Seat No./Enrollment No.: ________

GUJARAT TECHNOLOGICAL UNIVERSITY
BACHELOR OF ENGINEERING – SEMESTER 4 – EXAMINATION – SUMMER 2026

Subject Code: 3140510 **Date: 25/05/2026**

Subject Name: Numerical Methods in Chemical Engineering

Time: 10:30 AM TO 01:00 PM **Total Marks: 70**

Instructions:

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

Q.1 **(a)** Differentiate between accuracy and precision with appropriate examples. **03**

(b) Explain diagonal dominant condition and its importance in convergence of Gauss-sidel method. **04**

(c) A chemical reaction A→B takes place in a CSTR. The following model describes the system: **07**

$$\frac{C_{in} - C_A}{\tau} - \frac{k\sqrt{C_A}}{K + C_A} = 0$$

where, k=1, K=0.25, C_{in}=1 and τ=0.25. Report C_A obtained after fourth iteration of Secant method. Consider C_A=0 and C_A=1 as two initial guesses for Secant method

Q.2 **(a)** Explain about the system of ill-conditioned equations using appropriate example **03**

(b) Define Following Terms **04**
1. Accuracy Numbers
2. Inherent Errors
3. Absolute, Relative and Percentage Errors
4. Truncation Errors

(c) Amount of dissolved oxygen in a lake gives an estimate of its health. The saturation concentration of dissolved oxygen in freshwater can be calculated using: **07**

$$\ln(O_S) = -139.34411 + \frac{1.575701 \text{ X } 10^5}{T} - \frac{6.642308 \text{ X } 10^7}{T^2} + \frac{1.243800 \text{ X } 10^{10}}{T^3} - \frac{8.621949 \text{ X } 10^{11}}{T^4}$$

In the above equation, T is the temperature in Kelvins and o_S is the saturation oxygen concentration. The typical saturation concentrations ranges from 14.621 mg/L at 273 K to 6.413 mg/L at 313 K. Using bisection method, find temperature of fresh water that gives o_S= 8 mg/L

OR

Q.2 **(c)** Solve the following system of equations using Gauss elimination method. **07**

$x + 4y - z = -5$, $x + y - 6z = -12$
$3x - y - z = 4$

Q.3 **(a)** Write significance of least square method **03**

(b) Write an algorithm for false position method. **04**

(c) Consider the following example of linear equations in four variables **07**

$5x_1 + 4x_3 + x_4 = -6$

$4x_1 + 5x_2 + 2x_3 = 8$

$4x_1 + 4x_2 + 4x_3 + x_4 = 1$

$x_1 + 2x_2 + 2x_3 + 3x_4 = 2$

Please write the equations in the form Ax=b, and calculate the values of four variables using Gauss-Jordan method.

OR

Q.3 **(a)** Find a real root of the equation $e^x - 3x = 0$ up to one decimal places using Newton-Raphson method. Take $x_0 = 0$. **03**

(b) Find the root of the equation $xlog_{10}^{x} = 1.2$ using the regula-falsi (false position) method up to two iterations. **04**

(c) The relationship between stress ‘τ’ and the strain ‘γ’ for a pseudoplastic fluid can be expressed by the following equation: $\tau = \mu\gamma^n$ The following data come from a 0.5% hydroxethylcellulose in water solution. Using linear least square method, Estimate the parameters ‘μ’ and ‘n’. **07**

γ	50	70	90	110	130
τ	6.01	7.48	8.59	9.19	10.21

Q.4 **(a)** Describe application of Newton’s divided difference formula. **03**

(b) Apply Lagrange's interpolation formula to find the value of y when x=10, if the following values of x and y are given. **04**

x	5	6	9	11
y	12	13	14	16

(c) Find by Taylor’s series method, the values of y at x = 0.1 and x = 0.2 to five places of decimals from $\frac{dy}{dx} = x^2y - 1$, y (0) = 1. **07**

OR

Q.4 **(a)** Round off the number 75462 to four significant digits and then calculate the absolute error and percentage error. **03**

(b) Using the modified Euler’s method, find $y(0.2)$ given **04**

$$\frac{dy}{dx} = y + e^x, \qquad y(0) = 0$$

(c) Consider the following data obtained from experiments: **07**

x	1.0	1.1	1.2	1.3	1.4	1.5
y	2.0	2.3	2.6	2.95	3.34	3.76

The linear model is of the form: $y = a_0 + a_1x$

Obtain parameters a_0 and a_1 using method of group averages.

