



## **ANDHRA PRADESH STATE COUNCIL OF HIGHER EDUCATION**

(A Statutory body of the Government of Andhra Pradesh)

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Atmakur(V), Mangalagiri(M), Guntur-522 503, Andhra Pradesh  
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### **REVISED SYLLABUS OF B.A. /B.Sc. MATHEMATICS UNDER CBCS FRAMEWORK WITH EFFECT FROM 2020-2021**

#### **PROGRAMME: THREE-YEAR B.A. /B.Sc. MATHEMATICS**

*(With Learning Outcomes, Unit-wise Syllabus, References, Co-curricular Activities & Model Q.P.)*

*For Fifteen Courses of 1, 2, 3 & 4 Semesters)*

**(To be Implemented from 2020-21 Academic Year)**

**A.P. STATE COUNCIL OF HIGHER EDUCATION**

**B.A./B.Sc. MATHEMATICS**

**REVISED SYLLABUS FOR CORE COURSES**

**CBCS/ SEMESTER SYSTEM**

**(w.e.f. 2020-21 Admitted Batch)**

**CORE COURSES STRUCTURE**

**(Sem-I to Sem-IV)**

| Course      | Subject   | Hrs. | Credits | IA | ES | Total |
|-------------|---|------|---------|----|----|-------|
| Course -I   | Differential Equations<br>&<br>Differential Equations<br>Problem Solving Sessions   | 6    | 5       | 25 | 75 | 100   |
| Course -II  | Three dimensional analytical<br>Solid geometry<br>&<br>Three dimensional analytical<br>Solid Geometry<br>Problem Solving Sessions | 6    | 5       | 25 | 75 | 100   |
| Course -III | Abstract Algebra<br>&<br>Abstract Algebra<br>Problem Solving Sessions   | 6    | 5       | 25 | 75 | 100   |
| Course -IV  | Real Analysis<br>&<br>Real Analysis<br>Problem Solving Sessions   | 6    | 5       | 25 | 75 | 100   |
| Course -V   | Linear Algebra<br>&<br>Linear Algebra<br>Problem Solving Sessions   | 6    | 5       | 25 | 75 | 100   |

**COURSE-I**  
**CBCS/ SEMESTER SYSTEM**  
**B.A./B.Sc. MATHEMATICS (w.e.f. 2020-21 Admitted Batch)**  
**DIFFERENTIAL EQUATIONS**  
**SYLLABUS (75 Hours)**

**Course Outcomes:**

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

1. Solve linear differential equations
2. Convert nonexact homogeneous equations to exact differential equations by using integrating factors.
3. Know the methods of finding solutions of differential equations of the first order but not of the first degree.
4. Solve higher-order linear differential equations, both homogeneous and non homogeneous, with constant coefficients.
5. Understand the concept and apply appropriate methods for solving differential equations.

**Course Syllabus:**

**UNIT – I (12 Hours)**

**Differential Equations of first order and first degree:**

Linear Differential Equations; Differential equations reducible to linear form; Exact differential equations; Integrating factors; Change of variables.

**UNIT – II (12 Hours)**

Orthogonal Trajectories

**Differential Equations of first order but not of the first degree:**

Equations solvable for  $p$ ; Equations solvable for  $y$ ; Equations solvable for  $x$ ; Equations that do not contain  $x$  (or  $y$ ); Equations homogeneous in  $x$  and  $y$ ; Equations of the first degree in  $x$  and  $y$  – Clairaut's Equation.

### UNIT – III (12 Hours)

#### Higher order linear differential equations-I:

Solution of homogeneous linear differential equations of order  $n$  with constant coefficients; Solution of the non-homogeneous linear differential equations with constant coefficients by means of polynomial operators. General Solution of  $f(D)y=0$ .

General Solution of  $f(D)y=Q$  when  $Q$  is a function of  $x$ ,  $\frac{1}{f(D)}$  is expressed as partial fractions.

P.I. of  $f(D)y = Q$  when  $Q = be^{ax}$

P.I. of  $f(D)y = Q$  when  $Q$  is  $b\sin ax$  or  $b \cos ax$ .

### UNIT – IV (12 Hours)

#### Higher order linear differential equations-II:

Solution of the non-homogeneous linear differential equations with constant coefficients.

P.I. of  $f(D)y = Q$  when  $Q = bx^k$

P.I. of  $f(D)y = Q$  when  $Q = e^{ax}V$ , where  $V$  is a function of  $x$ .

P.I. of  $f(D)y = Q$  when  $Q = xV$ , where  $V$  is a function of  $x$ .

P.I. of  $f(D)y = Q$  when  $Q = x^mV$ , where  $V$  is a function of  $x$ .

### UNIT –V (12 Hours)

#### Higher order linear differential equations-III :

Method of variation of parameters; Linear differential Equations with non-constant coefficients; The Cauchy-Euler Equation, Legendre's linear equations, miscellaneous differential equations.

