SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES
(AUTONOMOUS)

QUESTION BANK

Year / Semester: II B. Tech I Semester **Regulation: R23**

Subject and Code: NUMERICAL METHODS & TRANSFORM TECHNIQUES (23BSC234)

SYLLABUS

23BSC234	NUMRICAL METHODS AND TRANSFORM TECHNIQUES	L	T	P	C
	(MECH)	2	1	-	3

PRE-REQUISITES: Algebra, Calculus, Differential equations, Set theory, Series

COURSE EDUCATIONAL OBJECTIVES:

1. To develop skill to analyze appropriate method to find the root of the Algebraic and Transcendental Equations and apply the concept of interpolation and Curve fitting for the Prediction of required values
2. To learn the method of evaluation of numerical derivative, numerical integration
3. To learn the method of solve ordinary differential equation using numerical methods.
4. To learn the concept of Laplace Transform and Inverse Laplace Transform
5. To develop skill to design sine and cosine waves with the help of Fourier Series and to learn the concept of Fourier Transform and Inverse Fourier Transform.

UNIT I: Solution of Algebraic & Transcendental Equations and Interpolation **09**

Introduction-Bisection Method-Iterative method, Regula-falsi method and Newton Raphson method Finite differences-Newton's forward and backward interpolation formulae – Lagrange's formulae.

UNIT II:Numerical Differentiation, Numerical Integration and Curve Fitting **09**

Numerical differentiation: Newton's forward and backward formulae
Numerical integration: Trapezoidal rule - Simpson's 1/3 Rule - Simpson's 3/8 Rule
Curve fitting: Fitting of straight line, second-degree and Exponential curve by method of least squares

UNIT III:Solution of Initial value problems to Ordinary differential equations **09**

Numerical solution of Ordinary Differential equations: Solution by Taylor's series-Picard's Method of successive Approximations-Euler's and modified Euler's methods-Runge-Kutta methods (second and fourth order).

UNIT IV: Laplace Transforms **09**

Definition-Laplace transform of standard functions-existence of Laplace Transform – Inverse transform – First shifting Theorem, transforms of derivatives and integrals - Convolution theorem – Application of Laplace transforms to ordinary differential equations of first and second order.

UNIT V: Fourier series & Fourier transforms **09**

Determination of Fourier coefficients (Euler's) – Dirichlet conditions for the existence of Fourier series -Fourier series of Even and odd functions – Fourier series in an arbitrary interval – Half-range Fourier sine and cosine expansions

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Fourier integral theorem (without proof) – Fourier sine and cosine integrals-complex form of Fourier integral. Fourier transform – Fourier sine and cosine transforms – Properties – Inverse transforms – convolution theorem.

COURSE OUTCOMES:

On successful completion of the course, students will be able to		POsrelatedtoCOs
CO1	Apply numerical methods to solve algebraic and transcendental equations and to Derive interpolating polynomials using interpolation formulae.	**PO1,PO2,PO3**
CO2	Demonstrate knowledge in finding the numerical values to derivatives, integrals through different mathematical methods and constructing a curve, or mathematical function, that has the best fit to a series of data points	**PO1,PO2,PO3**
CO3	Demonstrate knowledge in solving ordinary differential equations numerically through various methods	**PO1,PO2,PO3**
CO4	Understand the use of Laplace transform in system modeling, digital signal processing, process control, solving Boundary Value Problems.	**PO1,PO2,PO3**
CO5	Apply Fourier series and Fourier transform in communication theory and signal analysis, image processing and filters, data processing and analysis, solving partial differential equations for problems on gravity.	**PO1,PO2,PO3**

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO.1	3	3	3	-	-	-	-	-	-	-	-	-
CO.2	3	3	3	-	-	-	-	-	-	-	-	-
CO.3	3	3	3	-	-	-	-	-	-	-	-	-
CO.4	3	3	3	-	-	-	-	-	-	-	-	-
CO.5	3	3	3	-	-	-	-	-	-	-	-	-
CO*	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	-

