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UPSC CSE Mathematics: Previous Year Questions: Numerical Analysis

2025

1) Solve the following system of linear equations by Gauss-Seidel method:

$$10x + 2y + z = 9$$
$$2x + 20y - 2z = -44$$
$$-2x + 3y + 10z = 22$$

2) Convert the number $(3479)_{10}$ into binary system and the number $(7\text{AE} \cdot 9\text{ F})_{16}$ into decimal system.

3) Determine the truth table for the Boolean function $F(x, y, z) = (x + y + z')(x' + y')$
Also derive the full disjunctive normal form of $F(x, y, z)$ from the truth table.

4) Simplify the Boolean function $F(x, y, z) = xyz + x'yz + xy'z + xyz'$
and draw the corresponding GATE network.

5) Find the unique polynomial of degree 2 or less which fits the following data :

x	:	0	1	3
$f(x)$	:	1	3	55

Also obtain the bound on the truncation error.

6) Find the constant p and error term for the quadrature formula $\int_{x_0}^{x_1} f(x)dx = \frac{h}{2}(f_0 + f_1) + ph^2(f_0' - f_1')$ where $x_0 + h = x_1, f_0 = f(x_0), f_1 = f(x_1)$ and prime (') represents derivative with respect to x. Hence deduce the composite rule for integrating $\int_a^b f(x)dx, a = x_0 < x_1 < \cdots < x_N = b$

2024

1) Using Newton's forward difference formula for interpolation, estimate the value of $f(2 \cdot 5)$ from the following data:

x :	1	2	3	4	5	6
f(x) :	0	1	8	27	64	125

2) Integrate $f(x) = 5x^3 - 3x^2 + 2x + 1$ from $x = -2$ to $x = 4$ using
(i) Simpson's $\frac{3}{8}$ rule with width $\mathrm{h} = 1$, and
(ii) Trapezoidal rule with width $\mathrm{h} = 1$.

3) Draw the logical circuit for the Boolean expression $Y = AB\bar{C} + B\bar{C} + \bar{A}B$. Also, obtain the output Y (truth table) for the three input bit sequences:

$$A = 10001111,\ B = 00111100, C = 11000100$$

4) Solve the following system of linear equations by Gauss-Jordan method

$$2x + 3y - z = 5 \quad 4x + 4y - 3z = 3 \qquad 2x - 3y + 2z = 2$$

5) Determine the decimal equivalent in sign magnitude form of $(8\mathrm{D})_{16}$ and $(\mathrm{FF})_{16}$.

6) Determine the decimal equivalent of $(9\ \mathrm{B}2.1\ \mathrm{A})_{16}$.

2023

1) Given $\frac{dy}{dx} = \frac{y^2-x}{y^2+x}$ with initial condition $y = 1$ at $x = 0$. Find the value of y for $x = 0.4$ by Euler's method, correct to 4 decimal places, taking step length $h = 0.1$.

2) Evaluate, using the binary arithmetic, the following numbers in their given system :

(i) $(634\cdot235)_8 - (132\cdot223)_8$

(ii) $(7\mathrm{AB}\cdot432)_{16} - (5\mathrm{CA}\cdot\mathrm{D}61)_{16}$

3) Solve the system of linear equations

$$7x_1 - x_2 + 2x_3 = 11$$
$$2x_1 + 8x_2 - x_3 = 9$$
$$x_1 - 2x_2 + 9x_3 = 7$$

correct up to 4 significant figures by the Gauss-Seidel iterative method. Take initially guessed solution as $x_1 = x_2 = x_3 \equiv 0$.

4) Find the conjunctive normal form (CNF) of the following Boolean function:

$$f(x, y, z, t) = x \cdot y \cdot z + \bar{x} \cdot y \cdot (t + \bar{z})$$

5) Express the Boolean function $f(x, y, z) = x + \overline{(\bar{x} \cdot \bar{y} + \bar{x} \cdot z)} + z$ in disjunctive normal form (DNF) and construct the truth table for the function.

