B.Sc. Honours Mathematics – V Semester

Syllabus & Model Question papers

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
III	V	12	Linear Algebra & Problem Solving Sessions	5	4
		13	Vector Calculus & Problem Solving Sessions	5	4
		14	Functions of a Complex variable & Problem Solving Sessions **OR** Advanced Numerical Methods & Problem Solving Sessions	5	4
		15	Number Theory & Problem Solving Sessions. **OR** Mathematical Statistics & Problem Solving Sessions	5	4

Programme Outcomes for B.Sc. Mathematics (Major) - 4-Year Honours Degree

PO 1: Foundational Knowledge: Acquire a strong understanding of core concepts in mathematics, physical sciences, and chemical sciences, applying these principles to solve real-world problems.

PO 2: Analytical Skills : Develop proficiency in solving differential equations, analytical solid geometry, and algebraic structures through group theory and ring theory.

PO 3: Advanced Techniques : Master advanced mathematical methods, including Laplace transforms, integral transforms, special functions, real analysis, linear algebra, and vector calculus.

PO 4: Specialized Knowledge : Gain expertise in complex variables, numerical methods, number theory, mathematical statistics, algebra, classical mechanics, discrete mathematics, topology, and cryptography.

PO 5: Practical Application : Apply mathematical theories in real-world settings through internships and apprenticeships, enhancing practical understanding.

PO 6: Computational Skills: Develop computational abilities for numerical and symbolic computation using software tools and programming languages.

PO 7: Communication : Effectively communicate complex mathematical ideas and solutions, both orally and in writing.

PO 8: Collaboration : Work collaboratively with peers and professionals to solve interdisciplinary problems, integrating mathematical knowledge with other scientific domains.

PO 9: Critical Thinking : Cultivate critical thinking skills to systematically analyze and solve mathematical problems, fostering a lifelong learning attitude.

PO 10: Ethical Responsibility: Demonstrate ethical behaviour and professional responsibility, understanding the societal impact of mathematical solutions and promoting the responsible use of mathematical knowledge.

Program Specific Outcomes (PSOs) for BSc Honours in Mathematics

PSO 1: Advanced Mathematical Proficiency: Develop advanced problem-solving skills by mastering complex mathematical concepts such as differential equations, group theory, ring theory, and numerical methods.

PSO 2: Analytical and Computational Skills: Enhance analytical and computational abilities, including the use of mathematical software and programming to model, analyze, and interpret data effectively.

PSO 3: Research and Practical Application: Engage in research and internships to apply mathematical theories in real-world contexts, fostering innovation and interdisciplinary collaboration.

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III B Sc MATHEMATICS (w.e.f 2025-26)

V th Semester

PAPER-XII-**LINEAR ALGEBRA & Problem solving sessions**

No. of Hours per week: 05 **No. of Credits: 04**

Course Outcomes

After successful completion of this course, the student will be able to

1. understand the concepts of vector spaces ,subspaces
2. understand the concepts of Basis,Dimension and its properties
3. understand the concepts of Linear Transformations and its properties
4. understand the concepts of Rank of a matrix and solution of system of simultaneous Linear Equations.
5. understand the concepts of Eigen Values, Eigen Vectors.

UNIT – I

Vector Spaces-I: Vector Spaces, General properties of vector spaces, n-dimensional Vectors, addition and scalar multiplication of Vectors, internal and external composition, Null space, Vector subspaces, Algebra of subspaces, Linear Sum of two subspaces, linear combination of Vectors, Linear span Linear independence and Linear dependence of Vectors.

UNIT –II

Vector Spaces-II: Basis of Vector space, Finite dimensional Vector spaces, basis extension, co-ordinates, Dimension of a Vector space, Dimension of a subspace, Quotient space and Dimension of Quotient space.

UNIT –III

Linear Transformations: Linear transformations, linear operators, Properties of L.T, sum and product of LTs, Algebra of Linear Operators, Range and null space of linear transformation, Rank and Nullity of linear transformations – Rank – Nullity Theorem. Matrix of Linear Transformation (Confined to Definition and two problems).

UNIT –IV

Matrices-I: Definition of Matrix –Types of Matrices – Binary Operations (Using(a_{ij}) Notations) - Elementary Properties of Matrices – Inverse of a Matrix - Rank of a Matrix – System of Linear Equations - Solutions.

UNIT –V

Matrices-II: Characteristic equations - Characteristic Values & Vectors of square matrix – Properties Characteristic values and vectors - Cayley – Hamilton Theorem – Inverse of a Matrix using Cayley – Hamilton Theorem.

TextBook:

1. A textbook of B.Sc., Mathematics Volume-III, S.Chand & Company , Pvt.Ltd ., RamNagar, New Delhi, by V.Venkateswara Rao, N.Krishnamurthy, B.V.S.S.Sarma and S.AnjaneyaSastry

Reference Books :

1. Linear Algebra by J.N. Sharma and A. R. Vasishta, published by Krishna Prakashan Mandir Meerut-250002
2. Matrices by Shanti Narayana, published by S.ChandPublications.
3. Linear Algebra by Kenneh Hoffman and Ray Kunze, published by Pearson Education (Low Priced Edtion), New Delhi.