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Max Marks: 10

<table>
<tr><th>S.No.</th><th>CO</th><th>Questions</th><th>BT</th></tr>
<tr><td colspan="4">UNIT–1: SOLUTION OF ALGEBRAIC AND TRANSCENDENTAL EQUATIONS & INTERPOLATION</td></tr>
<tr><td>1</td><td>1</td><td>Find a Positive root of the equation $x^3 - x - 1 = 0$ correct to two decimal places by Bisection method.</td><td>L3</td></tr>
<tr><td>2</td><td>1</td><td>Find a positive root of the equation $x^3 - 4x - 9 = 0$ using Bisection method.</td><td>L3</td></tr>
<tr><td>3</td><td>1</td><td>Find a real root of the equation $x \log_{10} x = 1.2$ by Regular-False position method</td><td>L3</td></tr>
<tr><td>4</td><td>1</td><td>Find a real root of the following equation $x^3 - x - 1 = 0$ by Newton Raphson method.</td><td>L3</td></tr>
<tr><td>5</td><td>1</td><td>Solve the equation $3x = \cos x + 1$ by Iteration method.</td><td>L3</td></tr>
<tr><td>6</td><td>1</td><td>Find f(1.6) Using Newton's Forward difference interpolation formula for the data
<table>
<tr><td>X</td><td>1</td><td>1.4</td><td>1.8</td><td>2.2</td></tr>
<tr><td>F(x)</td><td>3.49</td><td>4.82</td><td>5.96</td><td>6.5</td></tr>
</table></td><td>L3</td></tr>
<tr><td>7</td><td>1</td><td>Find f(2.5) from the data using Newton's Forward interpolation formula
<table>
<tr><td>X</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td>Y(x)</td><td>0</td><td>1</td><td>16</td><td>81</td><td>256</td><td>625</td><td>1296</td></tr>
</table></td><td>L3</td></tr>
<tr><td>8</td><td>1</td><td>For x=0,1,2,3,4and$f(x)$=1,14,15,5,6. Find $f(3.2)$ using Backward difference table.</td><td>L3</td></tr>
<tr><td>9</td><td>1</td><td>Find y(9) using Newton's Backward difference formula from the table
<table>
<tr><td>X</td><td>2</td><td>5</td><td>8</td><td>11</td></tr>
<tr><td>f(x)</td><td>94.8</td><td>87.9</td><td>81.3</td><td>75.1</td></tr>
</table></td><td>L3</td></tr>
<tr><td>10</td><td>1</td><td>Using Lagrange's interpolation formula find the value of $y(10)$from the following table
<table>
<tr><td>X</td><td>5</td><td>6</td><td>9</td><td>11</td></tr>
<tr><td>f(x)</td><td>12</td><td>13</td><td>14</td><td>16</td></tr>
</table></td><td>L3</td></tr>
</table>

