SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES (AUTONOMOUS)

QUESTION BANK

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

Subject and Code: COMPLEX VARIABLES AND NUMERICAL METHODS (23BSC 231)

SYLLABUS

UNIT I : COMPLEX VARIABLE – DIFFERENTIATION (09)
Introduction to functions of complex variable-concept of Limit & continuity- Differentiation, Cauchy-Riemann equations, analytic functions harmonic functions, finding harmonic conjugate-construction of analytic function by Milne Thomson method.

UNIT II: COMPLEX VARIABLE-INTEGRATION (09)
Line integral, Cauchy's integral theorem (Simple Case), Cauchy Integral formula, Power series expansions: Taylor's series, Laurent's series, zeros of analytic functions, singularities, Residues, Cauchy Residue theorem (without proof).

UNIT III: 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 IV: 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 V: 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).

TEXT BOOKS:

1. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers,2017, 44th Edition
2. S S Sastry, Introductory Methods of Numerical Analysis, PHI Learning Private Limited.

REFERENCE BOOKS:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2018, 10th Edition.
2. B.V.Ramana, Higher Engineering Mathematics, by Mc Graw Hill publishers
3. R.K.Jain and S.R.K.Iyengar, Advanced Engineering Mathematics, Alpha Science International Ltd.,2021 5th Edition(9th reprint).

Prepared by Dr U Balakrishna

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Max Marks: 10

S.No.	CO	Questions	BT
UNIT I: COMPLEX VARIABLE – DIFFERENTIATION			
1	**1**	A.Show that $\sin z = \sin x \cosh y + i \cos x \sinh y$ B. Show that $\cos z = \cos x \cosh y - i \sin x \sinh y$	**L2**
2	**1**	If $\sin(A + iB) = x + iy$ then a) $\frac{x^2}{\cosh^2 B} + \frac{y^2}{\sinh^2 B} = 1$ b) $\frac{x^2}{\sin^2 A} - \frac{y^2}{\cos^2 A} = 1$	**L2**
3	**1**	If $\cos(A + iB) = x + iy$ then a) $\frac{x^2}{\cos^2 A} - \frac{y^2}{\sin^2 A} = 1$ b) $\frac{x^2}{\cosh^2 B} + \frac{y^2}{\sinh^2 B} = 1$	**L2**
4	**1**	Prove that $f(z) = z^2$ is analytic everywhere and hence find its derivative.	**L2**
5	**1**	Prove that $f(z) = z^3$ is analytic everywhere and hence find its derivative.	**L2**
6	**1**	Show that $f(z) = e^z$ is analytic everywhere and hence find its derivative	**L2**
7	**1**	Show that $f(z) = \sin z$ is analytic everywhere and hence find its derivative	**L2**
8	**1**	Find the Analytic function whose real part is $x^3 - 3xy^2 + 3x^2 - 3y^2 + 1$	**L2**
9	**1**	Find the analytic function whose imaginary part is $3x^2y - y^3$	**L2**
10	**1**	Find f(z) where $V = x^2 - y^2 + \frac{x}{x^2+y^2}$	**L2**

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S.No.	CO	Questions	BT
		UNIT II: COMPLEX VARIABLE-INTEGRATION	
1	2	Evaluate $\int_c f(z)dz$ where f(z) = y − x − 3x^2 and C is a straight line y = x from z=0 to z=1+i	L2
2	2	Evaluate $\int_c \frac{e^z}{(z-1)^2}dz$ where C is the circle $\|z\| = 2$	L2
3	2	Evaluate $\int_c \frac{\sin(z)}{\left(z-\frac{\pi}{6}\right)^2}dz$ where C is the circle $\|z\| = 1$	L2
4	2	Evaluate $\oint_C \frac{e^z}{(z-1)(z-2)}dz$; where C is the circle $\|z\| = 3$	L2
5	2	Expand f(z) = Sin z in Taylor's series about z= $\frac{\pi}{4}$	L2
6	2	Expand f(z)= Cos z in Taylor's series about z= $\frac{\pi}{2}$	L2
7	2	Determine the poles and residues at each pole of f(z) = $\frac{z+2}{(z-2)(z+1)^2}$	L2
8	2	Find the poles and residues at each pole of $f(z) = \frac{z}{(z-1)(z-2)}$	L2
9	2	Evaluate $\int_C \frac{1-2z}{z(z+1)(z-3)}dz$ where C is $\|z\| = 2$ by residue Theorem	L3
10	2	Evaluate $\int_C \frac{z^3}{(z-1)^2(z-3)}dz$ c : |z| = 2 using residue theorem	L3