Q.5 **(a)** List out the methods used to solve ODEs using numerical method and also write its limitation. **03**

(b) Given that evaluate $\int_4^{5.2} \log x \, dx$ Using any one method. **04**

x	4.0	4.2	4.4	4.6	4.8	5.0	5.2
log x	1.3863	1.4351	1.4816	1.5261	1.5686	1.6094	1.6487

(c) The following table gives the value of density (d) of a saturated water for various temperature (T) of saturated stream. **07**

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 270°C.

OR

Q.5 **(a)** Write the significance of Newton Rapson/Secant method. **03**

(b) Using Newton's divided difference formula find f(8) from given table: **04**

x	4	5	7	10	11	13
F(x)	48	100	294	900	1210	2028

(c) Using Runge-Kutta method of order 4, solve $\frac{dy}{dx} = xy + y^2$ with initial condition y (0) = 1 , For x = 0.1, 0.2. **07**

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Enrolment No./Seat No_______________

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV EXAMINATION – SUMMER 2025

Subject Code:3140510 Date:15-05-2025

Subject Name:Numerical Methods in Chemical Engineering

Time:10:30 AM TO 01:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

MARKS

Q.1 **(a)** Explain False position method. **03**

(b) Explain intermediate value property theorem. **04**

(c) Find the relative error if the number X = 0.004997 is **07**
(i) truncated to three decimal digits
(ii) rounded off to three decimal digits.

Q.2 **(a)** Enlist various methods for solving linear algebraic equations. **03**

(b) Explain various types of errors in computations. **04**

(c) Find a root of the equation $x^3 - 4x - 9 = 0$, using the bisection method correct to three decimal places. **07**

OR

(c) Find the root of the equation $xe^x = \cos x$, using the secant method correct to four decimal places. **07**

Q.3 **(a)** Explain Descarte's rule of sign with example. **03**

(b) Find x_2 of $x^4 - x = 10$, correct to three decimal places, using the Newton-Raphson method, where $x_0 = 2$. **04**

(c) Solve the following equations using Gauss-Jacobi's method. **07**

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

OR

Q.3 **(a)** Enlist Limitations of Newton-Raphson's Method. **03**

(b) Solve the following equations by the Gauss elimination method: **04**

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

(c) Fit a curve of the form $y = ae^{bx}$, to the following data: **07**

x:	0	1	2	3
y:	1.05	2.10	3.85	8.30

Q.4 **(a)** Find the iterative formula for finding $\sqrt{N}$ where is N is real number, using Newton Raphson formula. **03**

(b) Explain working procedure of method of least square. **04**

(c) Find the missing values in the following data: **07**

x:	45	50	55	60	65
y:	3.0	……	2.0	…..	-2.4

OR

Q.4 **(a)** Write down normal equations to fit the straight line $y = a + bx$. **03**

(b) Evaluate (i) $\Delta \tan^{-1} x$, (ii) $\Delta(e^x log2x)$ **04**

(c) Find the cubic polynomial which takes the following values: **07**

x:	0	1	2	3

y:	1	2	1	10

Hence evaluate $f(4)$.

Q.5 **(a)** Write an algorithm for Newton's Forward interpolation method. **03**

(b) Use the Trapezoidal rule to estimate the integral $\int_0^2 ex^2dx$ taking the number 10 intervals. **04**

(c) Solve $y' = x + y,\ y(0) = 1$ by Taylor's series method. Hence find the values of y at $x = 0.1\ and\ x = 0.2$. **07**

OR

Q.5 **(a)** Write an algorithm for Trapezoidal Rule. **03**

(b) Discuss in brief about boundary problems. **04**

(c) Using Euler's method, find an approximate value of y corresponding to $x = 1$, given that $dy/dx = x + y\ and\ y = 1\ when\ x = 0$. **07**

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Enrolment No./Seat No_______________

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV (NEW) EXAMINATION – SUMMER 2024

Subject Code:3140510 **Date:20-07-2024**

Subject Name: Numerical Methods in Chemical Engineering

Time:10:30 AM TO 01:00 PM **Total Marks:70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

Q.1 **(a)** Differentiate between accuracy and precision with appropriate example. **03**

(b) Find the percentage error in the area of an ellipse where an error of 1% is made in measuring its major and minor axis. **04**

(c) Fit a second degree parabola to the following data. **07**

x	0	1	2	3	4
y	1	1.8	1.3	2	6.3

Q.2 **(a)** Use Descartes' rule of signs to find the number of positive, negative and imaginary roots of the function: $x^6 - x^5 - 10x + 7 = 0$ **03**

(b) Find root of the equation $x^3 - 2x - 5 = 0$ using the bisection method correct upto three decimal places. **04**