6) Compute a root of the equation $\log_{10}(2x + 1) - x^2 + 3 = 0$, in the interval [0, 3], by Regula-Falsi method, correct to 6 decimal places.

2022

1) Solve, by Gauss elimination method, the system of equations

$$2x + 2y + 4z = 18$$
$$x + 3y + 2z = 13$$
$$3x + y + 3z = 14$$

2) Convert the number $(1093 \cdot 21875)_{10}$ into octal and the number $(1693.0628)_{10}$ into hexadecimal systems.

3) Express the Boolean function $F(x, y, z) = xy + x'z$ in a product of maxterms form.

4) Find a combinatorial circuit corresponding to the Boolean function

$$f(x, y, z) = [x \cdot (\bar{y} + z)] + y$$

and write the input/output table for the circuit.

5) Using Runge-Kutta method of fourth order, solve the differential equation $\frac{dy}{dx} = x + y^2$ with $y(0) = 1$, at $x = 0 \cdot 2$. Use four decimal places for calculation and step length 0-1.

6) The velocity of a train which starts from rest is given by the following table, the time being reckoned in minutes from the start and the velocity in km/ hour :

t (minutes)	2	4	6	8	10	12	14	16	18	20
v (km/hour)	16	28·8	40	46·4	51·2	32	17·6	8	3·2	0

Using Simpson's $\frac{1}{3}$rd rule, estimate approximately in km the total distance run in 20 minutes.

2021

1) Find a positive root of the equation $3x = 1 + \cos x$ by a numerical technique using initial values $0, \frac{\pi}{2}$; and further improve the result using Newton-Raphson method correct to 8 significant figures.

2) Convert $(3798 \cdot 3875)_{10}$ into octal and hexadecimal equivalents.

3) Obtain the principal conjunctive normal form of $(7P \rightarrow R) \wedge (Q \rightleftarrows P)$.

4) Solve the system of equations

$$\begin{aligned} 3x_1 + 9x_2 - 2x_3 &= 11 \\ 4x_1 + 2x_2 + 13x_3 &= 24 \\ 4x_1 - 2x_2 + x_3 &= -8 \end{aligned}$$

correct up to 4 significant figures by using Gauss-Seidel method after verifying whether the method is applicable in your transformed form of the system.

5) Derive Newton's backward difference interpolation formula and also do error analysis.

6) Obtain the Boolean function $F(x, y, z)$ based on the table given below. Then simplify $F(x, y, z)$ and draw the corresponding GATE network:

x	y	z	$F(x, y, z)$
1	1	1	1
1	1	0	1
1	0	1	1
1	0	0	0
0	1	1	1
0	1	0	0
0	0	1	0
0	0	0	0

2020

1) Show that the equation $f(x) \equiv \cos\frac{\pi(x+1)}{8} + 0.148x - 0.9062 = 0$ has one root in the interval $(-1,0)$ and one in $(0,1)$. Calculate the negative root correct to four decimal places using Newton-Raphson Method.

2) Let $g(w,x,y,z) = (w+x+y)(x+\bar{y}+z)(w+\bar{y})$ be a Boolean function. Obtain the conjunctive normal form for $g(w,x,y,z)$. Also express $g(w,x,y,z)$ as product of maxterms.

3) For the solution of system of equations:

$$4x + y + 2z = 4$$
$$3x + 5y + z = 7$$
$$x + y + 3z = 3$$

Set up the Gauss-Seidel iterative scheme and iterate three times starting with initial vector $X^{(0)} = 0$. Also find the exact solutions and compare with the iterated solutions.

4) Find a quadrature formula $\int_0^1 f(x)\frac{dx}{\sqrt{x(1-x)}} = \alpha_1 f(0) + \alpha_2 f\left(\frac{1}{2}\right) + \alpha_3 f(1)$ which is exact for polynomials of highest possible degree. Then use the formula to evaluate $\int_0^1 \frac{dx}{\sqrt{x-x^3}}$ (correct up to three decimal places).

