GOVERNMENT COLLEGE FOR MEN (AUTONOMOUS), KADAPA

Model Syllabus for 4-Year UG Honours in B.Sc. (Mathematics) as Major in consonance with Curriculum framework w.e.f. AY 2025-26

COURSE STRUCTURE (for Semester I to VI)

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
I	I	1	Differential Equations	5	4
		2	Solid Geometry	5	4
	II	3	Group Theory	5	4
		4	Elementary Real Analysis	5	4
II	III	5	Ring Theory	5	4
		6	Advanced Real Analysis	5	4
		7	Theory of Matrices	5	4
	IV	8	Linear algebra	5	4
		9	Vector Calculus	5	4
		10	Linear Programming Program	5	4
III	V	11	Special Functions	5	4
		12 A	Laplace Transforms	5	4
		OR			
		12 B	Foundations of Automata Theory	5	4
		13 A	Numerical Methods	5	4
		OR			
		13 B	Mathematical Methods using MatLab	5	4

	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
	VI	14 A	Integral Transforms	5	4
		OR			
		14 B	Statistical Analysis using R	5	4
		15 A	Advanced Numerical Methods	5	4
		OR			
		15 B	Mathematical Computations using Python	5	4

Note: In the III Year (during the V and VI Semesters), students are required to select a pair of electives from one of the **Two** specified domains. **For example: if set 'A' is chosen, courses 12 to 15 to be chosen as 12 A, 13 A, 14 A and 15 A.** To ensure in-depth understanding and skill development in the chosen domain, students must continue with the same domain electives in both the V and VI Semesters

Model Syllabus for Mathematics (Minor) in consonance with Curriculum framework w.e.f. AY 2025-26

COURSE STRUCTURE

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
II	III	1	Differential Equations	5	4
	IV	2	Group Theory	5	4
III	V	3	Ring Theory	5	4
		4	Elementary Real Analysis	5	4
	VI	5	Linear algebra	5	4
		6	Advanced Real Analysis	5	4

Program Outcomes (POs):

On successful completion of the program, students will be able to:

1. **PO1: Knowledge of Mathematics** – Demonstrate comprehensive knowledge of core areas of mathematics such as Algebra, Analysis, Differential Equations, Geometry, Linear Algebra, and Statistics.
2. **PO2: Problem Solving Skills** – Identify, formulate, and solve mathematical problems using logical reasoning, abstract thinking, and analytical techniques.
3. **PO3: Application of Mathematics** – Apply mathematical methods to model, analyze, and solve real-life problems in science, engineering, technology, economics, and social sciences.

4. **PO4: Use of Modern Tools** – Utilize modern mathematical software, programming languages (Python, MATLAB, R), and computational techniques to explore and solve problems effectively.
5. **PO5: Research and Inquiry** – Develop the ability to conduct investigations, analyze data, interpret results, and draw valid conclusions using mathematical principles.
6. **PO6: Communication Skills** – Communicate mathematical ideas, reasoning, and findings clearly and effectively through oral, written, and digital forms.
7. **PO7: Lifelong Learning** – Recognize the importance of independent learning, adaptability, and continual upgrading of knowledge in mathematics and related fields.
8. **PO8: Ethics and Responsibility** – Apply ethical principles, social responsibility, and professional integrity while using mathematical knowledge in real-world contexts.

Program Specific Outcomes (PSOs):

After completing the B.Sc. Mathematics (Honours), students will be able to:

1. **PSO1: Mastery of Core Concepts** – Attain strong conceptual understanding of Differential Equations, Group Theory, Ring Theory, Real Analysis, Vector Calculus, and Linear Algebra.
2. **PSO2: Mathematical Modeling & Computation** – Develop models for physical, biological, and engineering systems using methods such as Laplace Transforms, Numerical Methods, and Linear Programming.
3. **PSO3: Software & Programming Proficiency** – Gain hands-on skills in mathematical computing using MATLAB, R, and Python for problem solving, simulations, and data analysis.
4. **PSO4: Specialization & Research Readiness** – Acquire knowledge of advanced areas like Automata Theory, Integral Transforms, and Special Functions to prepare for research, higher studies, and competitive exams.
5. **PSO5: Career & Industry Readiness** – Apply mathematical knowledge and computational skills to pursue careers in academia, research, IT, finance, analytics, teaching, and government sectors.