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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 III: SOLUTION OF ALGEBRAIC & TRANSCENDENTAL EQUATIONS AND INTERPOLATION</td></tr>
<tr><td>1</td><td>3</td><td>A.Find a Positive root of the equation $x^3 - x - 1 = 0$ by Bisection method
B. Find a real root for$x^3 - 4x - 9 = 0$by Bisection method</td><td>L2</td></tr>
<tr><td>2</td><td>3</td><td>A. Find a real root of the equation $xe^x = 3$by Regular-False position method
B. Find a real root of the equation $x\ log_{10}x = 1.2$ by Regular-False position method</td><td>L2</td></tr>
<tr><td>3</td><td>3</td><td>Find a real root of the equation $x^3 - 5x - 6 = 0$ by Newton Raphson method.</td><td>L2</td></tr>
<tr><td>4</td><td>3</td><td>Find a real root of the equation $2x^3 - 3x - 6 = 0$ by Newton Raphson method.</td><td>L2</td></tr>
<tr><td>5</td><td>3</td><td>Using Newton’s Forward difference interpolation formula, and the given table value and obtain the value of f(x) at x=1.05
<table>
<tr><td>x</td><td>1.0</td><td>1.1</td><td>1.2</td><td>1.3</td><td>1.4</td><td>1.5</td></tr>
<tr><td>f(x)</td><td>0.841</td><td>0.891</td><td>0.932</td><td>0.964</td><td>0.985</td><td>1.015</td></tr>
</table></td><td>L2</td></tr>
<tr><td>6</td><td>3</td><td>The population of the town in the decimal census was given below. Determine the population of the year 1895.
<table>
<tr><td>Year x</td><td>1891</td><td>1901</td><td>1911</td><td>1921</td><td>1931</td></tr>
<tr><td>Population y (thousands)</td><td>46</td><td>66</td><td>81</td><td>93</td><td>101</td></tr>
</table></td><td>L2</td></tr>
<tr><td>7</td><td>3</td><td>Find y(142) from the data using Newton’s Forward interpolation formula
<table>
<tr><td>x</td><td>140</td><td>150</td><td>160</td><td>170</td><td>180</td></tr>
<tr><td>f(x)</td><td>3.685</td><td>4.854</td><td>6.302</td><td>8.076</td><td>10.225</td></tr>
</table></td><td>L2</td></tr>
<tr><td>8</td><td>3</td><td>Using appropriate interpolation formula, find y(2.5) for the data y(0)=1, y(1)=0, y(2)=1 and y(3)=10.</td><td>L2</td></tr>
<tr><td>9</td><td>3</td><td>Find f(2.0) using Newton’s Backward difference formula from the table
<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>10</td><td>3</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 IV: NUMERICAL DIFFERENTIATION, NUMERICAL INTEGRATION AND CURVE FITTING</td></tr>
<tr><td>1</td><td>4</td><td>Evaluate $\int_4^{5.2} \log x \, dx$ by Simpson's 3/8th rule from the data
<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>L2</td></tr>
<tr><td>2</td><td>4</td><td>Evaluate $\int_0^2 e^{-x^2} dx$ using Simpson's rule taking h=0.25</td><td>L2</td></tr>
<tr><td>3</td><td>4</td><td>Evaluate $\int_0^1 x^3 dx$ with 5 sub-intervals by Trapezoidal Rule.</td><td>L2</td></tr>
<tr><td>4</td><td>4</td><td>Evaluate $\int_0^4 e^x dx$ by Simpson's $\frac{1}{3}$ rule with n=10</td><td>L3</td></tr>
<tr><td>5</td><td>4</td><td>Use the Trapezoidal Rule with n=4 to estimate $\int_0^1 \frac{1}{1+x^2} dx$</td><td>L3</td></tr>
<tr><td>6</td><td>4</td><td>Evaluate $\int_0^1 \frac{1}{1+x} dx$ by using Simpson's $\frac{1}{3}$ rule and Simpson's $\frac{3}{8}$ rule.</td><td>L3</td></tr>
<tr><td>7</td><td>4</td><td>Find the line of best fit for the following data (2,1),(3,7),(6,5),(7,9)</td><td>L3</td></tr>
<tr><td>8</td><td>4</td><td>Find the line of best fit for
<table>
<tr><td>x</td><td>3</td><td>5</td><td>7</td><td>9</td><td>11</td></tr>
<tr><td>y</td><td>2.3</td><td>2.6</td><td>2.8</td><td>3.2</td><td>3.5</td></tr>
</table></td><td>L3</td></tr>
<tr><td>9</td><td>4</td><td>Calculate fitting second degree polynomial for
<table>
<tr><td>x</td><td>2</td><td>4</td><td>6</td><td>8</td><td>10</td></tr>
<tr><td>y</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
</table></td><td>L3</td></tr>
<tr><td>10</td><td>4</td><td>Calculate fitting second degree parabola for
<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>3</td><td>4</td><td>5</td><td>6</td></tr>
</table></td><td>L3</td></tr>
</table>