5) Write the three-point Lagrangian interpolating polynomial relative to the points $x_0, x_0+\varepsilon$ and x_1. Then by taking the limit $\varepsilon \to 0$, establish the relation

$$f(x) = \frac{(x_1-x)(x+x_1-2x_0)}{(x_1-x_0)^2}f(x_0) + \frac{(x-x_0)(x_1-x)}{(x_1-x_0)}f'(x_0) + \frac{(x-x_0)^2}{(x_1-x_0)}f(x_1) + E(x)$$

where $E(x) = \frac{1}{6}(x_1-x_0)^2(x-x_1)f'''(\xi)$ is the error function and $\min(x_0, x_0+\varepsilon, x_1) < \xi < max(x_0, x_0+\varepsilon, x_1)$.

2019

1) Apply Newton-Raphson method, to find real root of transcendental equation, $x\log_{10} x = 1.2$ correct to three decimal places.

2) Using Runge-Kutta method of forth order to solve $\frac{dy}{dx} = \frac{y^2-x^2}{y^2+x^2}$ with $y(0) = 1$ at $x = 0.2$. Use four decimal places for calculation and step length 0.2

3) Draw a flow chart and write a basic algorithm for (in FORTRAN/C/C ++) for evaluating $y = \int_0^6 \frac{dx}{1+x^2}$ using Trapezoidal rule

4) Find the equivalent numbers given in a specified number to the system mentioned against them:
   - (i) Integer 524 in binary system.
   - (ii) 101010110101.101101011 to octal system.
   - (iii) decimal number 5280 to hexadecimal system.

(iv) Find the unknown number $(1101.101)_8 \rightarrow (\,?\,)_{10}$.

5) Apply Gauss-Seidel iteration method to solve the following system of equations:

$2x + y - 2z = 17\ 3x + 20y - z = 182x - 3y + 20z = 25$, correct to three decimal places.

6) Given the Boolean expression. $X = AB + ABC + A\bar{B}\bar{C} + \bar{A}\bar{C}$

(i) Draw the logical diagram for the expression.

(ii) Minimize the expression.

(iii) Draw the logical diagram for the reduced expression.

2018

1) Using Newton's forward difference formula find the lowest degree polynomial u_x when it is given that $u_1 = 1, u_2 = 9, u_3 = 25, u_4 = 55$ and $u_2 = 105$.

2) Starting from rest in the beginning, the speed (in $\mathrm{km/h}$) of a train at different times (in minutes) is given by the below table:

समय (मिनट) *Time (Minutes)*	2	4	6	8	10	12	14	16	18	20
रफ़्तार (किमी/घं) *Speed (Km/h)*	10	18	25	29	32	20	11	5	2	8·5

Using Simpsons' $\frac{1}{3}rd$ rule, Find the approximate distance travelled (in km) in 20 minutes from the beginning.

3) Write down the basic algorithm for solving the equation $xe^x - 1 = 0$ by bisection method, correct to 4 decimal places.

4) Find the equivalent of numbers given in a specified number system to the system mentioned against them.

(i) $(111011 \cdot 101)_2$ to decimal system

(ii) $(1000111110000 \cdot 00101100)_2$ to hexadecimal system

(iii) $(\mathrm{C4\ F2})_{16}$ to decimal system

(iv) $(418)_{10}$ to binary system

5) Simplify the Boolean expression: $(a + b).(\bar{b} + c) + b \cdot (\bar{a} + \bar{c})$ By using the laws of Boolean algebra. From its truth table write it in min-terms normal form.

6) Find the values of the constants a, b, c such that the quadrature formula

$\int_o^h f(x)dx = h\left[af(o) + bf\left(\frac{h}{3}\right) + cf(h)\right]$ is exact for polynomials of as high degree as possible, and hence find the order of the truncation error.