#### Co-Curricular Activities(15 Hours)

Seminar/ Quiz/ Assignments/ Applications of Differential Equations to Real life Problem /Problem Solving.

**Text Book :**

Differential Equations and Their Applications by Zafar Ahsan, published by Prentice-Hall of India Pvt. Ltd, New Delhi-Second edition.

**Reference Books :**

1. A text book of Mathematics for B.A/B.Sc, Vol 1, by N. Krishna Murthy & others, published by S.Chand & Company, New Delhi.
2. Ordinary and Partial Differential Equations by Dr. M.D,Raisinghania, published by S. Chand & Company, New Delhi.
- 3.Differential Equations with applications and programs – S. Balachandra Rao & HR Anuradha-Universities Press.
4. Differential Equations -Srinivas Vangala & Madhu Rajesh, published by Spectrum University Press.

**COURSE-II**  
**CBCS/ SEMESTER SYSTEM**  
**(w.e.f. 2020-21 Admitted Batch)**  
**B.A./B.Sc. MATHEMATICS**  
**THREE DIMENSIONAL ANALYTICAL SOLID GEOMETRY**  
**Syllabus (75 Hours)**

**Course Outcomes:**

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

1. get the knowledge of planes.
2. basic idea of lines, sphere and cones.
3. understand the properties of planes, lines, spheres and cones.
4. express the problems geometrically and then to get the solution.

**Course Syllabus:**

**UNIT – I (12 Hours)**

**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, Orthogonal projection on a plane.

**UNIT – II (12 hrs)**

**The Line :**

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

**UNIT – III (12 hrs)**

**The Sphere :**

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; Power of a point; Tangent plane; Plane of contact; Polar plane; Pole of a Plane; Conjugate points; Conjugate planes;

#### **UNIT – IV (12 hrs)**

##### **The Sphere and Cones :**

Angle of intersection of two spheres; Conditions for two spheres to be orthogonal; Radical plane; Coaxial system of spheres; Simplified form of the equation of two spheres.

Definitions of a cone; vertex; guiding curve; generators; Equation of the cone with a given vertex and guiding curve; equations of cones with vertex at origin are homogenous; Condition that the general equation of the second degree should represent a cone;

#### **UNIT – V (12 hrs)**

##### **Cones :**

Enveloping cone of a sphere; right circular cone: equation of the right circular cone with a given vertex, axis and semi vertical angle: Condition that a cone may have three mutually perpendicular generators; intersection of a line and a quadric cone; Tangent lines and tangent plane at a point; Condition that a plane may touch a cone; Reciprocal cones; Intersection of two cones with a common vertex.

##### **Co-Curricular Activities(15 Hours)**

Seminar/ Quiz/ Assignments/Three dimensional analytical Solid geometry and its applications/ Problem Solving.

**Text Book :**

Analytical Solid Geometry by Shanti Narayan and P.K. Mittal, published by S. Chand & Company Ltd. 7th Edition.

**Reference Books :**

1. A text book of Mathematics for BA/B.Sc Vol 1, by V Krishna Murthy & Others, published by S. Chand & Company, New Delhi.
2. A text Book of Analytical Geometry of Three Dimensions, by P.K. Jain and Khaleel Ahmed, published by Wiley Eastern Ltd., 1999.
3. Co-ordinate Geometry of two and three dimensions by P. Balasubrahmanyam, K.Y. Subrahmanyam, G.R. Venkataraman published by Tata-MC Gran-Hill Publishers Company Ltd., New Delhi.
4. Solid Geometry by B.Rama Bhupal Reddy, published by Spectrum University Press.



**COURSE-III**  
**CBCS/ SEMESTER SYSTEM**  
**(w.e.f. 2020-21 Admitted Batch)**  
**B.A./B.Sc. MATHEMATICS**  
**ABSTRACT ALGEBRA**  
**SYLLABUS (75 Hours)**

**Course Outcomes:**

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

1. acquire the basic knowledge and structure of groups, subgroups and cyclic groups.
2. get the significance of the notation of a normal subgroups.
3. get the behavior of permutations and operations on them.
4. study the homomorphisms and isomorphisms with applications.
5. understand the ring theory concepts with the help of knowledge in group theory and to prove the theorems.
6. understand the applications of ring theory in various fields.

**Course Syllabus:**

**UNIT – I (12 Hours)**

**GROUPS :**

Binary Operation – Algebraic structure – semi group-monoid – Group definition and elementary properties Finite and Infinite groups – examples – order of a group, Composition tables with examples.

**UNIT – II (12 Hours)**

**SUBGROUPS :**

Complex Definition – Multiplication of two complexes Inverse of a complex-Subgroup definition- examples-criterion for a complex to be a subgroups. Criterion for the product of two subgroups to be a subgroup-union and Intersection of subgroups.

**Co-sets and Lagrange's Theorem :**

Cosets Definition – properties of Cosets–Index of a subgroups of a finite groups–Lagrange's Theorem.