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

SEMESTER-I

PAPER 1: DIFFERENTIAL EQUATIONS

Theory	Credits: 4	5 hrs/week

Course Objectives:

- To introduce the concepts and methods for solving first-order differential equations, including exact, linear, and Bernoulli equations.
- To understand special types of first-order differential equations such as Clairaut's equations and those solvable for p, x or y.
- To develop techniques for solving higher-order linear differential equations with constant coefficients.
- To apply the operator method for finding particular integrals of non-homogeneous differential equations with various types of right-hand side functions.
- To learn the method of variation of parameters for solving non-homogeneous differential equations.

Course Outcomes:

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

1.Solve exact differential equations, linear equations, Bernoulli's equations, and equations reducible to exact form using integrating factors.

2.Analyze and solve first-order differential equations that are solvable for p, , and y, including Clairaut's equations.

3.Solve homogeneous and non-homogeneous linear differential equations of higher order with constant coefficients using operator methods.

4.Compute particular integrals for non-homogeneous equations when the right-hand side is a polynomial, exponential, or trigonometric function.

5.Solve non-homogeneous differential equations using the method of variation of parameters and other applicable techniques.

Unit -1(Differential Equations of First order and First Degree)

Exact Differential Equations - Integrating factors - Equations reducible to Exact Equations by Integrating Factors $\frac{1}{Mx+Ny}$ and $\frac{1}{Mx-Ny}$ Linear Differential Equations – Bernoulli's equations.

Unit – 2 (Differential Equations of First order,not of First Degree)

Equations solvable for p, Equations solvable for y, Equations solvable for x – Clairaut's equation

Unit – 3 (Higher Order Differential Equations-I)

Solutions of homogeneous linear differential equations of second and higher order with constant coefficients *f(D)y = 0* - Solutions of non-homogeneous linear differential equations *f(D)y = Q(x)* of second order with constant coefficients by means of polynomial operators (i) $Q(x) = b\ e^{ax}$ where b is a real constant - (ii) $Q(x) = Sin\ ax$ (or) $Cos\ ax$ where a is a real constant

Unit – 4 (Higher Order Differential Equations-II)

Solution to a non-homogeneous linear differential equations of second order with constant coefficients by means of polynomial operators $Q(x) = b\ x^k$, $Q(x) = e^{ax}$, where V is a function of x.

Unit – 5 (Higher Order Differential Equations-III)

Solution of the non-homogeneous linear differential equations of second order with constant coefficients by means of polynomial operators $Q(x) = x\ V$, where V is a function of x – Problems on Method of Variation of parameters to find solutions of linear differential equations with variable coefficients.

Activities

- The activities planned throughout the Differential Equations course include a variety of interactive and evaluative methods such as quizzes, assignments, seminars, and student presentations.
- Students will also engage in a mini project, prepare concept flowcharts, and participate in operator method chart activities. Peer teaching sessions, LMS-based online quizzes, and board work challenges will foster collaborative and digital learning.
- Additionally, poster presentations on applications and visual aids like chalk talks will be incorporated to support diverse learning styles and deepen conceptual clarity.

Text Book:

A textbook of B.Sc., Mathematics Volume-I , 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. Ordinary and Partial Differential Equations by Dr. M.D. Raisinghania, published by S. Chand & Company, New Delhi.
2. Differential Equations with applications and programs – S. Balachandra Rao & HR Anuradha- Universities Press.

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Course Outcomes (COs)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	-	-	-	2	-	-	-	3	3	-
CO 2	3	2	2	-	-	-	2	-	-	-	3	3	-
CO 3	3	2	2	-	-	-	3	-	-	-	3	3	2
CO 4	3	2	2	-	-	-	3	-	-	-	3	3	2
CO 5	3	2	3	-	-	-	3	-	-	-	3	3	2

Pattern of External Examination Max .Marks 60

S.No	Type of Questions	NO. of Questions	Marks allotted	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 Procedure -Max .Marks 40

S.NO	TEST	WEIGHTAGE
A	Two Mid Examinations	20+20=40
B	Seminar / Group Discussion	5+5=10
C	Project Based Learning (Course Wise)	10
D	Peer Group Learning (Course Wise)	10
E	Attendance and Participation in Clean and Green Activities)	5
	Total Marks	75*

Note- * This has to be scale down to 40 Marks (As per Our College pattern)