2017

1) Explain the main steps of the Gauss-Jordan method and apply this method to find the inverse of the matrix $\begin{bmatrix} 2 & 6 & 6 \\ 2 & 8 & 6 \\ 2 & 6 & 8 \end{bmatrix}$

2) Write the Boolean expression $z(y+z)(x+y+z)$ in the simplest form using Boolean postulate rules. Mention the rules used during simplification. Verify your result by constructing the truth table for the given expression and for its simplest form.

3) For given equidistant values u_{-1}, u_0, u_1 and u_2 a values are interpolated by Lagrange's formula. Show that it may be written in the form $u_x = yu_0 + xu_1 + \frac{y(y^2-1)}{3!}\Delta^2 u_{-1} + \frac{x(x^2-1)}{3!}\Delta^2 u_0,$ where $x + y = 1$.

4) Derive the formula $\int_a^b ydx = \frac{3h}{8}[(y_0 + y_n) + 3(y_1 + y_2 + y_4 + y_5 + \cdots + y_{n-1}) + 2(y_3 + y_6 + y_{n-3})]$. Is there any restriction on ? State that condition. What is the error bounded in the case of Simpson's $\frac{3}{8}$ rule?

5) Write an algorithm in the form of a flow chart for Newton-Raphson method. Describe the cases of failure of this method.

2016

1) Convert the following decimal numbers to univalent binary and hexadecimal numbers:

   [i] 4096 [ii] 0.4375 [iii] 2048.0625

2) Let $f(x) = e^{2x}\cos\ 3x$ for $x \in [0,1]$. Estimate the value of $f(0.5)$ Using Lagrange interpolating polynomial of degree 3 over the nodes $x = 0, x = 0.3, x = 0.6$ and $x = 1$. Also compute the error bound over the interval $[0,1]$ and the actual error $E(0.5)$

3) For an integral $\int_{-1}^{1} f(x)dx$ show that the two-point Gauss quadrature rule is given by $\int_{-1}^{1} f(x)dx = f\left(\frac{1}{\sqrt{3}}\right) + f\left(-\frac{1}{\sqrt{3}}\right)$ using this rule estimate $\int_2^4 2xe^x dx$

4) Let A, B, C be Boolean variable denote complement $A, A + B$ of is an expression for $AORB$ and $B.A$ is an expression for $AANDB$. Then simplify the following expression and draw a block diagram of the simplified expression using AND and OR gates.

   A.$(A + BC) \cdot (\bar{A} + B + C) \cdot (A + \bar{B} + C) \cdot (A + B + \bar{C})$.

2015

1) Find the principal [or canonical] disjunctive normal form in three variables p, q, r for the Boolean expression $((p \wedge q) \to r) \vee ((p \wedge q) \to -r)$. Is the given Boolean expression a contradiction or a tautology?

2) Find the Lagrange interpolating polynomial that fits the following data:

x	:	-1	2	3	4
$f(x)$	:	-1	11	31	69

Find $f(1.5)$

3) Solve the initial value problem $\frac{dy}{dx} = x(y - x), y(2) = 3$ in the interval [2, 2.4] using the RungeKutta fourth-order method with step size $h = 0.2$

4) Find the solution of the system

$$10x_1 - 2x_2 - x_3 - x_4 = 3$$
$$-2x_1 + 10x_2 - x_3 - x_4 = 15$$
$$-x_1 - x_2 + 10x_3 - 2x_4 = 27$$
$$-x_1 - x_2 - 2x_3 + 10x_4 = -9$$

using Gauss-Seidel method (make four iterations)

2014

1) Apply Newton-Raphson method to determine a root of the equation $\cos x - xe^x = 0$ correct up to four decimal places.

2) Use five subintervals to integrate $\int_0^1 \frac{dx}{1+x^2}$ using trapezoidal rule.