### **UNIT –III (12 Hours)**

#### **NORMAL SUBGROUPS :**

Definition of normal subgroup – proper and improper normal subgroup–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 group – criteria for the existence of a quotient group.

#### **HOMOMORPHISM :**

Definition of homomorphism – Image of homomorphism elementary properties of homomorphism – Isomorphism – automorphism definitions and elementary properties–kernel of a homomorphism – fundamental theorem on Homomorphism and applications.

### **UNIT – IV (12 Hours)**

#### **PERMUTATIONS AND CYCLIC GROUPS :**

Definition of permutation – permutation multiplication – Inverse of a permutation – cyclic permutations – transposition – even and odd permutations – Cayley’s theorem.

**Cyclic Groups :-** Definition of cyclic group – elementary properties – classification of cyclic groups.

### **UNIT – V (12 Hours)**

#### **RINGS :**

Definition of Ring and basic properties, Boolean Rings, divisors of zero and cancellation laws Rings, Integral Domains, Division Ring and Fields, The characteristic of a ring - The characteristic of an Integral Domain, The characteristic of a Field. Sub Rings, Ideals

#### **Co-Curricular Activities(15 Hours)**

Seminar/ Quiz/ Assignments/ Group theory and its applications / Problem Solving.

**Text Book :**

A text book of Mathematics for B.A. / B.Sc. by B.V.S.S. SARMA and others, published by S.Chand & Company, New Delhi.

**Reference Books :**

1. Abstract Algebra by J.B. Fraleigh, Published by Narosa publishing house.
2. Modern Algebra by M.L. Khanna.
3. Rings and Linear Algebra by Pundir & Pundir, published by Pragathi Prakashan.

**COURSE-IV**  
**CBCS/ SEMESTER SYSTEM**  
**(w.e.f. 2020-21 Admitted Batch)**  
**B.A./B.Sc. MATHEMATICS**  
**REAL ANALYSIS**  
**SYLLABUS (75 Hours)**

**Course Outcomes:**

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

1. get clear idea about the real numbers and real valued functions.
2. obtain the skills of analyzing the concepts and applying appropriate methods for testing convergence of a sequence/ series.
3. test the continuity and differentiability and Riemann integration of a function.
4. know the geometrical interpretation of mean value theorems.

**Course Syllabus:**

**UNIT – I (12 Hours)**

**REAL NUMBERS :**

The algebraic and order properties of  $\mathbb{R}$ , Absolute value and Real line, Completeness property of  $\mathbb{R}$ , Applications of supremum property; intervals. (No question is to be set from this portion).

**Real Sequences:**

Sequences and their limits, Range and Boundedness of Sequences, Limit of a sequence and Convergent sequence. The Cauchy's criterion, properly divergent sequences, Monotone sequences, Necessary and Sufficient condition for Convergence of Monotone Sequence, Limit Point of Sequence, Subsequences and the Bolzano-weierstrass theorem – Cauchy Sequences – Cauchy's general principle of convergence theorem.

**UNIT –II (12 Hours)**

**INFINITE SERIES :**

**Series :**Introduction to series, convergence of series. Cauchy's general principle of convergence for series tests for convergence of series, Series of Non-Negative Terms.

1. P-test
2. Cauchy's  $n^{\text{th}}$  root test or Root Test.

3. D'-Alemberts' Test or Ratio Test.

4. Alternating Series – Leibnitz Test.

Absolute convergence and conditional convergence.

### **UNIT – III (12 Hours)**

#### **CONTINUITY :**

**Limits :** Real valued Functions, Boundedness of a function, Limits of functions. Some extensions of the limit concept, Infinite Limits. Limits at infinity. (No question is to be set from this portion).

**Continuous functions :** Continuous functions, Combinations of continuous functions, Continuous Functions on intervals, uniform continuity.

### **UNIT – IV (12 Hours)**

#### **DIFFERENTIATION AND MEAN VALUE THEORMS :**

The derivability of a function, on an interval, at a point, Derivability and continuity of a function, Graphical meaning of the Derivative, Mean value Theorems; Rolle's Theorem, Lagrange's Theorem, Cauchy's Mean value Theorem

### **UNIT – V (12 Hours)**

#### **RIEMANN INTEGRATION :**

Riemann Integral, Riemann integral functions, Darboux theorem. Necessary and sufficient condition for R – integrability, Properties of integrable functions, Fundamental theorem of integral calculus, integral as the limit of a sum, Mean value Theorems.

#### **Co-Curricular Activities(15 Hours)**

Seminar/ Quiz/ Assignments/ Real Analysis and its applications / Problem Solving.

**Text Book:**

Introduction to Real Analysis by Robert G. Bartle and Donald R. Sherbert, published by John Wiley.

**Reference Books:**

1. A Text Book of B.Sc Mathematics by B.V.S.S. Sarma and others, published by S. Chand & Company Pvt. Ltd., New Delhi.
2. Elements of Real Analysis as per UGC Syllabus by Shanthi Narayan and Dr. M.D. Raisinghania, published by S. Chand & Company Pvt. Ltd., New Delhi.