Internal Assessment Marks $= \frac{Marks\ secured}{75} \times 40$

Government College for Men (Autonomous) :: Kadapa

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

Semester – I

Paper I - DIFFERENTIAL EQUATIONS

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. Solve $(1+e^{\frac{x}{y}})dx + e^{\frac{x}{y}}\left(1-\frac{x}{y}\right)dy = 0$
2. Solve $xdy - ydx = xy^2dx$
3. Solve $(py+x)(px-y) = 2p$
4. Solve $p^2 + 2pycotx = y^2$
5. Solve $(D^4 - 4D^3 + 6D^2 - 4D + 1)y = 0.$
6. Solve $(D^3+1)y = 0$
7. Solve $(x^2D^2 - xD + 1)y = 2\ logx$
8. Solve $(D^2 - 3D + 2)y = coshx$

Section-II

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

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

9. Show that the equation $xdx + ydy = \frac{a^2(xdy - ydx)}{x^2+y^2}$ is an exact differential equation and hence solve it.
10. Solve $xy\ dx - (x^2 + 2y^2)dy = 0$
11. Solve $y = (1+p)x + p^2$
12. Solve $y + px = p^2x^4$
13. Solve $(D^2+4)y = e^x + sin2x + cos2x$
14. Solve $(D^2 - 2D + 4)y = 8(x^2 + e^{2x} + sin2x).$
15. Solve $(D^2 - 6D + 13)y = 8e^{3x}sin2x$
16. Solve $(D^2 + a^2)y = tanax$ by the method of variation of parameters

I B.Sc Honours MATHEMATICS (w.e.f.2025-26)
SEMESTER-I
PAPER II : SOLID GEOMETRY

Theory **Credits: 4** **5 hrs/week**

Course Objectives

- To introduce fundamental concepts of planes, lines, and spheres in 3D geometry.
- To develop analytical skills for deriving equations of planes, lines, and spheres in different forms.
- To analySe geometric relationships, including angles, distances, and intersections between lines, planes, and spheres.
- To study advanced properties of spheres, such as tangents, polar planes, and orthogonality conditions.
- To apply geometric principles to solve problems involving coplanarity, shortest distances, and sphere-line/plane interactions.

Course Outcomes:

After completing this course, students will be able to

1.Derive and interpret equations of planes and lines in various forms.

2.Compute angles, distances, and intersection conditions between geometric elements (lines, planes, spheres).

3.Determine co-planarity of lines and solve problems involving shortest distances in 3D space.

4.Analyse sphere-related problems, including tangents, intersections, and circle equations in 3D.

5.Apply advanced concepts like polar planes, conjugate points, and orthogonality conditions of spheres.

Unit – 1 (The Plane)

Equation of plane in terms of its intercepts on the axis - Equations of the plane through the given points - Length of the perpendicular from a given point to a given plane - Bisectors of angles between two planes - Combined equation of two planes

Unit – 2 (The Line -I)

Equation of a line in various forms - Angle between a line and a plane - The condition that a given line may lie in a given plane - The condition that two given lines are coplanar - Number of arbitrary constants in the equations of straight line - Sets of conditions which determine a line

Unit – 3 (The Line-II)

The shortest distance between two skew lines - The length and equations of the line of shortest distance between two skew lines - Length of the perpendicular from a given point to a given line.

Unit – 4 (The Sphere -I)

Definition and equation of the sphere - Equation of the sphere through four given points - Plane sections of a sphere - Intersection of two spheres - Equation of a circle - Sphere through a given circle - Intersection of a sphere and a line

Unit – 5 (The Sphere-II)

Power of a point - Tangent plane - Plane of contact; Polar plane - Pole of a Plane - Conjugate points - Conjugate planes - Angle of intersection of two spheres - Conditions for two spheres to be orthogonal - Radical Plane – Coaxial system of spheres-Limiting Points.

Activities

The activities include quizzes, assignments, seminars, and student presentations. Additional tasks involve mini projects, concept flowcharts, operator method charts, peer teaching, LMS-based quizzes, board work challenges, poster presentations, and visual aids like chalk talks to enhance learning and engagement.

