Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
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I SEMESTER M.TECH. (BT & CHEMICAL)
END SEMESTER EXAMINATIONS, JANUARY 2023

SUBJECT: MATHEMATICAL & NUMERICAL TECHNIQUES IN CHEMICAL AND BIOLOGICAL ENGINEERING [MAT 5158]

REVISED CREDIT SYSTEM

Time: 3Hrs Date: 05-01-2023 Max. Marks: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A.	Find the inverse of the matrix $A = \begin{bmatrix} 13 & 14 & 6 & 4 \\ 8 & -1 & 13 & 9 \\ 6 & 7 & 3 & 2 \\ 9 & 5 & 16 & 11 \end{bmatrix}$ by Partition method.	**4**
1B.	Using Jacobi's method find all the eigen values and the eigen vectors of the matrix A= $\begin{bmatrix} -1 & 3 & 5 \\ 3 & 4 & 3 \\ 5 & 3 & -1 \end{bmatrix}$. Carryout two iterations.	**3**
1C.	Using Gauss- Seidel method, solve: $6x + y + z = 105;\ \ 4x + 8y + 3z = 155;\ 5x + 4y - 10z = 65.$ Carryout four iterations.	**3**
2A	Using Newton – Gauss algorithm fit a function $f(x) = a_0(1 - e^{-a_1 x})$. to the data x: 0.25, 0.75, 1.25, 1.75, 2.25 y: 0.28, 0.57, 0.68, 0.74, 0.79 Take $a_0 = 1,\ a_1 = 1.$	**4**
2B.	Evaluate: $\int_0^{\frac{\pi}{3}} \sqrt{sinx}\, dx$ with n =6 using Simpson's 1/3rd rule.	**3**
2C	Fit a curve of the form $y = ae^{bx}$ to the following data x: 0, 1, 2, 3 y: 1.05, 2.10, 3.85, 8.30	**3**

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3A.	Perform two iterations of the Newton-Raphson method to solve $3yx^2 - 10x + 7 = 0;\ y^2 - 5y + 4 = 0$. Take $x_0 = 0.5, y_0 = 0.5$.	**4**
3B.	Perform two iterations of the Bairstow method to extract a quadratic factor of the equation $x^4 - 3x^3 + 20x^2 + 44x + 54 = 0$. Take $p_0 = 2,\ q_0 = 2$.	**3**
3C	Using Rayleigh's power method find the largest eigen value and the corresponding eigen vector of the matrix $\boldsymbol{A} = \begin{bmatrix} \mathbf{25} & \mathbf{1} & \mathbf{2} \\ \mathbf{1} & \mathbf{3} & \mathbf{0} \\ \mathbf{2} & \mathbf{0} & \mathbf{-4} \end{bmatrix}$. Take $\mathbf{X^{(0)}} = [\mathbf{1} \quad \mathbf{0} \quad \mathbf{0}]^{\mathbf{T}}$ and carryout four iterations.	**3**
4A	Use finite difference method to solve $\mathbf{y'' + y = x, 0 < x < 1}$ with $\mathbf{y(0) = 0},\ \mathbf{y(1) = 2}$. Take h = $\frac{1}{4}$.	**4**
4B	Using Runge- Kutta method of order four compute y for x = 0.2 given $\frac{dy}{dx} = y - \frac{2x}{y}$, y(0) =1, h = 0.2	**3**
4C	Solve: $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 8x^2y^2$, 0<x<4, 0<y<4, h=1 and u(x,y)=0 on the boundary.	**3**
5A	With $h = \frac{1}{4}$, solve $32\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$, 0< x <1, t > 0 for four time steps using Schmidt's method. Take $\lambda = \frac{1}{2}$. u(x,0) =0, u(0,t) =100sin$\left(\frac{\pi t}{6}\right)$, u(1,t) =0	**4**
5B	Find the extreme values of $f(x,y) = x^3 + y^3 + 2x^2 + 4y^2 + 6$ ***using the Hessian matrix***.	**3**
5C	Maximize: $f(x,y) = 2xy + 2x - x^2 - 2y^2$ using Steepest Ascent method. Take $x_0 = 2, y_0 = 0$. Carryout one iteration.	**3**