Course Outcomes (CO) – Programme Outcomes (PO) & Programme Specific Outcomes (PSO) Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1: The concept of Vector spaces & subspaces	3	3	2	-	-	-	-	-	-	-	3	-	-
CO2: The concept of Basis & Dimension	3	3	2	-	-	-	-	-	-	-	2	-	-
CO3: The concept of Linear Transformations	3	3	3	-	-	-	-	-	-	-	3	-	-
CO4: The concept of Rank & Linear equations	3	3	3	-	-	-	-	-	-	3	3	-	-
CO5: The concept of Eigenvalues & Eigenvectors	3	3	3	-	-	-	-	-	-	-	3	-	-

(Here 3 = Strongly Related, 2 = Moderately Related, 1 = Slightly Related, "–" = No relation)

Pattern of External Examination Max. Marks 60

S. No	Type of Questions	NO. of Questions	Marks alloted	Total Marks
1	Short Questions	5 out of 8 (Atleast one question must be given from each unit by the paper setter)	4	20
2	Essay Questions	5 out of 8 (Atleast one question must be given from each unit by the paper setter)	8	40
Total Marks				60

Internal Assessment : Max Marks-40

Internal I	: Max Marks-20
Internal II	: Max Marks-15
Assignment	: Max Marks-05
Seminar	: Max Marks-05
Cleaning, Greening & Attendance	: Max Marks-05
Total marks	: Max Marks-50

Scale down 50 marks to 40 marks

$$\text{Internal Assessment Marks} = \frac{Marks\ secured}{50} \times 40$$

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Semester-V

Paper-XII -Mathematics (**LINEAR ALGEBRA & Problem Solving Sessions)**

Model Paper (w.e.f 2025-26)

Time:3 Hrs Max Marks: 60

Section-I

Answer any **FIVE(05)**of the following questions.Each question carries **04** marks. 5 x 4 = 20

(Paper setter should give at least one question from each unit)

1. Show that the system of vectors (1, 3, 2), (1, -7, -8), (2, 1, -1) of $V_3(R)$ is linearly dependent.
2. Find the co-ordinates of $\alpha = (4, 5, 6)$ with respect to the basis set $\{x, y, z\}$where x = (1 ,1,1), y = (-1, 1, 1), z = (1, 0, -1)
3. Show that the set $\{(1, 2, 1), (2, 1, 0), (1, -1, 2)\}$ forms a basis of $V_3(F)$
4. Define Linear transformation. Show that the mapping T :$V_3(R) \to V_2(R)$ defined by T(x, y, z) = (x-y, x-z) is a linear transformation.
5. Let T :$V_3(R) \to V_2(R) and$H : $V_3(R) \to V_2(R)$ be the two linear transformations defined by T (x, y, z) = (x-y, y+z) and H(x, y, z) = (2x, y-z). Find (i) H+T (ii) aH
6. If the system of equations $2x - 2y + z = \lambda x, 2x - 3y + 2z = \lambda y, -x + 2y = \lambda z$ has non-zero solution then find the values of λ.
7. Find the inverse of $A = \begin{pmatrix} 1 & 0 & 1 \\ -2 & 1 & 0 \\ 0 & -1 & 1 \end{pmatrix}$ using elementary operations.
8. If the matrix A is non-singular, show that the eigen values of $A^{-1}$are the reciprocals of the eigen values of A.

Section-II

Answer any **FIVE(05)**of the following questions.Each question carries **08**marks. 5 x 8 = 40

(Paper setter should give at least one question from each unit)

9. Let V (F) be a vector space. A non-empty set W ⊆ V. The necessary and sufficient condition for W to be a subspace of V is a, b∈ F, α, $\beta \in$ W $\Rightarrow$ a α+$b\beta \in$W
10. Let W_1 and W_2 be two subspaces of a finite dimensional vector space V (F). Then prove that $\dim(W_1 + W_2) = \dim W_1 + dim W_2 - dim(W_1 \cap W_2)$.

11. Let W_1 and W_2 be two subspaces of R^4 given by $W_1 = \{(a,b,c,d); b-2c+d=0\}$, $W_2 = \{(a,b,c,d): a=d, b=2c\}$. Find the basis and dimensions of (i) W_1 , (ii) W_2 , (iii) $W_1 \cap W_2$ and hence find $\dim(W_1+W_2)$.

12. Let U (F) and V (F) be two vector spaces. Let T: U (F)→ $V(F)$ be a linear transformation. Let U be a finite dimensional Vector Space then show that $\rho(T) + \upsilon(T) = \dim U$.

13. Find the rank of the matrix $A = \begin{bmatrix} 1 & 3 & 2 \\ 2 & -1 & 3 \\ 3 & -5 & 4 \\ 1 & 17 & 4 \end{bmatrix}$ by reducing into normal form.

14. Solve the system of linear equations

$$x - 4y + 7z = 8{,}3x + 8y - 2z = 6{,}7x - 8y + 26z = 31$$

15.Find the Eigen values and corresponding Eigen vectors of the matrix

$$\text{A}= \begin{pmatrix} 8 & -6 & 2 \\ -6 & 7 & -4 \\ 2 & -4 & 3 \end{pmatrix}$$

16. State and prove Caley – Hamilton theorem.

GOVT. COLLEGE FOR MEN (A), KADAPA

III B.Sc. Mathematics (w.e.f. 2025-26)

SEMESTER-V

Paper XIII – Vector Caluculus & Problem Solving Sessions

No. of Hours per week: 05 **No. of Credits: 04**

Course Outcomes

After successful completion of this course, the student will be able to

1. Learn multiple integrals as a natural extension of definite integral to a function of two variables in the case of double integral/three variables in the case of triple integral.