**COURSE-V**  
**CBCS/ SEMESTER SYSTEM**  
**(w.e.f. 2020-21 Admitted Batch)**  
**B.A./B.Sc. MATHEMATICS**  
**LINEAR ALGEBRA**  
**SYLLABUS (75 Hours)**

**Course Outcomes:**

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

1. understand the concepts of vector spaces, subspaces, bases, dimension and their properties
2. understand the concepts of linear transformations and their properties
3. apply Cayley- Hamilton theorem to problems for finding the inverse of a matrix and higher powers of matrices without using routine methods
4. learn the properties of inner product spaces and determine orthogonality in inner product spaces.

**Course Syllabus:**

**UNIT – I (12 Hours)**

**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 (12 Hours)**

**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 (12 Hours)**

**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.

#### **UNIT –IV (12 Hours)**

##### **Matrix :**

Matrices, Elementary Properties of Matrices, Inverse Matrices, Rank of Matrix, Linear Equations, Characteristic equations, Characteristic Values & Vectors of square matrix, Cayley – Hamilton Theorem.

#### **UNIT –V (12 Hours)**

##### **Inner product space :**

Inner product spaces, Euclidean and unitary spaces, Norm or length of a Vector, Schwartz inequality, Triangle Inequality, Parallelogram law, Orthogonality, Orthonormal set, complete orthonormal set, Gram – Schmidt orthogonalisation process. Bessel's inequality and Parseval's Identity.

##### **Co-Curricular Activities(15 Hours)**

Seminar/ Quiz/ Assignments/ Linear algebra and its applications / Problem Solving.



**Text Book:**

Linear Algebra by J.N. Sharma and A.R. Vasista, published by Krishna Prakashan Mandir, Meerut- 250002.

**Reference Books :**

1. Matrices by Shanti Narayana, published by S.Chand Publications.
2. Linear Algebra by Kenneth Hoffman and Ray Kunze, published by Pearson Education (low priced edition), New Delhi.
3. Linear Algebra by Stephen H. Friedberg et. al. published by Prentice Hall of India Pvt. Ltd. 4<sup>th</sup> Edition, 2007.

**Recommended Question Paper Patterns and Models**  
**BLUE PRINT FOR QUESTION PAPER PATTERN**  
**COURSE-I, DIFFERENTIAL EQUATIONS**

| Unit         | TOPIC   | S.A.Q(including choice) | E.Q(including choice) | Total Marks |
|--------------|---|-------------------------|-----------------------|-------------|
| <b>I</b>     | Differential Equations of 1 <sup>st</sup> order and 1 <sup>st</sup> degree                                    | 2                       | 2                     | 30          |
| <b>II</b>    | Orthogonal Trajectories,<br>Differential Equations of 1 <sup>st</sup> order but not of 1 <sup>st</sup> degree | 2                       | 2                     | 30          |
| <b>III</b>   | Higher Order Linear Differential Equations (with constant coefficients) – I                                   | 1                       | 2                     | 25          |
| <b>IV</b>    | Higher Order Linear Differential Equations (with constant coefficients) – II                                  | 2                       | 2                     | 30          |
| <b>V</b>     | Higher Order Linear Differential Equations (with non constant coefficients)                                   | 1                       | 2                     | 25          |
| <b>TOTAL</b> |   | 8                       | 10                    | 140         |

**S.A.Q.** = Short answer questions (5 marks)

**E.Q.** = Essay questions (10 marks)

Short answer questions : 5 X 5 M = 25 M

Essay questions : 5 X 10 M = 50 M

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Total Marks = 75 M

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**CBCS/ SEMESTER SYSTEM**  
**(W.e.f 2020-21 Admitted Batch)**  
**B.A./B.Sc. MATHEMATICS**  
**COURSE-I, DIFFERENTIAL EQUATIONS**  
**MATHEMATICS MODEL PAPER**

**Time: 3Hrs**

**Max.Marks:75M**

**SECTION - A**

**Answer any FIVE questions. Each question carries FIVE marks 5 X 5 M=25 M**

1. Solve  $(1 + e^{x/y}) dx + e^{x/y} \left(1 - \frac{x}{y}\right) dy = 0$ .

2. Solve  $(y - e^{\sin^{-1} x}) \frac{dx}{dy} + \sqrt{1 - x^2} = 0$

3. Solve  $y + px = p^2 x^4$ .

4. Solve  $(px - y)(py + x) = 2p$

5. Solve  $(D^2 - 3D + 2) = \cosh x$

6. Solve  $(D^2 - 4D + 3)y = \sin 3x \cos 2x$ .

7. Solve  $\frac{d^2y}{dx^2} - 6\frac{dy}{dx} + 13y = 8e^{3x} \sin 2x$ .

8. Solve  $x^2 y'' - 2x(1+x)y' + 2(1+x)y = x^3$

**SECTION - B**

**Answer ALL the questions. Each question carries TEN marks. 5 X 10 M = 50 M**

9 a) Solve  $x \frac{dy}{dx} + y = y^2 \log x$ .