3) Use only AND and OR logic gates to construct a logic circuit for the Boolean expression $z = xy + uv$

4) Solve the system of equations using Gauss-Seidel iteration method [perform three iterations]

$$2x_1 - x_2 = 7$$
$$-x_1 + 2x_2 - x_3 = 1$$
$$-x_2 + 2x_3 = 1$$

5) Use Runge-Kutta formula of fourth order to find the value of y at $x = 0.8$, where $\frac{dy}{dx} = \sqrt{x + y}, y(0.4) = 0.41$. Take the step length $h = 0.2$

6) Draw a flowchart for Simpson's one-third rule.

7) For any Boolean variables x and y, show that $x + xy = x$.

2013

1) In an examination, the number of students who obtained marks between certain limits were given in the following table:

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

Using Newton's forward interpolation formula, find the number of students whose marks lie between 45 and 50.

2) Develop an algorithm for Newton-Raphson method to solve $f(x) = 0$ starting with initial iterate x_0, n be the number of iterations allowed, epsilon be the prescribed relative error and delta be the prescribed lower bound for $f'(x)$

3) Use Euler's method with step size $h = 0.15$ to compute the approximate value of $y(0.6)$, correct up to five decimal places from the initial value problem. $y' = x(y + x) - 1, y(0) = 2$

4) The velocity of a train which starts from rest is given in the following table. The time is in minutes and velocity is in km/ hour.

t	2	4	6	8	10	12	14	16	18	20
v	16	28·8	40	46·4	51·2	32·0	17·6	8	3·2	0

Estimate approximately the total distance run in 30 minutes by using composite Simpson's $\frac{1}{3}$ rule.

2012

1) Use Newton-Raphson method to find the real root of the equation $3x = \cos x + 1$ correct to four decimal places

2) Provide a computer algorithm to solve an ordinary differential equation $\frac{dy}{dx} = f(x, y)$ in the interval $[a, b]$ for n number of discrete points, where the initial value is $y(a) = \alpha$, using Euler's method.

3) Solve the following system of simultaneous equations, using Gauss-Seidel iterative method:

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

4) Find $\frac{dy}{dx}$ at $x = 0.1$ from the following data:

x :	0·1	0·2	0·3	0·4
y :	0·9975	0·9900	0·9776	0·9604

5) In a certain examination, a candidate has to appear for one major and two minor subjects. The rules for declaration of results are : marks for major are denoted by M_1 and for minors by M_2 and M_3. If the candidate obtains 75% and above marks in each of the three subjects, the candidate is declared to have passed the examination in first class with distinction. If the candidate obtains 60% and above marks in each of the three subjects, the candidate is declared to have passed the examination in first class. If the candidate obtains 50% or above

in major, 40% or above in each of the two minors and an average of 50% or above in all the three subjects put together, the candidate is declared to have passed the examination in second class. All those candidates, who have obtained 50% and above in major and 40% or above in minor, are declared to have passed the examination. If the candidate obtains less than 50% in major or less than 40% in any one of the two minors, the candidate is declared to have failed in the examinations. Draw a flow chart to declare the results for the above.

2011

1) Calculate $\int_2^{10} \frac{dx}{1+x}$ [up to 3 places of decimal] by dividing the range into 8 equal parts by Simpson's $\frac{1}{3}$rd rule.

2) Compute $(3205)_{10}$ to the base 8.

3) Let A be an arbitrary but fixed Boolean algebra with operations ∧,∨ and ' and the zero and the unit element denoted by 0 and 1 respectively. Let x, y, z ... be elements of A. If $x, y \in A$ be such that $x \wedge y = 0$ and $x \vee y = 1$ then prove that $y = x'$

4) A solid of revolution is formed by rotating about the x-axis, the area between the x-axis, the line $x = 0$ and $x = 1$ and a curve through the points with the following co-ordinates:

x	·00	·25	·50	·75	1
y	1	·9896	·9589	·9089	·8415

Find the volume of the solid.

5) Find the logic circuit that represents the following Boolean function. Find also an equivalent simpler circuit:

x	y	z	f(x, y, z)
1	1	1	1
1	1	0	0
1	0	1	0
1	0	0	0
0	1	1	1
0	1	0	0
0	0	1	0
0	0	0	0

6) Draw a flow chart for Lagrange's interpolation formula.