2.Learn applications in terms of finding surface area by double integral and volume by triple integral

3 Determine the gradient,divergence and curl of a vector and vector identities.

4. Evaluate line,surface and volume integrals.

5.understand relation between surface and volume integrals (Gauss divergence theorem),relation between line integral and volume integral(Green'stheorem),relation between line and surface integral(Stoke's theorem)

Unit–1:Multiple integrals-I

1. Introduction , Double integrals , Evaluation of double integrals , Properties of double integrals.
2. Region of integration ,Change of variables in double integrals , Fubini's theorem (only statement), change of order of integration.
3. Double integration in Polar Co-ordinates,

Unit–2:Multiple integrals-II

1. Triple integral, region of integration , change of variables.
2. Plane areas by double integrals , surface area by double integral.
3. Volume as a double integral , volume as a triple integral.

Unit–3:Vector differentiation

1. Vector differentiation, ordinary derivatives of vectors.
2. Differentiability , Gradient , Divergence , Curl operators,
3. Formulae involving the operators.

Unit– 4:Vector integration

1. Line Integrals with examples.
2. Surface Integral with examples.
3. Volume integral with examples

Unit–5:Vector integration applications

1. Gauss theorem and applications of Gauss theorem.
2. Green's theorem in plane and applications of Green's theorem.
3. Stokes's theorem and applications of Stokes theorem.

Text Book :

1., A textbook of B.Sc., Mathematics Volume-III, S.Chand & Company , Pvt.Ltd ., RamNagar ,New Delhi, by V.Venkateswara Rao,N.Krishnamurthy,B.V.S.S.Sarma and S.AnjaneyaSastry

Reference Books :

1.Calculus and Analytic geometry by George B.Thomas and Ross L.Finney, Narosa Publishing house, New Delhi.

2. Higher Engineering Mathematics by B.S.Grewal, Khanna Publishers.

3. Advanced Engineering Mathematics by Erwin Kreyszig, Wiley Publishers.

Suggested Activities:

Seminar/ Quiz/ Assignments/ Project on Group theory and its applications in Graphics and Medical image Analysis

Course Outcomes (CO) – Programme Outcomes (PO) & Programme Specific Outcomes (PSO) Mapping

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1: To Learn multiple integrals as an extension of definite integrals	2	3	–	–	–	–	–	–	–	–	2	–	3
CO2: To Apply double and triple integrals to surface area and volume	–	2	3	–	–	–	–	–	2	–	3	–	2
CO3: To Determine gradient, divergence, curl and vector identities	–	2	3	–	–	–	–	–	–	–	2	–	3
CO4: To Evaluate line, surface, and volume integrals	3	2	–	–	–	–	–	–	3	–	3	2	3
CO5:To Understand Gauss, Green's, and Stoke's theorems with applications	–	–	3	–	2	2	–	–	–	–	–	3	2

✓ where 3 = Strong, 2 = Moderate, and – = No relation.

Pattern of External Examination Max. Marks 60

S.No	Type of Questions	NO. of Questions	Marks alloted	Total Marks
1	Short Questions	5 out of 8 (Atleast one question must be given from each unit by the paper setter)	4	20
2	Eassay Questions	5 out of 8 (Atleast one question must be given from each unit by the paper setter)	8	40
Total Marks				60

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III B.Sc MATHEMATICS (w.e.f.2025-26)
Semester – V

Paper XIII -VECTOR CALUCULUS & Problem Solving Sessions

Model Paper(w.e.f 2025-26)

Time : 3 Hrs Max Marks : 60

Section-I

Answer any **FIVE(05)** of the following questions. Each question carries 04 marks. 5 x 4 = 20

(Paper setter should give at least one question from each unit)

1. Evaluate $\int_0^1 \int_x^{\sqrt{x}} (x^2 + y^2) dxdy$.
2. Change the order of integration and evaluate $\int_0^{4a} \int_{\frac{x^2}{4a}}^{2\sqrt{ax}} dxdy$.
3. Evaluate $\int_0^{2a} \int_0^x \int_y^x xyz \ dxdydz$.
4. Find the angle of intersection at (4, -3, 2) of spheres $x^2 + y^2 + z^2 = 29$ and $x^2 + y^2 + z^2 + 4x - 6y - 8z - 47 = 0$.
5. Find Curl $\bar{f}$, where $f = grad\ (x^2 + y^2x + z^2)$ at (1, 1, -2)
6. If F = $(x^2 + y^2)i - 2xyj$ evaluate $\int_C \bar{F}.\overline{dr}$ where **C** is the rectangle in the XY plane bounded by $y = 0, y = b, x = 0, x = a$.
7. Evaluate $\int_c y\,dx + z\,dy + xdz$ where **C** is the curve of intersection of $x^2 + y^2 + z^2 = a^2$ and $x + z = a$.
8. Find $\oint_c (xy + y^2)dx + (x^2)dy$, where **C** is the closed curve of the region bounded by $y = x$ and $y = x^2$.

Section-II

Answer any FIVE of the following questions .Each question carries 08 Marks 5 x8 = 40

(Paper setter should give at least one question from each unit)

9. Evaluate $\iint_R x^2 dxdy$, where R is the region of integration in the first quadrant bounded by the hyperbola $xy = 16$ and the lines $y = x, y = 0$.
10. Evaluate $\iiint_V (2x + y)\, dxdydz$, where V is the closed region bounded by the

cylinder $z = 4 - x^2$ and the planes $x = 0, y = 0, y = 2$ and $z = 0$.