Text Book

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

Reference Books

1. A text Book of Analytical Geometry of Three Dimensions, by P.K. Jain and Khaleel Ahmed, published by Wiley Eastern Ltd., 1999.
2. Co-ordinate Geometry of two and three dimensions by P. Balasubrahmanyam, K.Y. Subrahmanyam, G.R. Venkataraman published by Tata McGraw - Hill Publishers.
3. Solid Geometry by B. Rama Bhupal Reddy, published by Spectrum University Press.

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CO–PO–PSO Mapping (APSCHE Matrix Style)

Course Outcomes (COs)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	-	-	-	2	-	-	-	3	2	-
CO 2	3	2	2	-	-	-	2	-	-	-	3	3	-
CO 3	3	2	3	-	-	-	2	-	-	-	3	3	-
CO 4	3	2	2	-	-	-	2	-	-	-	3	3	-
CO 5	3	2	3	-	-	-	3	-	-	-	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

S.NO	TEST	WEIGHTAGE
A	Two Mid Examinations	20+20=40
B	Seminar / Group Discussion	5+5=10
C	Project Based Learning(Course Wise)	10
D	Peer Group Learning(Course Wise)	10
E	Attendance and Participation in Clean and Green Activities)	5
	Total Marks	75*

Note- * This has to be scale down to 40 Marks (As per Our College pattern)

Internal Assessment Marks $= \frac{Marks\ secured}{75} \times 40$

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

Semester-I

Paper II - SOLID GEOMETRY

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

Time:3hrs Max Marks:60

Section-I

Answer any **05 (Five)** questions. Each question carries 04 marks 5 x 4 = 20

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

1. Find the angles between the planes $2x - 3y - 6z = 6$ and $6x + 3y - 2z = 18$
2. Find the equation to the plane through the points $(2, 2, 1), (9, 3, 6)$ and perpendicular to the plane$2x + 6y + 6z = 9$
3. Find k so that the lines $\frac{x+1}{-3} = \frac{y+2}{2k} = \frac{z-3}{2}$ and $\frac{x-1}{3k} = \frac{y+5}{1} = \frac{z+6}{7}$ are perpendicular
4. Prove that the lines $\frac{x-1}{2} = \frac{y-2}{3} = \frac{z-3}{4}$; $\frac{x-2}{3} = \frac{y-3}{4} = \frac{z-4}{5}$ are coplanar
5. Show that $(1, -3, 2)$ is the point of intersection of the line $\frac{x+1}{1} = \frac{y+3}{3} = \frac{z-2}{2}$ with the plane $3x + 4y + 5z = 5$.
6. A plane through a fixed point (a, b, c) and intercepts the axes in A, B, C. Show that centre of the sphere OABC lies on $\frac{a}{x} + \frac{b}{y} + \frac{c}{z} = 2$.
7. Show that the spheres $x^2 + y^2 + z^2 - 25 = 0$ and $x^2 + y^2 + z^2 - 24x - 40y - 18z + 225 = 0$ touch each other externally at the point $(\frac{12}{5}, 4, \frac{9}{5})$
8. Show that the plane $2x - 2y + z + 12 = 0$ touches the sphere $x^2 + y^2 + z^2 - 2x - 4y + 2z - 3 = 0$

Section-II

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

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

9. A variable plane moves so that the sum of the reciprocals of its intercepts on the coordinates axes is a constant. Show that it passes through a fixed point
10. Prove that the equation $2x^2 - 6y^2 - 12z^2 + 18yz + 2zx + xy = 0$ represents a pair of planes, and find the angle between them.
11. Show that the lines $\frac{x-1}{2} = \frac{y+1}{-3} = \frac{z+10}{8}$; $\frac{x-4}{1} = \frac{y+3}{-4} = \frac{z+1}{7}$ intersect. Also find their point of intersection and the plane containing the lines.
12. Prove that the lines $\frac{x+4}{3} = \frac{y+6}{5} = \frac{z-1}{-2}$ and$3x - 2y + z + 5 = 0 = 2x + 3y + 4z - 4$ are coplanar. Find the point of intersection.
13. Find the length and equations to the line of S.D. between the lines $\frac{x-3}{-1} = \frac{y-4}{2} = \frac{z+2}{1}$; $\frac{x-1}{1} = \frac{y\mp7}{3} = \frac{z+2}{2}$.
14. Find the centre and radius of the circle $x^2 + y^2 + z^2 - 2y - 4z - 11 = 0, x + 2y + 2z - 15 =$