(Or)

9 b) Solve  $\left(y + \frac{1}{3}y^3 + \frac{1}{2}x^2\right) dx + \frac{1}{4}(x + xy^2) dy = 0$ .

10 a) Solve  $p^2 + 2p \cot x = y^2$ .

(Or)

10 b) Find the orthogonal trajectories of the family of curves

$x^{2/3} + y^{2/3} = a^{2/3}$  where 'a' is the parameter.

11 a) Solve  $(D^3 + D^2 - D - 1)y = \cos 2x$ .

(Or)

11 b) Solve  $(D^2 - 3D + 2)y = \sin e^{-x}$ .

12 a) Solve  $(D^2 - 2D + 4)y = 8(x^2 + e^{2x} + \sin 2x)$

(Or)

12 b)  $\frac{d^2y}{dx^2} + 3\frac{dy}{dx} + 2y = xe^x \sin x$

13 a) Solve  $(D^2 - 2D)y = e^x \sin x$  by the method of variation of parameters.

(Or)

13 b) Solve  $3x^2 \frac{d^2y}{dx^2} + x \frac{dy}{dx} + y = x$

**BLUE PRINT FOR QUESTION PAPER PATTERN**  
**COURSE-II, THREE DIMENSIONAL ANALYTICAL SOLID GEOMETRY**

| <b>Unit</b>  | <b>TOPIC</b>             | <b>S.A.Q(including choice)</b> | <b>E.Q(including choice)</b> | <b>Total Marks</b> |
|--------------|--------------------------|--------------------------------|------------------------------|--------------------|
| <b>I</b>     | The Plane                | 2                              | 2                            | 30                 |
| <b>II</b>    | The Right Line           | 2                              | 2                            | 30                 |
| <b>III</b>   | The Sphere               | 2                              | 2                            | 30                 |
| <b>IV</b>    | The Sphere<br>& The Cone | 1                              | 2                            | 25                 |
| <b>V</b>     | The Cone                 | 1                              | 2                            | 25                 |
| <b>TOTAL</b> |                          | 8                              | 10                           | 140                |

**S.A.Q.** = Short answer questions (5 marks)

**E.Q.** = Essay questions (10 marks)

Short answer questions : 5 X 5 M = 25 M

Essay questions : 5 X 10 M = 50 M

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 Total Marks = 75 M

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**CBCS/ SEMESTER SYSTEM**  
**(w.e.f. 2020-21 Admitted Batch)**  
**B.A./B.Sc. MATHEMATICS**  
**COURSE-II, THREE DIMENSIONAL ANALYTICAL SOLID GEOMETRY**  
**Time: 3Hrs** **Max.Marks:75 M**

**SECTION - A**

Answer any **FIVE** questions. Each question carries **FIVE** marks **5 X 5 M=25 M**

1. Find the equation of the plane through the point  $(-1,3,2)$  and perpendicular to the planes  $x+2y+2z=5$  and  $3x+3y+2z=8$ .
2. Find the bisecting plane of the acute angle between the planes  $3x-2y-6z+2=0$ ,  $-2x+y-2z-2=0$ .
3. Find the image of the point  $(2,-1,3)$  in the plane  $3x-2y+z=9$ .
4. Show that the lines  $2x + y - 4 = 0 = y + 2z$  and  $x + 3z - 4 = 0$ ,  $2x + 5z - 8 = 0$  are coplanar.
5. A variable plane passes through a fixed point  $(a, b, c)$ . It meets the axes in  $A, B, C$ . Show that the centre of the sphere  $OABC$  lies on  $ax^{-1}+by^{-1}+cz^{-1}=2$ .
6. Show that the plane  $2x-2y+z+12=0$  touches the sphere  $x^2+y^2+z^2-2x-4y+2z-3=0$  and find the point of contact.
7. Find the equation to the cone which passes through the three coordinate axes and the lines  $\frac{x}{1} = \frac{y}{-2} = \frac{z}{3}$  and  $\frac{x}{2} = \frac{y}{1} = \frac{z}{1}$
8. Find the equation of the enveloping cone of the sphere  $x^2 + y^2 + z^2 + 2x - 2y = 2$  with its vertex at  $(1, 1, 1)$ .

**SECTION - B**

Answer **ALL** the questions. Each question carries **TEN** marks. **5 X 10 M = 50 M**

9(a) A plane meets the coordinate axes in  $A, B, C$ . If the centroid of  $\Delta ABC$  is

$(a,b,c)$ , show that the equation of the plane is  $\frac{x}{a} + \frac{y}{b} + \frac{z}{c} = 3$ .

(OR)

(b) A variable plane is at a constant distance  $p$  from the origin and meets the axes in  $A, B, C$ . Show that the locus of the centroid of the tetrahedron  $OABC$  is  $x^{-2}+y^{-2}+z^{-2}=16p^{-2}$ .