11. Prove that $Curl(\bar{A}X\bar{B}) = \bar{A}div\bar{B} - \bar{B}div\bar{A} + (\bar{B}.\nabla)\bar{A} - (\bar{A}.\nabla)\bar{B}$.

12. Prove that $grad(A.B) = (B.\nabla)A + (A.\nabla)B + (B \times curlA) + (A \times curlB)$.

13. Evaluate $\int_S \bar{F}.\bar{N}ds$ where $\bar{F} = 18z\bar{\imath} - 12\bar{\jmath} + 3y\bar{k}$ and S is the part of the plane $2x + 3y + 6z = 12$ located in the first octant

14. If $\Phi = 45x^2y$ evaluate $\iiint_V \phi dv$ where V is the closed region bounded by the planes $4x + 2y + z = 8, x = 0, y = 0, z = 0$.

15. State and prove Gauss's Divergence theorem.

16. Verify Green's theorem in the plane for $\oint_C (3x^2 - 8y^2)\,dx + (4y - 6xy)dy$ where C is the region bounded by $y = \sqrt{x}$ and $y = x^2$

Internal Assessment : Max Marks-40

Internal I	: Max Marks-20
Internal II	: Max Marks-15
Assignment	: Max Marks-05
Seminar	: Max Marks-05
Cleaning, Greening & Attendance	: Max Marks-05
Total marks	: Max Marks-50
Scale down 50 marks to 40 marks	

Internal Assessment Marks = $\frac{Marks\ secured}{50}$ x 40

GOVT. COLLEGE FOR MEN (A), KADAPA

III B.Sc. Mathematics (w.e.f. 2025-26)

SEMESTER-V

Paper XIV – Functions of a complex Variable & Problem Solving Sessions

No. of Hours per week: 05 **No. of Credits: 04**

Course Outcomes

1 After successful completion of this course, the student will be able to:

2 Determine a bilinear transformation under given conditions.

3 Understand continuity, compactness, and connectedness of sets in the complex plane.

4 Know the necessary and sufficient conditions for f(z)f(z)f(z) to be analytic.

5 Understand the inverse of an analytic function.

6 Know about the convergence of sequences and the necessary & sufficient conditions for sequence convergence.

7 Understand the power series expansion of elementary functions.

Unit 1: Bilinear Transformations – I

Extended Complex Plane. Infinite Point – Vertex of stereographic projection corresponding to the point at infinity – Resultant and Inverse of a Bilinear Transformation – The Linear Group – Critical points – Expression of a given bilinear transformation as the resultant of bilinear transformations with simple geometric imports – Geometrical Significance of the Transformation – A given bilinear transformation as resultant of an even number of inversions – Angle Preserving Property of Bilinear Transformation.

Unit 2: Bilinear Transformations - II

Cross Ratio – Preservation of the family of straight lines and circles – Preservation of the configuration formed by a circle and a pair of inverse points for the same – Fixed points of a bilinear transformation – Normal form of a bilinear transformation – Determination of Bilinear Transformations under Given Conditions – Some Special Bilinear Transformations – Determination of the totality of bilinear transformations which map $|z| = 1$ onto |w|=1. – Determination of the totality of bilinear transformation which maps the real axis $I(z) = 0$ onto the unit circle $|w| = 1$.

Unit 3: Analytic Functions

Differentiable Functions of a Complex Variable – Geometrical Representation of a Variable – Analytic Function – Elementary Rules and Chain Rule – Derivatives of Polynomials and Rational Functions – Necessary and Sufficient Condition for $f(z)$ to be Analytic – Analytic Functions in a

Domain – Derivative of w in Polar Form – Construction of $f(z)$ when one conjugate function is given.

Unit 4: Inverse of an Analytic Function and Infinite Series

Inverse of an Analytic Function – Neighbourhood Preserving Mappings – Domain Preserving and Angle Preserving Properties of Analytic Mappings – Convergent Sequences – Necessary and Sufficient Condition for Convergence – Cauchy Sequences – Convergence of Infinite Series – Cauchy's General Principle of Convergence – Absolute Convergence – Abel's and Dirichlet's Tests – Rearrangement and Product of Series.

Unit 5: Power Series

Power Series – Exponential, Trigonometric, and Hyperbolic Functions – Zeros of $sin\, z, \cos z$ – Periods of $sin\, z, cos\, z, E(z)$ – A Law of Logarithms – Analytic Character of $Log\, z$ – Generalized a^b – Analytic Character of z^n, n being any constant number – Inverse of $sin\, z, cos\, z$ and Their Derivatives

Activities

Seminar/ Quiz/ Assignments/ Applications of Functions of a Complex Variable to real life problem / Problem solving sessions.

Text Book

- Theory of Functions of a Complex Variable by **Shanti Narayan & Dr. P. K. Mittal**, S. Chand & Company Ltd.

Reference Books

- Theory of Functions of a Complex Variable by **A. I. Markushevich**, Second Edition, AMS Chelsea Publishing
- Complex Variables: Theory and Applications by **M. S. Kasara**, 2nd Edition, Prentice Hall India Learning Pvt. Ltd.