2010

1) Find the positive root of the equation $10xe^{-x^2} - 1 = 0$ correct up to 6 decimal places by using Newton-Raphson method. Carry out computations only for three iterations.

2) Suppose a computer spends 60 per cent of its time handling a particular type of computation when running a given program and its manufacturers make a change that improves its performance on that type of computation by a factor of 10 . If the program takes 100 sec to execute, what will its execution time be after the change?

3) If $A \oplus B = AB' + A'B$, find the value of $x \oplus y \oplus z$.

4) Given the system of equations

$$\begin{aligned} &2x + 3y = 1 \\ &2x + 4y + z = 2 \\ &2y + 6z + Aw = 4 \\ &4z + Bw = C \end{aligned}$$

State the solvability and uniqueness conditions for the system. Give the solution when it exists.

5) Find the value of the integral $\int_1^5 \log_{10} x dx$ by using Simpson's $\frac{1}{3}$rd rule correct up to 4 decimal places. Take 8 subintervals in your computation.

6) Find the hexadecimal equivalent of the decimal number $(587632)_{10}$

7) For the given set of data points $(x_1, f(x_1), (x_2, f(x_2), \ldots . (x_n, f(x_n))$. Write an algorithm to find the value of $f(x)$ by using Lagrange's interpolation formula

8) Using Boolean algebra, simplify the following expressions

[a] $a + a'b + a'b'c + a'b'c'd + \cdots$

[b] $x'y'z + yz + xz$ where x' represents the complement of x

2009

1) The equation $x^2 + ax + b = 0$ has two real roots α and β. Show that the iterative method given by: $x_{k+1} = -\frac{(ax_k+b)}{x_k}, k = 0,1,2 \ldots$ is convergent near $x = \alpha$, if $|\alpha| > |\beta|$

2) Find the values of two valued Boolean variables A, B, C, D by solving the following simultaneous equations:

$$\begin{aligned} &\bar{A} + AB = 0 \\ &AB + AC \\ &AB + A\bar{C} + CD = \bar{C}D \end{aligned}$$

where $\bar{x}$ represents the complement of x

3) Realize the following expressions by using NAND gates only: $g = (\bar{a} + \bar{b} + c)\bar{d}(\bar{a} + e)f$ where $\bar{x}$ represents the complement of x.

4) Find the decimal equivalent of $(357.32)_8$

5) Develop an algorithm for Regula-Falsi method to find a root of $f(x) = 0$ starting with two initial iterates x_0 and x_1 to the root such that $\operatorname{sign}(f(x_0)) \neq \operatorname{sign}(f(x_1))$. Take n as the maximum number of iterations allowed and epsilon be the prescribed error.

6) Using Lagrange interpolation formula, calculate the value of $f(3)$ from the following table of values of x and $f(x)$:

x	0	1	2	4	5	6
f(x)	1	14	15	5	6	19

7) Find the value of $y(1.2)$ using Runge-Kutta fourth order method with step size $h = 0.2$ from the initial value problem: $y' = xy, y(1) = 2$

2008

1) Find the smallest positive root of equation $xe^x - \cos\ x = 0$ using Regula-Falsi method. Do three iterations.

2) State the principle of duality

   (i) in Boolean algebra and give the dual of the Boolean expressions

   $$(X + Y) \cdot (\bar{X} \cdot \bar{Z}) \cdot (Y + Z) \text{ and } X\bar{X} = 0$$

   (ii) Represent $(\bar{A} + \bar{B} + \bar{C})(A + \bar{B} + C)(A + B + \bar{C})$ in NOR to NOR logic network.

3) The following values of the function $f(x) = \sin\ x + \cos\ x$ are given:

x	10^0	20^0	30^0
$f(x)$	1.1585	1.2817	1.3360

Construct the quadratic interpolating polynomial that fits the data. Hence calculate $f\left(\frac{\pi}{12}\right)$. Compare with exact value.