(c) Air at 25 °C and 1 atm flows through a 4 mm diameter tube with an average velocity of 50 m/s. The roughness is e = 0.0015 mm. Density of air at 25 °C and 1 atm is 1.23 kg/m^3. Calculate the friction factor using the Colebrook equation **07**

$$\frac{1}{\sqrt{f}} = -2.0\log\{\frac{\frac{e}{D}}{3.7} + \frac{2.51}{Re\sqrt{f}}\}$$

Determine the pressure drop in 1 m section of the tube using the relation

$$\Delta P = \frac{fLV^2\rho}{2D}$$

OR

(c) Solid particles having a diameter of 0.12 mm, shape factor Φ_s =0.88 and a density of 1000 kg/m^3 are to be fluidized using air at 2.0 atm and 25°C. The voidage at minimum fluidization is 0.42. The viscosity of air under these conditions is 1.845*10^{-5} kg/m.s. The molecular weight of air is 28.97 g/mol. The diameter of the particle is 1.2*10^{-4} m. Estimate the minimum fluidization velocity using newton Raphson method. **07**

The Ergun equation for packed bed is given below.

$$[\frac{1.75\ \rho(1-e_{mf})}{\Phi_s d_p\ e_{mf}^3}]v_{mf}^2 + [\frac{150\ \mu(1-e_{mf})^2}{\Phi_s^2 d_p^2\ e_{mf}^3}]v_{mf} - (1 - e_{mf})(\rho_p - \rho)g = 0$$

Q.3 **(a)** Define Eigen values and Eigen vectors. **03**

(b) Find numerically the largest Eigen value and corresponding Eigen Vector of the following matrix using power method. **04**

$$A = \begin{bmatrix} 1 & 6 & 1 \\ 1 & 2 & 0 \\ 0 & 0 & 3 \end{bmatrix}$$

(c) Given the values **07**

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

Determine f(9).

OR

Q.3 **(a)** Discuss the pitfalls of Gauss - Elimination method and techniques for improving solutions. **03**

(b) Solve the following system of simultaneous equations by Gauss seidal method **04**

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

(c) The function y= sinx is tabulated below **07**

x	0	π/4	π/2
y	0	0.70711	1.0

Using Lagrange's interpolation formula find the value of sin(π/6)

Q.4 **(a)** State the formulas for Trapezoidal Rule, Simpsons 1/3rd rule, Simpsons 3/8th rule. **03**

(b) Solve the following system of equations by Gauss Elimination method: **04**

$2x + y + z = 10$

$3x + 2y + 3z = 18$

$x + 4y + 9z = 16$

(c) Given that y = ln x, and **07**

x	4.0	4.2	4.4	4.6	4.8	5.0	5.2
y	1.3863	1.4351	1.4816	1.5261	1.5686	1.6094	1.6487

Evaluate $\int_4^{5.2} \ln x \, dx$ using simpsons 3/8 rule.

OR

Q.4 **(a)** Derive formula for Trapezoidal Rule of numerical integration. **03**

(b) Apply Gauss Jordan to solve the equations **04**

10x + y + z = 12

x +10y + z = 12

x + y + 10z = 12

(c) Evaluate $\int_0^6 \frac{1}{1+x} dx$ taking h=1 using Simpson 1/3 rule. **07**

Q.5 **(a)** Discuss in brief about initial and boundary value problems. **03**

(b) Prove the following **04**

(i) $\Delta = E-1$

(ii) $\nabla = 1-E^{-1}$

(c) Using Euler's method, find an approximate value of y corresponding to x = 0.1 for the following equation. **07**

$$\frac{dy}{dx} = \frac{y-x}{y+x}$$

Take y(0)=1 and h=0.02

OR

Q.5 **(a)** Explain Milne’s predictor corrector method **03**

(b) Given that **04**

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

Find $\frac{dy}{dx}$ at x=1.1

(c) Using Runge Kutta method of fourth order, solve the following at x=0.2 and 0.4. Take y(0)=1 **07**

$$\frac{dy}{dx} = \frac{y^2 - x^2}{y^2 + x^2}$$

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Seat No.: ________ Enrolment No.___________

GUJARAT TECHNOLOGICAL UNIVERSITY

BE –SEMESTER -IV (NEW)EXAMINATION- SUMMER 2024

Subject Code:3140510 **Date:**

Subject Name: Numerical Methods in Chemical Engineering

Time: **Total Marks: 70**

Instructions:

5. **Attempt all questions.**
6. **Make suitable assumptions wherever necessary.**
7. **Figures to the right indicate full marks.**