Course Outcomes (CO) – Programme Outcomes (PO) & Programme Specific Outcomes (PSO) Mapping

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1: To Determine a bilinear transformation under given conditions	3	3	–	–	–	–	–	–	–	–	3	–	2

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO2: To Understand continuity, compactness, and connectedness of sets in the complex plane	2	3	2	–	–	–	–	–	–	–	2	–	3
CO3: To Know the necessary and sufficient conditions for f(z)f(z)f(z) to be analytic	2	3	3	–	–	–	–	–	–	–	3	–	3
CO4: To Understand the inverse of an analytic function	3	2	–	–	2	–	–	–	–	–	3	2	3
CO5: To Know about convergence of sequences and necessary & sufficient conditions for convergence	2	3	3	–	–	–	–	–	2	–	3	–	2
CO6: To Understand the power series expansion of elementary functions	3	2	3	–	2	–	–	–	–	–	3	–	3

Pattern of External Examination Max .Marks 60

S.No	Type of Questions	NO. of Questions	Marks alloted	Total Marks
1	Short Questions	5 out of 8 (Atleast one question must be given from each unit by the paper setter)	4	20
2	Eassay Questions	5 out of 8 (Atleast one question must be given from each unit by the paper setter)	8	40
Total Marks				60

Internal Assessment : Max Marks-40

Internal I : Max Marks-20
Internal II : Max Marks-15
Assignment : Max Marks-05
Seminar : Max Marks-05
Cleaning, Greening & Attendance : Max Marks-05
Total marks : Max Marks-50
Scale down 50 marks to 40 marks

$$\text{Internal Assessment Marks} = \frac{Marks\ secured}{50} \times 40$$

Government College for Men (Autonomous) :: Kadapa

III B.Sc MATHEMATICS (w.e.f.2025-26)

Semester-V

Paper-XIV - Functions of a complex Variables & Problem Solving Sessions

Model Paper(w.e.f 2025-26)

Time:3 Hrs Max Marks: 60

Section-I

Answer any **05** of the following questions Each question carries **04** marks. 5 x 4 = 20

(Paper setter should give at least one question from each unit)

1. Prove that the set of all bilinear transformation form a group w.r.to multiplication of transformation.
2. Find the fixed points of the following bilinear transformations: $(a) w = \frac{z-1}{z+1}$ $(b)\ w = \frac{1+3iz}{i+z}$
3. Find the bilinear transformation $w = f(z)$ mapping the half plane $Im(z) > 0$ onto itself and satisfying the conditions $w(0) = 1, w(1) = 2\ , w(2) = \infty$.
4. Find the conjugate harmonic function of the harmonic function U= $y^2 - x^2$.
5. If f(z) is an analytic function of z, prove that $\left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}\right)|Re\ f(z)|^2 = 2\left|f^{|}(z)\right|^2$.
6. The geometric series $1 + z + z^2 + \cdots \ldots + z^n + \cdots$ converges if and only if $|z| < 1$. Also the converges is absolute.
7. State and prove Able's theorem.
8. Find the radii of convergence of the following power series $(a) \sum \frac{1}{n^n} z^n$ $(b) \sum \frac{n!}{n^n} z^n$.

Section-II

Answer any **05 (FIVE)** of the following questions. Each question carries 8 marks. 5 x 8 = 40

(Paper setter should give at least one question from each unit)

9.Consider the transformation $w = T_1(z) = \frac{z+2}{z+3}$, $w = T_2(z) = \frac{z}{z+1}$. find $(a) T_1^{-1}, (b) T_1 T_2(z)\ and (c)\ T_2^{-1}\ T_1(z)$.

10.Any bilinear transformation can be expressed as a product of translation, rotation, magnification and inversion.

11.If for a bilinear transformation, w_1, w_2, w_3, w_4 are the transforms of z_1, z_2, z_3, z_4 respectively, then bilinear transformation $(w_1, w_2, w_3, w_4) = (z_1, z_2, z_3, z_4)$

12.Prove that the function $f(z) = u + iv, where\ f(z) = \frac{x^3(1+i) - y^3(1-i)}{x^2 + y^2}, (z \neq 0), f(0) = 0$ is

continuous and that Cauchy – Riemann equations are satisfied at the origin.

13.State and prove Cauchy – Riemann equations in polar form.

14.If the sequence of partial sums of a series $\sum a_n$ is bounded and if and only if $\sum |v_n - v_{n+1}|$ converges and the series and $\lim v_n = 0$.then the series $\sum a_n v_n$is convergent.

15.Examine the behaviour of the series $\sum_{n=2}^{\infty} \frac{z^n}{n(\log n)^2}$ on the circle of convergence.

16.Define Exponential function. Show that $E(z_1 + z_2) = E(z_1).E(z_2)$ and also Period of $E(z)$.

GOVT. COLLEGE FOR MEN (A), KADAPA

III B.Sc. Mathematics (w.e.f. 2025-26)

SEMESTER-V

Paper XIV – Advanced Numerical Analysis & Problem Solving Sessions

No. of Hours per week: 05 **No. of Credits: 04**

Course Outcomes

After successful completion of this course, the student will be able to

1)find derivatives using various difference formulae
2)understand the process of Numerical Integration
3)solve Simultaneous Linear systems of Equations
4)understand Iterative methods
5)find Numerical Solution of Ordinary Differential Equations

UNIT – I

Numerical Differentiation

Derivatives using Newton's forward difference formula - Newton's backward difference formula- Derivatives using central difference formula - Stirling's interpolation formula - Newton's divideddifference formula.

UNIT – II

Numerical Integration

General quadrature formula on errors - Trapezoidal rule – Simpson's 1/3 rule - Simpson's 3/8 rule- Weddle's rule - Euler-Maclaurin formula of summation and quadrature - The Euler transformation.

UNIT – III

Solution of Simultaneous Linear systems of Equations – I

Solution of linear systems - Direct Methods - Matrix inversion method – Gaussian elimination method-Gauss Jordan Method.