10(a) Find the shortest distance between the lines

$$\frac{x-3}{3} = \frac{y-8}{-1} = \frac{z-3}{1}; \quad \frac{x+3}{-3} = \frac{y+7}{2} = \frac{z-6}{4}.$$

(OR)

(b) 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. Also find their point of intersection and the plane containing the lines.

11 (a) Show that the two circles  $x^2+y^2+z^2-y+2z=0, x-y+z=2;$

$x^2+y^2+z^2+x-3y+z-5=0, 2x-y+4z-1=0$  lie on the same sphere and find its equation.

(OR)

(b) Find the equation of the sphere which touches the plane  $3x+2y-z+2=0$  at  $(1,-2,1)$  and cuts orthogonally the sphere  $x^2+y^2+z^2-4x+6y+4=0$ .

12 (a) Find the limiting points of the coaxial system of spheres

$$x^2+y^2+z^2-8x+2y-2z+32=0, x^2+y^2+z^2-7x+z+23=0.$$

(OR)

(b) Find the equation to the cone with vertex is the origin and whose base curve is  $x^2+y^2+z^2+2ux+d=0$ .

13 (a) Prove that the equation  $\sqrt{fx} \pm \sqrt{gy} \pm \sqrt{hz} = 0$  represents a cone that touches the coordinate planes and find its reciprocal cone.

(OR)

(b) Find the equation of the sphere  $x^2+y^2+z^2-2x+4y-1=0$  having its generators parallel to the line  $x=y=z$ .

**BLUE PRINT FOR QUESTION PAPER PATTERN**  
**COURSE-III, ABSTRACT ALGEBRA**

| Unit  | TOPIC                                     | S.A.Q(including<br>choice) | E.Q(including<br>choice) | Total Marks |
|-------|---|----------------------------|--------------------------|-------------|
| I     | Groups                                    | 2                          | 2                        | 30          |
| II    | Subgroups, Cosets & Lagrange's<br>theorem | 1                          | 2                        | 25          |
| III   | Normal Subgroups and<br>Homomorphism      | 1                          | 2                        | 25          |
| IV    | Permutations and Cyclic groups            | 2                          | 2                        | 30          |
| V     | Rings                                     | 2                          | 2                        | 30          |
| Total |   | 8                          | 10                       | 140         |

**S.A.Q.** = Short answer questions (5 marks)

**E.Q.** = Essay questions (10 marks)

Short answer questions : 5 X 5 M = 25 M

Essay questions : 5 X 10 M = 50 M

.....  
Total Marks = 75 M  
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**CBCS/ SEMESTER SYSTEM**  
**(w.e.f. 2020-21 Admitted Batch)**  
**B.A./B.Sc. MATHEMATICS**  
**COURSE-III, ABSTRACT ALGEBRA**

**Time: 3Hrs**

**Max.Marks:75M**

**SECTION - A**

**Answer any FIVE questions. Each question carries FIVE marks 5 X 5 M=25 M**

1. Show that the set  $G = \{x/x = 2^a 3^b \text{ and } a, b \in \mathbb{Z}\}$  is a group under multiplication
2. Define order of an element. In a group  $G$ , prove that if  $a \in G$  then  $O(a) = O(a)^{-1}$ .
3. If  $H$  and  $K$  are two subgroups of a group  $G$ , then prove that  $HK$  is a subgroup  $\Leftrightarrow HK=KH$
4. If  $G$  is a group and  $H$  is a subgroup of index 2 in  $G$  then prove that  $H$  is a normal subgroup.
5. Examine whether the following permutations are even or odd

i) 
$$\begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 \\ 6 & 1 & 4 & 3 & 2 & 5 & 7 & 8 & 9 \end{pmatrix}$$

ii) 
$$\begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 \\ 3 & 2 & 4 & 5 & 6 & 7 & 1 \end{pmatrix}$$

6. Prove that a group of prime order is cyclic.
7. Prove that the characteristic of an integral domain is either prime or zero.
8. If  $F$  is a field then prove that  $\{0\}$  and  $F$  are the only ideals of  $F$ .

**SECTION - B**

**Answer ALL the questions. Each question carries TEN marks. 5 X 10 M = 50 M**

9 a) Show that the set of  $n^{\text{th}}$  roots of unity forms an abelian group under multiplication.

(Or)

9 b) In a group  $G$ , for  $a, b \in G$ ,  $O(a)=5$ ,  $b \neq e$  and  $aba^{-1} = b^2$ . Find  $O(b)$ .

10 a) The Union of two subgroups is also a subgroup  $\Leftrightarrow$  one is contained in the other.

(Or)

b) State and prove Lagrange's theorem.

11 a) Prove that a subgroup  $H$  of a group  $G$  is a normal subgroup of  $G$  iff the product of two right cosets of  $H$  in  $G$  is again a right coset of  $H$  in  $G$ .