0

15. Find the equation of the sphere circumscribing the tetrahedron formed by the planes $\frac{y}{b}+\frac{z}{c}=0$, $\frac{z}{c}+\frac{x}{c}=0$, $\frac{x}{a}+\frac{y}{b}=0$, $\frac{x}{a}+\frac{y}{b}+\frac{z}{c}=1$

16. Find the limiting points of coaxial system determined by two spheres whose equations are $x^2+y^2+z^2+3x-3y+6=0$ and $x^2+y^2+z^2-6y-6z+6=0$

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I B.Sc Honours MATHEMATICS (w.e.f.2025-26)
SEMESTER-II

PAPER III : GROUP THEORY

Theory	Credits: 4	5 hrs/week

Course Objectives:

1. To introduce students to the foundational concepts of algebraic structures with a focus on groups.
2. To develop an understanding of subgroups, cosets, and their relevance in group theory.
3. To explore the properties and significance of normal subgroups and their role in constructing quotient groups.
4. To study and apply the concepts of group homomorphisms, isomorphisms, and the fundamental theorem of homomorphism.
5. To examine the structure and properties of permutation and cyclic groups, including their role in group classification.

Course Outcomes:

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

1. Understand the definition and basic properties of groups, including finite and infinite groups, and construct composition tables.
2. Analyze subgroups and cosets, apply Lagrange's Theorem, and understand the structure of a group through its subgroups.
3. Identify and verify normal subgroups, and understand their role in forming quotient groups.
4. Understand and apply homomorphisms and isomorphisms, including the fundamental homomorphism theorem and its applications.
5. Work with permutations, transpositions, and cyclic groups, and understand their properties and significance in group theory, including Cayley's Theorem.

Unit – 1 (Groups)

Binary Operation – Algebraic structure – **S**emi group - **M**onoid – Group definition and **its** elementary properties - **F**inite and Infinite groups – examples – order of a group - Composition tables with examples.

Unit – 2 (Sub Groups)

Definition of Complex – Multiplication of two complexes- Inverse of a complex- Definition of Subgroup - examples-Criterion for a complex to be a subgroup- Criterion for the product of two subgroups to be a subgroup-Union and Intersection of subgroups – Definition of Cosets – Properties of Cosets – Index of a subgroup of a finite group – Lagrange's Theorem.

Unit – 3 (Normal Subgroups)

Normal Subgroups - Definition of normal subgroup – Proper and improper normal subgroups – Hamilton group- Criterion for a subgroup to be a normal subgroup – Intersection of two normal subgroups - Sub group of index 2 is a normal sub group, Quotient groups

Unit – 4 (Homomorphisms)

Definition of homomorphism – Image of a homomorphism- Elementary properties of homomorphisms – Isomorphism – Automorphism- Definitions and elementary properties–Kernel of a homomorphism – Fundamental theorem of Homomorphism and applications.

Unit – 5 (Permutation Groups and Cyclic Groups)

Definition of permutation –Multiplication of Permutations– Inverse of a permutation – Cyclic permutations – Transposition – Even and odd permutations – Cayley's theorem - Cyclic Groups - Definition of cyclic group – Elementary properties

Activities:

The activities include quizzes, assignments, seminars, and student presentations. Additional tasks involve mini projects, concept flowcharts, operator method charts, peer teaching, LMS-based quizzes, board work challenges, poster presentations, and visual aids like chalk talks to enhance learning and engagement.

Text Book:

A textbook of B.Sc., Mathematics Volume-II , 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. Abstract Algebra by J.B. Fraleigh, Published by Narosa publishing house.
2. Modern Algebra by M.L. Khanna, Jai Prakash and Co. Printing Press, Meerut
3. Rings and Linear Algebra by Pundir & Pundir, published by Pragathi Prakashan

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CO–PO–PSO Mapping (APSCHE Matrix Style)

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO 1	3	2	2	-	-	-	2	-	-	-	3	2	-
CO 2	3	2	2	-	-	-	2	-	-	-	3	3	-
CO 3	3	2	2	-	-	-	3	-	-	-	3	3	-
CO 4	3	2	3	-	-	-	3	-	-	-	3	3	2
CO 5	3	2	3	-	-	-	3	-	-	-	3	3	2

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

S.NO	TEST	WEIGHTAGE
A	Two Mid Examinations	20+20=40
B	Seminar / Group Discussion	5+5=10
C	Project Based Learning(Course Wise)	10
D	Peer Group Learning(Course Wise)	10
E	Attendance and Participation in Clean and Green Activities)	5
	Total Marks	75*