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<tr><td></td><td>(b)</td><td>Solve the following system of equations by Gauss Elimination method:
$2x + y + z = 10$
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10x + y + z = 12
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$$\frac{dy}{dx} = \frac{y - x}{y + x}$$
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Find $\frac{dy}{dx}$ at x=1.1</td><td>04</td><td>CO4</td><td>U</td></tr>
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	(c)	Using Runge Kutta method of fourth order, solve the following at x=0.2 and 0.4. Take y(0)=1 $$\frac{dy}{dx}=\frac{y^2-x^2}{y^2+x^2}$$	**07**	CO**6**	A

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Seat No.: ________ Enrolment No.___________

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– IV(NEW) EXAMINATION – SUMMER 2023

Subject Code:3140510 Date:13-07-2023

Subject Name:Numerical Methods in Chemical Engineering

Time:10:30 AM TO 01:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

Marks

Q.1 **(a)** Explain three sources of arising errors in numerical computation. **03**

(b) Re-arrange the given equations in diagonally dominant form and solve the new linear system by using Gauss Seidel Method with $X_0 = [0\ 0\ 0]$. Perform only three iterations. Calculate $\varepsilon_a = max[\varepsilon_{a,x}, \varepsilon_{a,y}, \varepsilon_{a,z}]$ only in the last iteration. **04**

$$2x + 15y - 3z = 16, \quad 2x - 3y + 25z = 23, \quad 12x + 2y + z = 27.$$

(c) Fit a second degree polynomial using least square method to the following data **07**

x	0	1	2	3	4
y	1	1.8	1.3	2.5	6.3

Q.2 **(a)** In calculating the area of a rectangle, an error of 3% is made in measuring each of its sides. Find the percentage error in calculating area of the rectangle. **03**

(b) Find a root of the function $f(x) = \cos x - xe^x$ using Bisection Method. Perform only four iterations. **04**

(c) Find the root of the equation $x^3 - 2x - 5 = 0$ using Secant method correct up to three decimal places. **07**

OR

(c) Find a positive root of $x^3 - 4x + 1 = 0$ by the method of false position correct upto three decimal places. **07**

Q.3 **(a)** Explain the Gauss Jordan method to solve the system of linear equations. **03**

(b) Fit a curve of the form $y = a\,e^{bx}$ to the following data: **04**

x	1	3	5	7	9
y	115	105	95	85	80

(c) Using Newton- Raphson iterative method, find the real root of $x\, log_{10}\, x = 1.2$ correct to five decimal places. **07**

OR

Q.3 **(a)** Determine the largest eigenvalue and the corresponding eigenvector of the matrix $A = \begin{bmatrix} 5 & 4 \\ 1 & 2 \end{bmatrix}$. **03**

(b) Fit a curve of the form $y = ax^b$ to the following data: **04**

x	20	16	10	11	14
y	22	41	120	89	56

(c) Examine the system of equations **07**
$3x+3y+2z = 1, x+2y = 4, 10y+3z = -2, 2x-3y-z = 5$ for consistency and then solve it by Gauss Elimination method.

Q.4 **(a)** Construct the divided difference table with the arguments 2, 4, 9, 10 of the function $f(x) = x^3 - 2x$. **03**

(b) Using Newton's forward interpolation formula, find the value of $f(1.6)$. **04**

x	1	1.4	1.8	2.2
$f(x)$	3.49	4.82	5.96	6.5

(c) Find the polynomial $f(x)$ by using Lagrange's interpolation formula and hence find $f(3)$ for the below data: **07**

x	0	1	2	5
$f(x)$	2	3	12	147

OR

Q.4 **(a)** Derive formula for Trapezoidal Rule of numerical integration. **03**

(b) The residents of a town are given below. Estimate the residents for the year 1830 using Newton's backward interpolation. **04**

Year- x:	1791	1801	1811	1821	1831
residents –y: (in thousand)	46	66	81	93	101

(c) Using Modified Euler's method, find an approximate value of y when $x = 0.6$ with $h = 0.1$ given that $\frac{dy}{dx} = x + 3y,\ subject\ to\ y(0) = 1$. **07**

Q.5 **(a)** Find the approximate solution of $\frac{dy}{dx} = x + y,\ y(0) = 0$ with $h = 2$ using Euler's Method in five steps. **03**

(b) Evaluate $\int_0^3 \frac{1}{1+x}\, dx$ with $n = 6$ by using Simpson's 3/8 rule. **04**

(c) Using Milne's Predictor-Corrector Methods, find $y(4.4)$ given that $5xy' + y^2 - 2 = 0$ with $y(4) = 1, y(4.1) = 1.0049, y(4.2) = 1.0097,$ $y(4.3) = 1.0143$. **07**