(Or)

11 b) State and prove fundamental theorem of homomorphisms of groups.

12 a) Let  $S_n$  be the symmetric group on  $n$  symbols and let  $A_n$  be the group of even permutations. Then show that  $A_n$  is normal in  $S_n$  and  $O(A_n) = \frac{1}{2}(n!)$

(Or)

12 b) Prove that every subgroup of a cyclic group is cyclic.

13 a) Prove that every finite integral domain is a field.

(Or)

13 b) Define principal ideal. Prove that every ideal of  $\mathbb{Z}$  is a principal ideal.

**BLUE PRINT FOR QUESTION PAPER PATTERN**  
**COURSE-IV, REAL ANALYSIS**

| <b>Unit</b> | <b>TOPIC</b>                           | <b>S.A.Q(including choice)</b> | <b>E.Q(including choice)</b> | <b>Total Marks</b> |
|-------------|--|--------------------------------|------------------------------|--------------------|
| I           | Real Number System and Real Sequence   | 2                              | 2                            | 30                 |
| II          | Infinite Series                        | 1                              | 2                            | 25                 |
| III         | Limits and Continuity                  | 1                              | 2                            | 25                 |
| IV          | Differentiation and Mean Value Theorem | 2                              | 2                            | 30                 |
| V           | Riemann Integration                    | 2                              | 2                            | 30                 |
|             | <b>TOTAL</b>                           | 8                              | 10                           | 140                |

**S.A.Q.** = Short answer questions (5 marks)

**E.Q.** = Essay questions (10 marks)

Short answer questions : 5 X 5 M = 25 M

Essay questions : 5 X 10 M = 50 M

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Total Marks = 75 M  
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**B.A./B.Sc. MATHEMATICS**  
**COURSE-IV, REAL ANALYSIS**

**Time: 3Hrs**

**Max.Marks:75M**

**SECTION - A**

Answer any **FIVE** questions. Each question carries **FIVE** marks **5 X 5 M=25 M**

1. Prove that every convergent sequence is bounded.
2. Show that  $\lim\left(\frac{1}{(n+1)^2} + \frac{1}{(n+2)^2} + \dots + \frac{1}{(n+n)^2}\right) = 0$ .
3. Test the convergence of the series  $\sum_{n=1}^{\infty} (\sqrt[3]{n^3 + 1} - n)$ .
4. Examine for continuity of the function  $f$  defined by  $f(x) = |x| + |x - 1|$  at  $x=0$  and  $1$ .
5. Show that  $f(x) = x \sin \frac{1}{x}$ ,  $x \neq 0$ ;  $f(x) = 0$ ,  $x = 0$  is continuous but not derivable at  $x=0$ .
6. Verify Rolle's theorem for the function  $f(x) = x^3 - 6x^2 + 11x - 6$  on  $[1, 3]$ .
7. If  $f(x) = x^2 \forall x \in [0, 1]$  and  $p = \{0, \frac{1}{4}, \frac{2}{4}, \frac{3}{4}, 1\}$  then find  $L(p, f)$  and  $U(p, f)$ .
8. Prove that if  $f: [a, b] \rightarrow \mathbb{R}$  is continuous on  $[a, b]$  then  $f$  is R- integrable on  $[a, b]$ .

**SECTION -B**

Answer **ALL** the questions. Each question carries **TEN** marks. **5 X 10 M = 50 M**

9.(a) If  $S_n = 1 + \frac{1}{2!} + \frac{1}{3!} + \dots + \frac{1}{n!}$  then show that  $\{S_n\}$  converges.

(OR)

(b) State and prove Cauchy's general principle of convergence.

10.(a) State and Prove Cauchy's nth root test.

(OR)

(b) Test the convergence of  $\sum \frac{x^n}{x^n + a^n}$  ( $x > 0, a > 0$ ).

11.(a) Let  $f: \mathbb{R} \rightarrow \mathbb{R}$  be such that

$$f(x) = \frac{\sin(a+1)x + \sin x}{x} \text{ for } x < 0$$
$$= c \text{ for } x = 0$$

$$= \frac{(x+bx^2)^{1/2} - x^{1/2}}{bx^{3/2}} \text{ for } x > 0$$

Determine the values of  $a, b, c$  for which the function  $f$  is continuous at  $x=0$ .

(OR)

(b) Define uniform continuity, If a function  $f$  is continuous on  $[a, b]$  then  $f$  is uniformly continuous on  $[a, b]$

12.(a) Using Lagrange's theorem, show that  $x > \log(1+x) > \frac{x}{(1+x)} \forall x > 0$ .

(OR)

(b) State and prove Cauchy's mean value theorem.

13.(a) State and prove Riemann's necessary and sufficient condition for R- integrability.

(OR)

(b) Prove that  $\frac{\pi^3}{24} \leq \int_0^\pi \frac{x^2}{5+3\cos x} dx \leq \frac{\pi^3}{6}$ .