Note- * This has to be scale down to 40 Marks (As per Our College pattern)

Internal Assessment Marks = $\frac{Marks\ secured}{75}$ x 40

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

Semester – II

Paper III – GROUP THEORY

Model Paper

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. Shows that the set of residue classes modulo 5 form an abelian group with respect to the addition of residue classes.
2. Prove that a group (G,.) is abelian if and only if $(ab)^2 = a^2b^2$,$\forall$ $a, b \epsilon G$.
3. If a, b are two elements of a group (G, .) and H any subgroup of G, then prove that $Ha = Hb \Leftrightarrow ab^{-1} \in H$.
4. If G is a group and H is a Subgroup of index 2 in G, then prove that H is a normal subgroup of G.
5. If $f: G \rightarrow G^1$ is a group homomorphism then prove that ker f is a normal sub group.
6. If G is a group of non-zero real numbers under multiplication, prove that $\phi: G \rightarrow G$ where $\phi(x) = x^2$ $\forall$ $x \in G$ is a homomorphism. Determine kernel ϕ
7. Examine whether the permutation $\begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 \\ 3 & 2 & 4 & 5 & 6 & 7 & 1 \end{pmatrix}$ is even or odd.
8. Define cyclic group and show that the set $G = \{1, -1, i, -i\}$ is a cyclic group w.r.t. multiplication

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. Prove that the set Z of all integers form an abelian group with respect to the operation defined by $a * b = a + b + 2$ for all $a, b \in Z$
10. If a is an element of a group G such that $O(a) = n$, then $a^m = e$ if and only if n / m.
11. Prove that a non-empty complex H of a group G is a subgroup of G if and only if $a, b \in H \Longrightarrow ab \in H$.
12. State and prove Lagrange's theorem on finite groups.
13. Prove that a subgroup H of a group G is a normal subgroup of G iff the product of two right (left) cosets of H in G is again a right (left) coset of H in G
14. State and prove Fundamental theorem of homomorphism of groups.
15. State and prove Cayley's Theorem.
16. Prove that a group of prime order is cyclic.

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

SEMESTER-II

PAPER IV : ELEMENTRAY REAL ANALYSIS

Theory **Credits: 4** **5 hrs/week**

Course Objectives:

1. To develop a strong foundation in the real number system and its axiomatic structure.
2. To introduce the concepts of order, bounds, completeness, and related foundational properties of real numbers.
3. To explore the properties of sets in real analysis, including neighborhoods, limit points, open and closed sets.
4. To build analytical skills in handling sequences, convergence criteria, and monotonicity.
5. To understand the behavior of infinite series and apply standard convergence tests effectively.

Course Outcomes:

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

1. Understand the real number system, its axioms, and properties, including completeness, supremum, and infimum.
2. Apply the Archimedean property, denseness, and concepts of neighborhoods, limit points, and derived sets in problem-solving.
3. Analyze sequences for boundedness and convergence using definitions and the Cauchy criterion.
4. Understand the concept of subsequences, apply the Bolzano-Weierstrass theorem, and test convergence using Cauchy's general principle.
5. Determine the convergence of infinite series using various tests and solve related analytical problems.

Unit – 1 (Real Numbers-II)

Real number system - Field axioms – Properties of real numbers - Order axioms – Properties of Order relation - Principal of induction - Extended real number system – Modulus of a real number – Properties of modulus – Triangle property - Aggregates – Finite and infinite aggregates – Boundedness of an aggregate – Least upper bound (supremum) and greatest lower bound (infimum) of an aggregate – Properties of boundedness – Completeness axiom – Dedekind's theorem - Theorem on Dedekind's axiom and completeness axiom.

Unit – 2 (Real Numbers-II)

Archemedian Property - It's corollaries – Integral part of a real number - Denseness of the real number system – Intervals – Neighbourhood of a point - Limit point of an aggregate – Derived Set - Bolzano - Weierstrass theorem – Interior point of a set - Open and closed Sets – It's properties (without proofs) - Countable and uncountable sets - Properties of countable sets.