UNIT – IV

Solution of Simultaneous Linear systems of Equations – II

Method of factorization - solution of Tridiagonal systems - Iterative methods - Jacobi's method -Gauss - Siedal method.

UNIT – V

Numerical Solution of Ordinary Differential Equations

Introduction – solution of Taylor's series – Picard's method of successive approximations – Euler's method – Modified Euler's method – Runge-Kutta methods.

Activities

Seminar/ Quiz/ Assignments/ Applications of Numerical methods to Real life Problem /Problem Solving Sessions.

Text Book

Numerical Analysis by G. Shanker Rao, New Age International Publications

Reference Books

- Applied Numerical Analysis by Curtis F. Gerald and Patrick O. Wheatley, Pearson Publications.
- Numerical Methods for Scientific and Engineering Computation by M. K. Jain, S .R. K. Iyengar and
  R. K. Jain, New Age International Publishers.

Course Outcomes (CO) – Programme Outcomes (PO) & Programme Specific Outcomes (PSO) Mapping

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1:To Find derivatives using various difference formulae	3	2	–	–	–	–	–	–	–	–	3	–	2
CO2: To Understand the process of numerical integration	2	3	–	–	2	–	–	–	–	–	3	–	3
CO3:To Solve simultaneous linear systems of equations	3	3	2	–	–	–	–	–	–	–	3	2	3
CO4: To Understand iterative methods	2	3	3	–	–	–	–	–	–	–	2	–	3
CO5: To Find numerical solutions of ordinary differential equations	3	2	3	–	2	–	–	–	–	–	3	–	3

Pattern of External Examination Max. Marks 60

S. No	Type of Questions	NO. of Questions	Marks alloted	Total Marks
1	Short Questions	5 out of 8 (Atleast one question must be given from each unit by the paper setter)	4	20
2	Essay Questions	5 out of 8 (At least one question must be given from each unit by the paper setter)	8	40
Total Marks				60

Internal Assessment : Max Marks-40

Internal I : Max Marks-20
Internal II : Max Marks-15
Assignment : Max Marks-05
Seminar : Max Marks-05
Cleaning, Greening & Attendance : Max Marks-05
Total marks : Max Marks-50
Scale down 50 marks to 40 marks

$$\text{Internal Assessment Marks} = \frac{Marks\ secured}{50} \times 40$$

Government College for Men (Autonomous) :: Kadapa

III B.Sc MATHEMATICS (w.e.f.2025-26)

Semester-V

Paper-XIV - Advanced Numerical Methods& Problem Solving Sessions

Model Paper(w.e.f 2025-26)

Time:3 Hrs Max Marks: 60

Section –I

(Paper setter should give at least one question from each unit)

Answer any **FIVE(05)** of the following questions . Each question carries **4** marks. 5× 4 = 20

1)

2)

3)

4)

5)

6)

7)

8)

Section –II

(Paper setter should give at least one question from each unit)

Answer any **FIVE(05)** of the following questions . Each question carries **8** marks. 5× 8 = 40

1)

2)

3)

4)

5)

6)

7)

8)

GOVT. COLLEGE FOR MEN (A), KADAPA

III B.Sc. Mathematics (w.e.f. 2025-26)

SEMESTER-V

Paper XV – Number Theory & Problem Solving Sessions

Theory Credits: 4 5 hrs/week (Total 75)

Learning Outcomes

After successful completion of the course, students will be able to

1) understand the fundamental theorem of arithmetic
2) understand Mobius function, Euler quotient function, The Mangoldt function, Liouville's function, The divisor functions and the generalized convolutions.
3) understand Euler's summation formula, application to the distribution of lattice points and the applications to μ (n) and Λ (n)
4) understand the concepts of congruencies, residue classes and complete residues system
5) Comprehend the concept of quadratic residues mod p and quadratic non residues mod p.

UNIT-I

The Fundament Theorem of Arithmetic

Introduction, Divisibility, Greatest common divisor, Prime numbers, The fundamental theorem of arithmetic, The series of reciprocals of the primes, The Euclidean algorithm, The greatest common divisor of more than two numbers

UNIT-II

Arithmetical Functions and Dirichlet Multiplication

Introduction- The Mobius function $\mu\ (n)$ – The Euler quotient function $\varphi\ (n)$ - A relation connecting φ and μ - A product formula for $\varphi\ (n)$ - The Dirichlet product of arithmetical functions- Dirichlet inverses and the Mobius inversion formula- The Mangoldt function $\Lambda\ (n)$- multiplicativefunctions- multiplicative functions and Dirichlet multiplication- The inverse of a completely multiplicative function-Liouville's function $\lambda\ (n)$ - The divisor functions $\sigma_\alpha\ (n)$

UNIT-III

Averages Of Arithmetical Functions

Introduction- The big oh notation. Asymptotic equality of functions- Euler's summation formula- Some elementary asymptotic formulas-The average order of $d(n)$- The average order of the divisor functions $\sigma_\alpha\ (n)$- The average order of $\varphi\ (n)$- An application to the distribution of lattice points visible from the origin- The average order of $\mu\ (n)$ and $\Lambda(n)$-The partial sums of a Dirichlet product- Applications to $\mu\ (n)$ and $\Lambda\ (n)$

UNIT-IV

Congruences

Definition and basic properties of congruences- Residue classes and complete residue systems- Linear congruences- Reduced residue systems and the Euler- Fermat theorem- Polynomial congruences modulo p. Lagrange's theorem- Applications of Lagrange's theorem- Simultaneous linear congruences. The Chinese remainder theorem- Applications of the Chinese remainder theorem

UNIT-V

Quadratic Residues and the Quadratic Reciprocity Law

Quadratic Residues, Legendre's symbol and its properties, Evaluation of $(-1/p)$ and $(2/p)$, Gauss lemma, The Quadratic reciprocity law, Applications of the reciprocity law, The Jacobi Symbol, Gauss sums and the quadratic reciprocity law, the reciprocity law for quadratic Gauss sums, Another proof of the quadratic reciprocity law.