**BLUE PRINT FOR QUESTION PAPER PATTERN**  
**COURSE-V, LINEAR ALGEBRA**

| Unit  | TOPIC                             | S.A.Q<br>(including<br>choice) | E.Q<br>(including<br>choice) | Marks<br>Allotted |
|-------|-----------------------------------|--------------------------------|------------------------------|-------------------|
| I     | Vector spaces - I                 | 2                              | 2                            | 30                |
| II    | Vector spaces - II                | 1                              | 2                            | 25                |
| III   | Linear Transformation             | 2                              | 2                            | 30                |
| IV    | Char. values and char.<br>vectors | 1                              | 2                            | 25                |
| V     | Inner product spaces              | 2                              | 2                            | 30                |
| Total |                                   | 8                              | 10                           | 140               |

**S.A.Q.** = Short answer questions (5 marks)

**E.Q.** = Essay questions (10 marks)

Short answer questions : 5 X 5 M = 25 M

Essay questions : 5 X 10 M = 50 M

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Total Marks = 75 M

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**B.A./B.Sc. MATHEMATICS**  
**COURSE-V, LINEAR ALGEBRA**

**Time: 3Hrs**

**Max.Marks:75M**

**SECTION - A**

**Answer any FIVE questions. Each question carries FIVE marks 5 X 5 M=25 M**

1. Let  $p, q, r$  be fixed elements of a field  $F$ . Show that the set  $W$  of all triads  $(x, y, z)$  of elements of  $F$ , such that  $px+qy+rz=0$  is a vector subspace of  $V_3(R)$ .
2. Define linearly independent & linearly dependent vectors in a vector space. If  $\alpha, \beta, \gamma$  are linearly independent vectors of  $V(R)$  then show that  $\alpha + \beta, \beta + \gamma, \gamma + \alpha$  are also linearly independent.
3. Prove that every set of  $(n + 1)$  or more vectors in an  $n$  dimensional vector space is linearly dependent.
4. The mapping  $T : V_3(R) \rightarrow V_3(R)$  is defined by  $T(x, y, z) = (x-y, x-z)$ . Show that  $T$  is a linear transformation.
5. Let  $T: R^3 \rightarrow R^2$  and  $H: R^3 \rightarrow R^2$  be defined by  $T(x, y, z) = (3x, y+z)$  and  $H(x, y, z) = (2x-z, y)$ . Compute i)  $T+H$  ii)  $4T-5H$  iii)  $TH$  iv)  $HT$ .
6. If the matrix  $A$  is non-singular, show that the eigen values of  $A^{-1}$  are the reciprocals of the eigen values of  $A$ .
7. State and prove parallelogram law in an inner product space  $V(F)$ .
8. Prove that the set  $S = \left\{ \left( \frac{1}{3}, \frac{-2}{3}, \frac{-2}{3} \right), \left( \frac{2}{3}, \frac{-1}{3}, \frac{2}{3} \right), \left( \frac{2}{3}, \frac{2}{3}, \frac{-1}{3} \right) \right\}$  is an orthonormal set in the inner product space  $R^3(R)$  with the standard inner product.

**SECTION - B**

**Answer ALL the questions. Each question carries TEN marks. 5 X 10 M = 50 M**

- 9(a)) Define vector space. Let  $V(F)$  be a vector space. Let  $W$  be a non empty sub set of  $V$ . Prove that the necessary and sufficient condition for  $W$  to be a subspace of  $V$  is  $a, b \in F$  and  $\alpha, \beta \in V \Rightarrow a\alpha + b\beta \in W$ .

(OR)

(b) Prove that the four vectors  $(1,0,0)$ ,  $(0,1,0)$ ,  $(0,0,1)$  and  $(1,1,1)$  of  $V_3(\mathbb{C})$  form linearly dependent set, but any three of them are linearly independent.

10(a) Define dimension of a finite dimensional vector space. If  $W$  is a subspace of a finite dimensional vector space  $V(F)$  then prove that  $W$  is finite dimensional and  $\dim W \leq n$ .

(OR)

(b) If  $W$  be a subspace of a finite dimensional vector space  $V(F)$  then Prove that

$$\dim V/W = \dim V - \dim W.$$

11(a) Find  $T(x, y, z)$  where  $T: \mathbb{R}^3 \rightarrow \mathbb{R}$  is defined by  $T(1, 1, 1) = 3$ ,  $T(0, 1, -2) = 1$ ,  
 $T(0, 0, 1) = -2$

(OR)

(b) State and prove Rank Nullity theorem.

12(a) Find the eigen values and the corresponding eigen vectors of the matrix

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

(OR)

(b) State and prove Cayley-Hamilton theorem.

13(a) State and prove Schwarz's inequality in an Inner product space  $V(F)$ .

(OR)

(b) Given  $\{(2,1,3), (1,2,3), (1,1,1)\}$  is a basis of  $\mathbb{R}^3(\mathbb{R})$ . Construct an orthonormal basis using Gram-Schmidt orthogonalisation process.



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