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<table>
<tr><th>S.No.</th><th>CO</th><th>Questions</th><th>BT</th></tr>
<tr><td colspan="4">UNIT – 2: NUMERICAL DIFFERENTIATION, NUMERICAL INETEGRATION AND CURVE FITTING</td></tr>
<tr><td>1</td><td>2</td><td>Evaluate $\int_4^{5.2} logx\, dx$ by using Simpson's 3/8 rule
<table>
<tr><td>X</td><td>4</td><td>4.2</td><td>4.4</td><td>4.6</td><td>4.8</td><td>5.0</td><td>5.2</td></tr>
<tr><td>Log x</td><td>1.3863</td><td>1.4351</td><td>1.4816</td><td>1.5261</td><td>1.5686</td><td>1.6094</td><td>1.6487</td></tr>
</table></td><td>L3</td></tr>
<tr><td>2</td><td>2</td><td>Evaluate $\int_0^2 e^{-x^2}\ dx$ using simpson's 1/3 rule taking h=0.25</td><td>L3</td></tr>
<tr><td>3</td><td>2</td><td>Evaluate $\int_0^1 x^3\, dx$ using with 5 sub intervals by Trapezoidal Rule</td><td>L3</td></tr>
<tr><td>4</td><td>2</td><td>Evaluate $\int_0^4 e^x\, dx$ using simpson's1/3 rule with n=10</td><td>L3</td></tr>
<tr><td>5</td><td>2</td><td>Use the Trapezoidal Rule with n=4 to estimate $\int_0^1 \frac{1}{1+x^2}\, dx$, coreect to four decimal places</td><td>L3</td></tr>
<tr><td>6</td><td>2</td><td>$Evaluate\ \int_0^1 \frac{1}{1+x}\, dx$ by using Simpson's 1/3 and using Simpson's 3/8 rule</td><td>L4</td></tr>
<tr><td>7</td><td>2</td><td>Evaluate $f^1(1.5)$ and $f^{11}(1.5)$ from the following table.
<table>
<tr><td>X</td><td>1.5</td><td>2.0</td><td>2.5</td><td>3.0</td><td>3.5</td><td>4.0</td></tr>
<tr><td>f(x)</td><td>3.375</td><td>7.000</td><td>13.625</td><td>24.000</td><td>38.875</td><td>59.000</td></tr>
</table></td><td>L4</td></tr>
<tr><td>8</td><td>2</td><td>Using the following table, compute $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$ at x=1
<table>
<tr><td>X</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td>Y</td><td>1</td><td>8</td><td>27</td><td>64</td><td>125</td><td>216</td></tr>
</table></td><td>L4</td></tr>
</table>

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<table>
<tr><td>9</td><td>2</td><td>Fit a straight line y=a+bx from data
<table><tr><td>X</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>Y</td><td>1</td><td>1.8</td><td>3.3</td><td>4.5</td><td>6.3</td></tr></table></td><td>L4</td></tr>
<tr><td>10</td><td>2</td><td>Fit a parabola $y=a+bx+cx^2$ to the data given below.
<table><tr><td>X</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>Y</td><td>10</td><td>12</td><td>8</td><td>10</td><td>14</td></tr></table></td><td>L4</td></tr>
</table>

S.No.	CO	Questions	BT
UNIT–3: *SOLUTION OF INITIAL VALUE PROBLEM TO ORDINARY DIFFERENTIAL EQUATION*			
1	3	Solve $y^1 = x + y$, given y(1)=0 .Find y(1.1) and y(1.2) by Taylor's series method.	L3
2	3	Tabulate y(0.1), y(0.2) and y(0.3) using Taylor's series method given that $y^1 = y^2 + x$, and y(0)=1	L3
3	3	Obtain y(0.1), y(0.2) given $\frac{dy}{dx}$=x+y , $y(0)=1$ using Picard's Method	L3
4	3	Given $\frac{dy}{dx}$ =1+xy and y(0)=1, compute y(0.1), y(0.2) by Picard's Method	L3
5	3	Solve numerically using Euler's method $y^1 = y^2 + x$, y(0)=1.Find y(0.1) and y(0.2),y(0.3)	L3
6	3	Using Euler's method, solve for y at x=2 from $y^1 = 3x^2 + 1, y(1) = 2,$ taking step size h=0.25	L3
7	3	Apply Runge-Kutta forth order method to find y(0.1) and y(0.2) given that $y^1 = x^2 - y$ and y(0)=1	L4

8	**3**	Solve y^1=y-x using R-K method of fourth order given y(0)=2, h=0.2 and y(0.2).	L4
9	**3**	Use Picard's method to approximate y when x=0.2 given that y=1 when x=0 and $\frac{dy}{dx}$=x-y.	L3
10	**3**	Given $\frac{dy}{dx}=1+y^2$ where y=0 when x=0 and y(0.2) , y(0.4) using Runge kutta method	L4