4) Apply Gauss-Seidel method to calculate x, y, z from the system:

$$-x - y + 6z = 42$$
$$6x - y - z = 11.33$$
$$-x + 6y - z = 32$$

with initial values $(4.67, 7.62, 9.05)$. Carry out computations for two iterations

5) Draw a flow chart for solving equation $F(x) = 0$ correct to five decimal places by Newton-Raphson method

2007

1) Use the method of false position to find a real root of $x^3 - 5x - 7 = 0$ lying between 2 and 3 and correct to 3 places of decimals.

2) Convert:

   (i) 46655 given to be in the decimal system into one in base 6.

   (ii) $(11110.01)_2$ into a number in the decimal system.

3) Find from the following table, the area bounded by the x-axis and the curve $y = f(x)$ between $x = 5.34$ and $x = 5.40$ using the trapezoidal rule:

x	5.34	5.35	5.36	5.37	5.38	5.39	5.40
$f(x)$	1.82	1.85	1.86	1.90	1.95	1.97	2.00

4) Apply the second order Runge-Kutta method to find an approximate value of y at $x = 0.2$ taking $h = 0.1$, given that y satisfies the differential equation and initial condition $y' = x + y, y(0) = 1$

2006

1) Evaluate $I = \int_0^1 e^{-x^2} dx$ by the Simpson's rule

$\int_a^b f(x)dx \approx \frac{\Delta x}{3}[f(x_0) + 4f(x_1) + 2f(x_2)] + 4f(x_3) + \cdots .. +2f(x_{2n-2}) + 4f(x_{2n-1}) + f(x_{2n})\Big]$

with $2n = 10, \Delta x = 0.1, x_0 = 0, x_1 = 0.1, \dots, x_{10} = 1.0$

2) [i] Given the number 59.625 in decimal system. Write its binary equivalent.

[ii] Given the number 3898 in decimal system. Write its equivalent in system base 8.

3) If Q is a polynomial with simple roots $\alpha_1, \alpha_2, \dots \alpha_n$ and if P is a polynomial of degree $< n$, show that $\frac{P(x)}{Q(x)} = \sum_{k=1}^{n} \frac{P(\alpha_k)}{Q'(\alpha_k)(x-\alpha_k)}$. Hence prove that there exists a unique polynomial of degree with given values c_k at the point $\alpha_k, k = 1,2, \dots n.$.

4) Draw a flowchart and algorithm for solving the following system of 3 linear equations in 3 unknowns $x_1, x_2 \& x_3: C * X = D$ with $C = \left(c_{ij}\right)_{i,j=1}^{3}, X = \left(x_j\right)^3{}_{j=1}, D = (d_i)^3{}_{i=1}$

2005

1) Use appropriate quadrature formulae out of the Trapezoidal and Simpson's rules to numerically integrate $\int_0^1 \frac{dx}{1+x^2}$ with $h = 0.2$. Hence obtain an approximate value of π. Justify the use of particular quadrature formula.

2) Find the hexadecimal equivalent of $(41819)_{10}$ and decimal equivalent of $(111011.10)_2$

3) Find the unique polynomial $P(x)$ of degree 2 or less such that $P(1) = 1, P(3) = 27, P(4) = 64$. Using the Lagrange's interpolation formula and the Newton's divided difference formula, evaluate $P(1.5)$

4) Draw a flow chart and also write algorithm to find one real root of the nonlinear equation $x = \phi(x)$ by the fixed-point iteration method. Illustrate it to find one real root, correct up to four places of decimals, of $x^3 - 2x - 5 = 0$

2004

1) The velocity of a particle at distance from a pint on it s path is given by the following table:

S(meters)	0	10	20	30	40	50	60
V(m/sec)	47	58	64	65	61	52	38

Estimate the time taken to travel the first 60 meters using Simpson's $\frac{1}{3}$rd rule. Compare the result with Simpson's $\frac{3}{8}$th rule.