Activities

Seminar/ Quiz/ Assignments/ Applications of Number theory to Real life Problem /Problem Solving Sessions

Text Book

Introduction to Analytic Number Theory by T.M.Apostol, Springer Verlag-New York, Heidalberg-Berlin-1976.

Reference Books

- Elementary Number Theory by G.A.Jones and J.M.Jones, , Springer
- Elementary Number Theory by David, M. Burton, 2nd Edition UBS Publishers.
- Number Theory by Hardy & Wright, Oxford Univ., Press.
- Elements of the Theory of Numbers by Dence, J. B &Dence T.P, Academic Press

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Course Outcomes (CO) – Programme Outcomes (PO) & Programme Specific Outcomes (PSO) Mapping

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1: To Understand the fundamental theorem of arithmetic	3	2	–	–	–	–	–	–	–	–	3	–	2
CO2: To Understand Mobius, Euler quotient, Mangoldt, Liouville, divisor functions and convolutions	2	3	–	–	2	–	–	–	–	–	3	–	3
CO3: To Understand Euler's summation formula and applications to μ(n) and Λ(n)	3	3	2	–	–	–	–	–	–	–	3	2	3

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO4: To Understand congruences, residue classes, complete residue systems	**2**	**3**	**3**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**2**	**–**	**3**
CO5: To Comprehend quadratic residues and quadratic reciprocity law	**3**	**2**	**3**	**–**	**2**	**–**	**–**	**–**	**–**	**–**	**3**	**–**	**3**

Pattern of External Examination Max. Marks 60

S.No	Type of Questions	NO. of Questions	Marks alloted	Total Marks
1	Short Questions	5 out of 8 (Atleast one question must be given from each unit by the paper setter)	4	20
2	Eassay Questions	5 out of 8 (Atleast one question must be given from each unit by the paper setter)	8	40
Total Marks				60

Internal Assessment : Max Marks-40

Internal I : Max Marks-20
Internal II : Max Marks-15
Assignment : Max Marks-05
Seminar : Max Marks-05
Cleaning, Greening & Attendance : Max Marks-05
Total marks : Max Marks-50
Scale down 50 marks to 40 marks

$$\text{Internal Assessment Marks} = \frac{Marks\ secured}{50} \times 40$$

Government College for Men (Autonomous) :: Kadapa

III B.Sc. MATHEMATICS (w.e.f.2025-26)

Semester-V

Paper-XV -Mathematics (Number Theory & Problem-Solving Sessions)

Model Paper (w.e.f 2025-26)

Time:3 Hrs Max Marks: 60

Section-I

Answer any FIVE of the following questions. Each question carries 04 marks. 5 x 4 = 20

(Paper setter should give at least one question from each unit)

1)

2)

3)

4)

5)

6)

7)

8)

Section-II

Answer any FIVE of the following questions Each question carries 08 Marks 5 X 8 = 40

(Paper setter should give at least one question from each unit)

1)

2)

3)

4)

5)

6)

7)

8)

GOVT. COLLEGE FOR MEN (A), KADAPA

III B.Sc. Mathematics (w.e.f. 2025-26)

SEMESTER-V

Paper XV – Mathematical Statistics & Problem-Solving Sessions

No. of Hours per week: 05 **No. of Credits: 04**

Course outcomes:

After completion of the course, student will be able to

1. Understand the probability set function and conditional probability
2. Understand about random variables, discrete and continuous type distributions
3. Understand the distribution of two random variables and expectation of a random variable
4. Know binomial and related distributions
5. Normal distributions and the applications of normal distributions

Unit- 1
Probability and Distributions

Sets - set functions - The probability set function - counting rules - additional properties of probability - conditional probability and independence - simulations

Unit - 2
Probability and Distributions continued...

Random variables - Discrete random variables - Continuous random variables - Quantiles - Transformations - Mixture of continuous and discrete type distributions - Expectation of a random variable - Some special functions - Important Inequalities

Unit - 3
Multivariate Distributions

Distribution of two random variables - Marginal distributions - Expectation - Transformations - Bivariate random variables - Conditional distributions and expectations - Independent random variables - The correlation coefficient - Extension to several random variables - Multivariate variance - Covariance matrix.

Unit - 4
Some Special Distributions

The Binomial and related distributions - Negative binomial and geometric distributions - Multinomial distributions - Hyper geometric distribution - The Poisson distribution.

Unit - 5
Normal distribution

The normal distribution - Contaminated Normals - t - and F- Distributions. The Γ, χ^2 and β distributions - The χ^2- distribution - The β-distribution.

Activities

Seminar/ Quiz/ Assignments/ Applications of mathematical statics to real life problem / Problem solving sessions.