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UNIT V: SOLUTION OF INITIAL VALUE PROBLEMS TO ORDINARY DIFFERENTIAL EQUATIONS			
1	5	Solve $y^1 = x + y$, given y(1)=0 .Find y(1.1) and y(1.2) by Taylor's series method.	L2
2	5	Tabulate y(0.1), y(0.2) using Taylor's series method given that $\boldsymbol{y^1 = y^2 + x}$, and y(0)=1	L2
3	5	Find y(0.1),y(0.2) for $\boldsymbol{y^1 = x^2 - y; y(0) = 1}$ by Taylor series method	L2
4	5	Obtain y(0.1),y(0.2) given $\frac{dy}{dx} = \boldsymbol{x + y}$, y(0)=1 by Picard's method	L2
5	5	Given $\frac{dy}{dx} = \boldsymbol{1 + xy}$ and y(0)=1, compute y(0.1),y(0.2) by Picard's method	L2
6	5	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)	L2
7	5	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	L2
8	5	Apply Runge-Kutta fourth order method to find y(0.1) and y(0.2) given that $\boldsymbol{y^1 = x^2 - y}$ and y(0)=1	L2
9	5	Apply R-K fourth order to find y(0.1), y(0.2) given that $y^1 = 1 + xy$, $y(0) = 2$.	L2
10	5	Apply R-K fourth order to find y(0.1), y(0.2) given that $y^1 = xy + y^2$ $y(0) = 2$.	L2

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

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Instruction to Faculty Members:

The Six Levels of Bloom's Taxonomy:

1. **Remembering:** Retrieving, recognizing, and recalling relevant knowledge from long-term memory (e.g., list, define, name, locate).
2. **Understanding:** Constructing meaning, explaining ideas, or concepts (e.g., summarize, interpret, classify, compare).
3. **Applying:** Using information in new situations or implementing procedures to solve problems (e.g., solve, use, demonstrate, implement).
4. **Analyzing:** Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure (e.g., contrast, categorize, distinguish, diagram).
5. **Evaluating:** Making judgments based on criteria and standards through checking and critiquing (e.g., judge, critique, justify, defend, argue).
6. **Creating:** Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure (e.g., design, construct, develop, formulate).