OR

Q.5 **(a)** Derive formula for Simpson's 1/3 Rule of numerical integration. **03**

(b) Use second order Runge Kutta method to compute $y(0.2)$ given that $\frac{dy}{dx} = x + \sqrt{y},\ y(0) = 4$ by taking h=0.1. **04**

(c) Use the Taylor series method to find $y(0.2)$, given that $\frac{dy}{dx} = 2y + 3e^{x}$, $y(0)$=1. Taking h=0.1. **07**

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Seat No.: ________ Enrolment No.___________

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV (NEW) EXAMINATION – SUMMER 2022

Subject Code:3140510 Date:29-06-2022

Subject Name:Numerical Methods in Chemical Engineering

Time:10:30 AM TO 01:00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

Q.1 **(a)** Explain following terms: 1) Significant figures, 2) Truncation Error. **03**

(b) Define: 1) Absolute error, 2) Relative error, 3) Percentage error, 4) Inherent Error. **04**

(c) Evaluate sum $S = \sqrt{4} + \sqrt{6} + \sqrt{8}$ to four significant digits and find absolute & relative errors. **07**

Q.2 **(a)** Describe intermediate value properties. **03**

(b) Find the root of equation $x \log_{10} x = 1.2$ correct upto four decimal places using bisection method. **04**

(c) Enlist limitations of Newton-Raphson Method also find root of the function $x^4 - x = 10$ upto three decimal places using Newton-Raphson method. **07**

OR

(c) Solve following equation using Newton Raphson technique starting with $x_0 = 0.5\ and\ y_0 = 1.5$, carry out two iterations. **07**

$$\sin x - y = -0.9793$$
$$\cos y - x = -\ 0.6703$$

Q.3 **(a)** Explain Gauss elimination method with its pitfalls. **03**

(b) Solve the system of equation using Gauss Jordan method. **04**

$2x + y + z = 10; 3x + 2y + 3z = 18; x + 4y + 9z = 16$

(c) Solve following set of equation using jacobi's iteration method correct up to three decimal places. $x_0 = y_0 = z_0 = 0$ **07**

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

OR

Q.3 **(a)** Give the normal equation to fit the straight line y = a + bx to n observations. **03**

(b) Find the eigen-values and eigenvectors of the matrix **04**

$$\begin{bmatrix} 5 & 4 \\ 1 & 2 \end{bmatrix}$$

(c) The pressure and volume of a gas are related by the equation $pV^{\gamma} = k$, γ and k being constants. Fit this equation to the following set of observations: **07**

p (kg/cm^2)	0.5	1.0	1.5	2.0	2.5	3.0
V (lts)	1.62	1.00	0.75	0.62	0.52	0.46

Q.4 **(a)** Establish Newton’s backward interpolation formula. **03**

(b) If P is pull required to lift a load W by means of a pulley block, find a linear law of form $P = mW + C$ connecting P & W, using following data. **04**

P	12	15	21	25
W	50	70	100	120

(c) Obtain the density of a 26% solution of H_3PO_4 in water at 20 °C during using Lagrange’s interpolation formula can we perform the same calculation using Newton’s forward difference interpolation formula? Yes or No? **07**

y (Density)	1.0764	1.1134	1.2160	1.3350
x % H_3PO_4	14	20	35	50

OR

Q.4 **(a)** Write an algorithm for trapezoidal rule. **03**

(b) Using Newton’s backward difference formula, construct an interpolating polynomial of degree 3 for the data: $f(-0.75) = -0.0718125, f(-0.5) = -0.02475, f(-0.25) = 0.3349375, f(0) = 1.10100$. **04**

(c) Evaluate $\int_0^{0.6} e^{-x^2}$ using the trapezoidal rule and Simpson’s 1/3rd rule, taking h = 0.1 **07**

Q.5 **(a)** Discuss in brief about the boundary value problem. **03**

(b) Compute the value of $\int_{0.2}^{1.4}(\sin x - \log x + e^x)dx$ using Simpson’s 3/8 rule. **04**

(c) Using Euler’s method, find an approximate value of y corresponding to $x = 1$, given that $dy/dx = x + y$ and $y = 1$ when $x = 0$. **07**

OR

Q.5 **(a)** Describe Milne’s predictor-corrector method. **03**

(b) Apply the Runge - Kutta fourth order method to find an approximate value of y when $x = 0.2$ given that $dy/dx = x + y$ and $y = 1$ when $x = 0$. **04**

(c) Solve by Taylor’s series method the equation $\frac{dy}{dx} = \log(xy)$ for y(1.1) and y(1.2), given y(1) = 2. **07**

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