Text Book

Introduction to Mathematical Statistics by Robert V Hogg. Joseph W MacKeen, Eight Edition, Allen T Craig, Pearson

Reference Books

1. Fundamentals of Statistics by Goon A.M., Gupta M. K. and Dasgupta B., (2002) Vol. I & II, 8 th Edn. The world press, Kolkata.
2. Fundamentals of Mathematical Statics by Gupta, S. C and Kapoor, V.K. (2008): 4th Edn (Reprint), Sultan Chand & Sons
3. Mathematical Statics with Applications by Miller, Irvin and Miller, Marylees (2006) John E Freund's, (7th Edn.), Pearson Education, Asia.
4. Introduction to the Theory of Statistics by Mood, A.M. Graybill, F.A. and Boes, D.C.,(2007), 3rd Edn., (Reprint), Tata McGraw-Hill Pub.Co.Ltd.

Course Outcomes (CO) – Programme Outcomes (PO) & Programme Specific Outcomes (PSO) Mapping

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1: To Understand the probability set function and conditional probability	3	2	–	–	–	–	–	–	–	–	3	–	2
CO2: To Understand random variables, discrete and continuous type distributions	2	3	–	–	2	–	–	–	–	–	3	2	3
CO3: To Understand the distribution of two random variables and expectation	2	3	2	–	–	–	–	–	–	–	3	–	3
CO4: To Know binomial and related distributions	3	2	–	–	–	–	–	–	–	–	3	2	2
CO5: To study Normal distributions and applications	3	2	3	–	2	–	–	–	–	–	3	–	3

Pattern of External Examination Max. Marks 60

S. No	Type of Questions	NO. of Questions	Marks alloted	Total Marks
1	Short Questions	5 out of 8 (Atleast one question must be given from each unit by the paper setter)	4	20
2	Eassay Questions	5 out of 8 (At least one question must be given from each unit by the paper setter)	8	40
Total Marks				60

Internal Assessment : Max Marks-40

Internal I : Max Marks-20
Internal II : Max Marks-15
Assignment : Max Marks-05
Seminar : Max Marks-05
Cleaning, Greening & Attendance : Max Marks-05
Total marks : Max Marks-50
Scale down 50 marks to 40 marks

Internal Assessment Marks = $\frac{Marks\ secured}{50}$ x 40

Government College for Men (Autonomous) :: Kadapa

III B.Sc. MATHEMATICS (w.e.f.2025-26)

Semester-V

Paper-XV -Mathematics (Mathematical Statistics & Problem-Solving Sessions)

Model Paper

Time:3 Hrs Max Marks: 60

Section-I

Answer any FIVE of the following questions. 5 x 4 = 20

(Paper setter should give at least one question from each unit)

1. A card is drawn at random from an ordinary deck of 52 playing cards. If C_1 denote the collection of 13 hearts and C_2 denote the collection of 4 kings, then compute $P(C_1), P(C_2), (PC_1 \cap C_2)$ and $(PC_1 \cup C_2)$.
2. *Let the sample space* $\mathcal{C} = \{c: 0 < c < \infty\}$. *Let* $C \subset \mathcal{C}$ *be defined by* $C = \{c: 4 < c < \infty\}$ *and* $PC) = \int_C e^{-x}dx$. *Show that* $P(\mathcal{C}) = 1$. *Evaluate* $P(C), P(C^c)$ *and* $P(C \cup C^c)$
3. If the pdf of x is $f(x) = 2xe^{-x^2}, 0 < x < \infty$, zero elsewhere, determinethe pdf of $Y = X^2$
4. Define Mean and Variance and Moment generating function of a random variable X.
5. Let X_1 and X_2 have the joint pdf $f(x_1, x_2) = \begin{cases} x_1 + x_2, & 0 < x_1 < 1, 0 < x_2 < 1 \\ 0, & \text{elsewhere} \end{cases}$ Find the marginal pdfs.
6. If a random variable X has a Poisson distribution such that P(X=1) = P(X=2), then find P(X=4).
7. If the mgf of the random variable X is $M(t) = (\frac{2}{3} + \frac{1}{3}e^t)^5$ then find its mean and variance.
8. If $\bar{X}$ be the mean of a random sample of size 5 form a normal distribution with $\mu = 0$ and $\sigma^2 = 125$. Determine c so that $P(\bar{x} < c) = 0.90$

Section-II

Answer any <u>FIVE (05)</u> of the following questions. 5X8=40

(Paper setter should give at least one question from each unit)

9. In bolt factory machines A, B and C manufacture respectively 25%, 3%and 40% of the total. Of their output 5, 4, 2 percent are defective bolts. A bolt is drawn at random from the product and is found to be defective. what are the probabilities that it was manufactured by machines A, B and C.
10. State and Prove Baye's theorem.
11. Let X have the pdf

$f(x) = \begin{cases} \frac{x+2}{18}, -2 < x < 4 \\ 0, \text{elsewhere} \end{cases}$. Find $E(X), E[(x+2)^3]$ and $E[6X - 2(x+2)^3]$

12. State and prove Chebyshev's Inequality.

13. Obtain the correlation between X and Y whose joint pdf is given by

$$f(x,y) = \begin{cases} x + y, & 0 < x < 1, 0 < y < 1 \\ 0, & \text{elsewhere} \end{cases}$$

14. Suppose the joint mgf, $M(t_1, t_2)$ exists for the random variables X_1 and X_2.

    Then X_1 and X_2 are independent if and only if $M(t_1, t_2) = M(t_1, 0)\, M(0, t_2)$

15. Obtain the mgf, mean and variance of the Poisson distribution.

16. Derive the pdf of F-distribution