S.No.	CO	Questions	BT
		UNIT IV: (LAPLACE TRANSFORMS)	
1	**4**	Evaluate i) L $\{e^{2t}+4t^3-2\sin 3t+3\cos 3t\}$ ii) L $\{\cos^2 2t\}$	L3
2	**4**	Find L$\{e^{-3t}(2\cos 5t-3\sin 5t)\}$ ii) Find L {sint sinht}	L3
3	**4**	Find i) L$\{e^{at}\}$ ii) L {sinat} by using Laplace transform of derivatives	L4
4	**4**	**Find** $L^{-1}\left\{\frac{1}{P(P+1)(P+2)}\right\}$	L4
5	**4**	**Find** $L^{-1}\left\{\frac{4}{(P+1)(P+2)}\right\}$	L4
6	**4**	Find inverse laplace transform of $\frac{p^2+p-2}{p(p+3)(p-2)}$	L4
7	**4**	**Find** $L^{-1}\left\{\frac{5P+7}{p^2+p-2}\right\}$	L4
8	**4**	Using convolution theorem find $L^{-1}\left\{\frac{1}{(p+a)(p+b)}\right\}$	L5
9	**4**	Using laplace theorem solve $(D^2-2D+2)y=0$ if $y(0)=y^1(0)=1$	L4

10	4	Sovle the differential equation y''' + 2y'' - y' - 2y = 0 given that y(0)=0, y'(0) =0 and y''(0) = 6	L5
11	4	Sovle the differential equation y''' + 2y'' - y' - 2y = 0 given that y(0)=0, y'(0) =0 and y''(0) = 6	L4

S.No.	CO	Questions	BT
		UNIT–5: FOURIER SERIES AND FOURIER TRANSFORM	
1	5	Find the Fourier series representing $f(x) = x,\ 0 < x < 2\pi$.	L3
2	5	Find the Fourier expansion of $f(x) = e^{x}$, $(o, 2\pi)$	L3
3	5	Find a half-range cosine series of $f(x) = e^{x}$, $0 < x < l$	L4
4	5	Find the half range cosine series for the function $f(x) = x$ in the range $0 < x < \pi$	L4
5	5	Find the half range sine series for f(x)=x(*π-x)* 0 x <*π and deduce that* $\frac{1}{1^3} - \frac{1}{3^3} + \frac{1}{5^3} + \ldots \ldots = \frac{\pi^3}{32}$	L5
6	5	Find the Fourier transform of f(x) is defined by f(x)= $\begin{cases} 1, \|x\| < a \\ 0, \|x\| > a \end{cases}$ and hence evaluate $\int_{-\infty}^{\infty} \frac{sinap\ cospx}{p}\,dp$	L4
7	5	Find the Fourier transform of f(x) is defined by f(x)= $\begin{cases} sinx, 0 < x < \pi \\ 0 \quad ,otherwise \end{cases}$	L4

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8	**5**	Find the Fourier sine transform of f(x)=e^{-ax} and deduce that $\int_0^\infty \frac{s\sin(sx)}{a^2+s^2}$ ds	**L5**
9	**5**	Find the Fourier cosine transform of f(x)= e^{-ax} and deduce that $\int_0^\infty \frac{s\cos(sx)}{a^2+s^2}$ ds	**L4**
10	**5**	Find Fourier sine series of the function f(x)= x^2,0<x<3	**L4**
11	**5**	Find Fourier cosine series of the function f(x)= $\begin{cases} x^2 & ,0 \le x \le 2 \\ 0 & ,2 \le x \le 4 \end{cases}$	**L4**

Note: L1-Remembering, L2-Understanding, L3-Applying, L4-Analyzing, L5-Evaluating, and L6-Creating

TEXT BOOKS:

1. B.S. Grewal, Higher Engineering Mathematics, KhannaPublishers,2017, 44th Edition
2. Erwin Kreyszig, Advanced Engineering Mathematics , Wiley India

REFERENCE BOOKS:

1. R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, AlphaScience International Ltd., 2021 5th Edition (9th reprint).
2. B.V. Ramana, Higher Engineering Mathematics , Mc Graw Hill publishers
3. Alan Jeffrey, Advanced Engineering Mathematics, Elsevier

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