Unit – 3 (Sequences-I)

Sequences – Operations of sequences - Subsequences - Range and Boundedness of Sequences - Limit of a sequence and Convergent sequence – Divergent sequence – Uniqueness of a limit – Sandwich theorem on sequences - Monotone sequences - Problems

Unit – 4 (Sequences-II)

Limit Point of a Sequence - Bolzano-Weierstrass theorem on subsequences – Cauchy Sequences – Cauchy's general principle of convergence – Problems

Unit – 5 (Series)

Infinite Series – Convergence and divergence of series - Cauchy's general principle of convergence for series – Series of non-negative terms - Convergence of geometric series – p series test - comparison test –D'Alemberts's ratio test – Cauchys's n^{th} root test – problems.

Activities

- The activities include quizzes, assignments, seminars, and student presentations.
- Additional tasks involve mini projects, concept flowcharts, operator method charts, peer teaching, LMS-based quizzes, board work challenges, poster presentations, and visual aids like chalk talks to enhance learning and engagement.

Text Book:

A textbook of B.Sc., Mathematics Volume-II , S.Chand & Company , Pvt.Ltd, RamNagar New Delhi,byV.Venkateswara Rao,N.Krishnamurthy,B.V.S.S.Sarma and S.Anjaneya Sastry.

Reference Books

1. Elements of Real Analysis by Shanthi Narayan and Dr. M.D. Raisinghania, S. Chand & Company Pvt. Ltd., New Delhi.
2. Principles of Mathematical Analysis by Walter Rudin, McGraw-Hill Ltd.

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CO–PO–PSO Mapping Matrix

Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO 1	3	2	2	-	-	-	2	-	-	-	3	2	-
CO 2	3	2	2	-	-	-	3	-	-	-	3	3	-
CO 3	3	2	2	-	-	-	3	-	-	-	3	3	-
CO 4	3	2	3	-	-	-	3	-	-	-	3	3	2
CO 5.	3	2	3	-	-	-	3	-	-	-	3	3	2

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 Procedure

S.NO	TEST	WEIGHTAGE
A	Two Mid Examinations	20+20=40
B	Seminar / Group Discussion	5+5=10
C	Project Based Learning(Course Wise)	10
D	Peer Group Learning(Course Wise)	10
E	Attendance and Participation in Clean and Green Activities)	5
	Total Marks	75*

Note- * This has to be scale down to 40 Marks (As per Our College pattern)

Internal Assessment Marks = $\frac{Marks\ secured}{75}$ x 40

Government College for Men (Autonomous) :: Kadapa

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

Semester – II

Paper IV– ELEMENTRAY REAL ANALYSIS

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. Define l.u.b and g.l.b. Write an example for a bounded set
   (i) which contain its g.l.b but does not contain l.u.b.
   (ii) which contain its l.u.b but does not contain g. l.b.
2. If x and y are any two real numbers with $x > 0$, then there exists a natural number n such that $nx > y$.
3. Prove that the set of natural numbers is not bounded above.
4. Prove that the sequence $\{s_n\}$ defined by $s_n = 1 + \frac{1}{1!} + \frac{1}{2!} + \cdots \frac{1}{n!}$ is convergent
5. Prove that every convergent sequence is bounded.
6. Every convergent sequence is a Cauchy sequence.
7. Test the convergence of $\sum(\sqrt{n^3 + 1} - \sqrt{n^3 - 1}\ )$
8. If $\sum u_n$ converges absolutely, then prove that $\sum u_n$ converges.

Section-II

Answer any FIVE (05) of the following questions . 5X8=40

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

9. The necessary and sufficient condition for a real number 's' to be the supremum of a bounded set S is that 's' must satisfy the following conditions;
   (i) $x \leq s \quad \forall\, x \in S$
   (ii)for each positive number ε, there exists a real number $x \in S$ such that $x > s - \varepsilon$
10. State and prove Bolzano-Weierstrass theorem on sets.
11. Prove that the countable union of countable sets is countable
12. Prove that a monotone sequence is convergent if and only if it is bounded.
13. Prove that the sequence $\{S_n\}$ where $S_n = \left(1 + \frac{1}{n}\right)^n$ is convergent.
14. State and prove Cauchy's general principle of convergence for sequence.
15. State and prove Cauchy's n^{th} root test
16. Test for convergence of $\sum_{n=1}^{\infty} \frac{(-1)^n}{n}\left(1 + \frac{1}{2} + \frac{1}{3} + \cdots + \frac{1}{n}\right)$