAL METHODS IN CHEMICAL ENGINEERING** **COURSE OUTCOME:-3140510.3**

**SUBJECT CODE:- 3140510** **SEMESTER:- IV**

**BRANCH:-CHEMICAL ENGINEERING**

1) (a) Write formula to find inverse of matrix.

   (b) Inverse of A= $\begin{bmatrix} 5 & 3 \\ 3 & 2 \end{bmatrix}$ is ……
2) (a) Define Upper Triangular matrix.

   (b) If A=$\begin{bmatrix} 2 & 4 \\ 5 & 8 \end{bmatrix}$ Find the adj A.

   (c) The condition of convergence of Gauss-Siedel method is that the equations of the system are……..
3) Explain diagonally dominant system.
4) Define Eigen values and Eigen vectors.
5) Explain Gauss-Siedel Method.
6) Describe Gauss-Jordan elimination method.
7) Discuss about the pitfalls of Gauss Elimination method and techniques for improving solutions.

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## ASSIGNMENT:-5

**SUBJECT NAME:- NUMERICAL METHODS IN CHEMICAL ENGINEERING** **COURSE OUTCOME:-3140510.2**

**SUBJECT CODE:- 3140510** **SEMESTER:- IV**

**BRANCH:-CHEMICAL ENGINEERING**

1) Define : (A) Co-efficient of determination ($r^2$)
   (B) Co-relation Coefficient(r)
   (C) Standard error of estimate
2) Give the normal equations to fit a straight line $y = a + bx$ to n observations.
3) For perfect fit, what is value of Co-relation Coefficient(r)?
4) Write a short note on method of least square.
5) Derive normal equation to fit a 2nd order polynomial using least square method.
6) Suggest method to plot the variables y and x, given in the following equation, so that data fitting the equation will fall on straight line: $y = \frac{\alpha x}{1+x(\alpha-1)}$

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## ASSIGNMENT:-6

**SUBJECT NAME:- NUMERICAL METHODS IN CHEMICAL ENGINEERING** **COURSE OUTCOME:-3140510.3**

**SUBJECT CODE:- 3140510** **SEMESTER:- IV**

**BRANCH:-CHEMICAL ENGINEERING**

1. Find the root of equation $x^3-4x-9=0$ using Bisection method correct to three decimal places.