(AUTONOMOUS)

MSc DEGREE EXAMINATION MAY 2026
(Second Semester)

Branch – **MATHEMATICS**

MAJOR ELECTIVE COURSE – I COMPUTATIONAL METHODS (THEORY)

Time: Three Hours   Maximum: 75 Marks

SECTION-A (10 Marks)
Answer **ALL** questions
ALL questions carry **EQUAL** marks   (10 × 1 = 10)

Module No.	Question No.	Question	K Level	CO
1	1	In Gauss–Jacobi method, the values used for computing the next iteration are ________ a. Newly computed values immediately b. Only previous iteration values c. Average of old and new values d. Random values	K1	CO1
	2	The power method is used to find ________ a. Smallest eigenvalue b. All eigenvalues c. Dominant eigenvalue d. Determinant	K2	
2	3	The Trapezium rule is based on approximating the curve by ____ a. Parabola b. Cubic polynomial c. Circle d. Straight line	K1	CO2
	4	Gauss–Legendre integration is an example of _______ a. Newton-Cotes formula b. Closed formula c. Gaussian quadrature d. Finite difference method	K2	
3	5	An initial value problem (IVP) requires _______ a. Only boundary conditions b. Only final condition c. Initial condition at one point d. No condition	K1	CO3
	6	The order of the classical Runge - Kutta method is ______ a. 1 b. 2 c. 3 d. 4	K2	
4	7	If $B^2 - 4AC = 0$, the PDE is ________ a. Parabolic b.Linear c. Elliptic d. Hyperbolic	K1	CO4
	8	Laplace equation is given by _________ a. $u_{xx} = u_{yy}$ b. $u_{xx} = u_{tt}$ c. $u_{xx} - u_{yy} = 0$ d. $u_{xx} + u_{yy} = 0$	K2	
5	9	In the finite difference method, time derivative in the heat equation is usually approximated by ________ difference. a. Forward b. Backward c. Central d. Exact	K1	CO5
	10	The wave equation is ___________ a. $u_t = c^2 u_{xx}$ b. $u_t = c\, u_{xx}$ c. $u_{tt} = c^2 u_{xx}$ d. $u_{tt} = c\, u_{xx}$	K2	

SECTION - B (35 Marks)
Answer **ALL** questions
ALL questions carry **EQUAL** Marks   (5 × 7 = 35)

Module No.	Question No.	Question	K Level	CO
1	11a)	Solve the system of equations $4x_1 + x_2 + x_3 = 2, x_1 + 5x_2 + 2x_3 = -6$ and $x_1 + 2x_2 + 3x_3 = -4$ using Jacobi Iteration Method. Take the Initial approximation as $x^{(0)} = [0.5, -0.5, -0.5]^T$ and perform three iterations.	K2	CO1
		(OR)		
	11 b)	Consider the matrix $A = \begin{bmatrix} 1 & 2 & -2 \\ 1 & 1 & 1 \\ 1 & 3 & -1 \end{bmatrix}$ i) Find all the Eigen values and Eigen Vectors. ii) Verify that $S^{-1}AS$ is a diagonal matrix, where S is the matrix of Eigen vectors.		

Cont...