2) [i] If $(ABCD)_{16} = (x)_2 = (y)_8 = (z)_{10}$ then find $x, y\&z$

[ii] In a 4-bit representation, what is the value of 1111 in signed integer form, unsigned integer form, signed 1's complement form and signed 2's complement form?

3) How many positive and negative roots of the equation $e^x - 5\sin\, x = 0$ exist? Find the smallest positive root correct to 3 decimals, using Newton-Raphson method.

4) Using Gauss-Seidel iterative method, find the solution of the following system:

$$4x - y + 8z = 26$$
$$5x + 2y - z = 6 \text{ up to three iterations.}$$
$$x - 10y + 2z = -13$$

2003

1) Evaluate $\int_0^1 e^{-x^2} dx$ by employing three points Gaussian quadrature formula, finding the required weights and residues. Use five decimal places for computation.

2) [i] Convert the following binary number into octal and hexa decimal system: 101110010.10010

3) [ii] Find the multiplication of the following binary numbers: 11001.1 and 101.1

4) Find the positive root of the equation $2e^{-x} = \frac{1}{x+2} + \frac{1}{x+1}$ using Newton-Raphson method correct to four decimal places. Also show that the following scheme has error of second order: $x_{n+1} = \frac{1}{2}x_n\left(1 + \frac{a}{x_n^2}\right)$

5) Draw flow chart and algorithm for Simpson's $\frac{1}{3}$rd rule for integration $\int_a^b \frac{1}{1+x^2} dx$ correct to 10^{-6}

2002

1) Find a real root of the equation $f(x) = x^3 - 2x - 5 = 0$ by the method of false position.

2) Convert $(100.85)_{10}$ into its binary equivalent.

3) Multiply the binary numbers $(1111.01)_2$ and $(1101.11)_2$ and check with its decimal equivalent

4) Find the cubic polynomial which takes the following values: $y(0) = 1, y(1) = 0, y(2) = 1$ & $y(3) = 10$. Hence, or otherwise, obtain $y(4)$

5) Given: $\frac{dy}{dx} = y - x$ where $y(0) = 2$, using the Runge-Kutta fourth order method, find $y(0.1)$ and $y(0.2)$. Compare the approximate solution with its exact solution. ($e^{0.1} = 1.10517, e^{0.2} = 1.2214$).

6) Draw a flow chart to examine whether a given number is a prime.

2001

1) Show that the truncation error associated with linear interpolation of $f(x)$, using ordinates at x_0 and x_1 with $x_0 \leq x \leq x_1$ is not larger in magnitude than $\frac{1}{8}M_2(x_1 - x_0)^2$ where $M_2 = \max|f''(x)|$ in $x_0 \leq x \leq x_1$. Hence show that if $f(x) = \frac{2}{\sqrt{\pi}}\int_0^{\pi} e^{-t^2}dt$, the truncation error corresponding to linear interpolation of $f(x)$ in $x_0 \leq x \leq x_1$ cannot exceed $\frac{(x_1-x_0)^2}{2\sqrt{2\pi e}}$.

2) Given $A \cdot B' + A'.B = C$ show that $A \cdot C' + A' \cdot C = B$

3) Express the area of the triangle having sides of lengths $6\sqrt{2}$, 12,$6\sqrt{2}$ units in binary number system.

4) Using Gauss Seidel iterative method and the starting solution $x_1 = x_2 = x_3 = 0$, determine the solution of the following system of equations in two iterations

$$10x_1 - x_2 - x_3 = 8$$
$$x_1 + 10x_2 + x_3 = 12.$$
$$x_1 - x_2 + 10x_3 = 10$$

Compare the approximate solution with the exact solution

5) Find the values of the two-valued variables $A, B, C \& D$ by solving the set of simultaneous

$$A' + A \cdot B = 0$$

equations $A \cdot B = A \cdot C$

$$A \cdot B + A.C' + C.D = C'.D$$