<table>
<tr><td rowspan="3">2</td><td>12 a)</td><td>Evaluate the integral $I=\int_0^1 \frac{dx}{1+x}$ using Gauss – Legendre Formula.</td><td rowspan="3">K3</td><td rowspan="3">CO2</td></tr>
<tr><td></td><td>(OR)</td></tr>
<tr><td>12 b)</td><td>Evaluate the integral $I=\int_{y=1}^{1.5}\int_{x=1}^{2}\frac{dx\,dy}{x+y}$ using the Simpson's Rule with $h=0.5$ (along x – axis) and $y=0.25$ (along y – axis). Compare the Exact Solution.</td></tr>
<tr><td rowspan="3">3</td><td>13 a)</td><td>Given $\sigma(\xi)=(23\xi^2-16\xi+5)/12$, find $\rho(\xi)$ and write down an explicit linear multistep method.</td><td rowspan="3">K4</td><td rowspan="3">CO3</td></tr>
<tr><td></td><td>(OR)</td></tr>
<tr><td>13 b)</td><td>Solve the initial value problem $u'=-2tu^2, u(0)=1$ with $h=0.2$ on the interval $[0,0.4]$, using P – C method
$$P:\ u_{j+1}=u_j+\frac{h}{2}(3u_j'-u_{j-1}')$$
$$C:\ u_{j+1}=u_j+\frac{h}{2}(u_{j+1}'+u_j')$$
as $P(EC)^m E, m=2$</td></tr>
<tr><td rowspan="3">4</td><td>14a)</td><td>Classify the following PDE:
i) $2u_{xx}+5u_{xy}+2u_{yy}=0$
ii) $4u_{xx}+4u_{xy}+u_{yy}=0$</td><td rowspan="3">K5</td><td rowspan="3">CO4</td></tr>
<tr><td></td><td>(OR)</td></tr>
<tr><td>b)</td><td>Solve $y''=-y$ with boundary conditions $y(0)=0, y(\pi)=0$.</td></tr>
<tr><td rowspan="3">5</td><td>15a)</td><td>Solve the Heat Equation $\frac{\partial u}{\partial t}=\frac{\partial^2 u}{\partial x^2}$ with step sizes $h=1, k=0.25$. Initial values:
<table>
<tr><td>x</td><td>0</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td>$u(x,0)$</td><td>0</td><td>10</td><td>20</td><td>0</td></tr>
</table>
Also find $u(1,1)$.</td><td rowspan="3">K6</td><td rowspan="3">CO5</td></tr>
<tr><td></td><td>(OR)</td></tr>
<tr><td>b)</td><td>Given that for Wave Equation
<table>
<tr><td>x</td><td>0</td><td>1</td><td>2</td></tr>
<tr><td>$u(x,0)$</td><td>0</td><td>10</td><td>0</td></tr>
<tr><td>$u(x,1)$</td><td>0</td><td>8</td><td>0</td></tr>
</table>
Find $u(1,2)$, given $r=1$.</td></tr>
</table>

<u>SECTION -C (30 Marks)</u>

Answer **ANY THREE** questions

ALL questions carry **EQUAL** Marks (3 × 10 = 30)

<table>
<tr><th>Module No.</th><th>Question No.</th><th>Question</th><th>K Level</th><th>CO</th></tr>
<tr><td>1</td><td>16</td><td>Find the largest Eigen value in modulus and the corresponding Eigen vector of the matrix $A=\begin{bmatrix}-15 & 4 & 3\\ 10 & -12 & 6\\ 20 & -4 & 2\end{bmatrix}$ using Power Method.</td><td>K2</td><td>CO1</td></tr>
<tr><td>2</td><td>17</td><td>Evaluate the integral $I=\int_1^2\int_1^2\frac{dx\,dy}{x+y}$ using Trapezoidal Rule with $h=k=0.5$ and $h=k=0.25$.</td><td>K3</td><td>CO2</td></tr>
<tr><td>3</td><td>18</td><td>Solve the initial value problem $u''=(1+t^2)u, u(0)=0, u'(0)=0, t\in[0,0.4]$ by Runge – Kutta Method with $h=0.2$.Compare with exact solution $u(t)=e^{t^2/2}$.</td><td>K4</td><td>CO3</td></tr>
<tr><td>4</td><td>19</td><td>Derive finite difference approximation for Laplace equation.</td><td>K5</td><td>CO4</td></tr>
<tr><td>5</td><td>20</td><td>Solve the Heat Equation $\frac{\partial u}{\partial t}=\frac{\partial^2 u}{\partial x^2}$ for $0\le x\le 4$. Given Boundary Conditions $u(0,t)=0, u(4,t)=0$ and Initial Conditions
<table>
<tr><td>x</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td></tr>
<tr><td>$u(x,0)$</td><td>0</td><td>20</td><td>40</td><td>20</td><td>0</td></tr>
</table>
Step sizes $h=1, k=0.25$. Find the solution at first two time levels.</td><td>K6</td><td>CO5</td></tr>
</table>

Z-Z-Z END