

**NOTIFICATION****Sub: Amendment to Ordinance V****[E.C Resolution No. 18-1/ (18-1-4) dated 18.08.2022]**

Following addition be made to Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the University;

**Add the following:**

**Syllabi of Semester-I of the following departments under Faculty of Mathematical Sciences based on Under Graduate Curriculum Framework -2022 to be implemented from the Academic Year 2022-23.**

**FACULTY OF MATHEMATICAL SCIENCES****DEPARTMENT OF MATHEMATICS****B.SC. (H) MATHEMATICS****Category-I****DISCIPLINE SPECIFIC CORE COURSE – 1: ALGEBRA****CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE**

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Algebra	4	3	1	0	Class XII pass with Mathematics	Nil

**Learning Objectives**

The primary objective of this course is to introduce:

- The basic tools of theory of equations, number theory, and group theory.
- Symmetry group of a plane figure, basic concepts of cyclic groups.
- Classification of subgroups of cyclic groups.

**Learning Outcomes:**

This course will enable the students to:

- Determine number of positive/negative real roots of a real polynomial.

- Solve cubic and quartic polynomial equations with special condition on roots and in general.
- Employ De-Moivre's theorem in a number of applications to solve numerical problems.
- Use modular arithmetic and basic properties of congruences.
- Recognize the algebraic structure, namely groups, and classify subgroups of cyclic groups.

## SYLLABUS OF DSC-1

### Theory

#### Unit – 1 (24 hours)

##### Theory of Equations and Complex Numbers

General properties of polynomials and equations, Fundamental theorem of algebra, Relations between the roots and the coefficients, Upper bounds for the real roots; Theorems on imaginary, integral and rational roots; Newton's method for integral roots, Descartes' rule of signs; De-Moivre's theorem for integer and rational indices and their applications, The  $n$ th roots of unity, Cardan's solution of the cubic, Descartes' solution of the quartic equation.

#### Unit – 2 (16 hours)

##### Basic Number Theory

Division algorithm in  $\mathbb{Z}$ , Divisibility and the Euclidean algorithm, Fundamental theorem of arithmetic, Modular arithmetic and basic properties of congruences.

#### Unit – 3 (20 hours)

##### Basics of Group Theory

Groups, Basic properties, Symmetries of a square, Dihedral group, Order of a group, Order of an element, Subgroups, Center of a group, Centralizer of an element, Cyclic groups and properties, Generators of a cyclic group, Classification of subgroups of cyclic groups.

#### Practical component (if any) - NIL

#### Essential Readings

1. Andreescu, Titu & Andrica, D. (2014). Complex numbers from A to...Z. (2nd ed.). Birkhäuser.
2. Dickson, Leonard Eugene (2009). First Course in the Theory of Equations. John Wiley & Sons, Inc. The Project Gutenberg eBook: <http://www.gutenberg.org/ebooks/29785>
3. Gallian, Joseph. A. (2017). Contemporary Abstract Algebra (9th ed.). Cengage Learning India Private Limited, Delhi. Indian Reprint 2021.
4. Goodaire, Edgar G., & Parmenter, Michael M. (2006). Discrete Mathematics with Graph Theory (3rd ed.). Pearson Education Pvt. Ltd. Indian Reprint 2018.

#### Suggestive Readings

- Burnside, W.S., & Panton, A.W. (1979), The Theory of Equations, Vol. 1. Eleventh

Edition, (Fourth Indian Reprint. S. Chand & Co. New Delhi), Dover Publications, Inc.

- Burton, David M. (2011). Elementary Number Theory (7th ed.). McGraw-Hill Education Pvt. Ltd. Indian Reprint.
- Rotman, Joseph J. (1995). An Introduction to The Theory of Groups (4th ed.). Springer-Verlag, New York.

**Note:** Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

**DISCIPLINE SPECIFIC CORE COURSE – 2:  
ELEMENTARY REAL ANALYSIS**

**CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE**

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Elementary Real Analysis	4	3	1	0	Class XII pass with Mathematics	NIL

**Learning Objectives**

The course will develop a deep and rigorous understanding of:

- Real line  $\mathbb{R}$  with algebraic.
- Order and completeness properties to prove the results about convergence and divergence of sequences and series of real numbers.

**Learning Outcomes**

This course will enable the students to:

- Understand the fundamental properties of the real numbers, including completeness and Archimedean, and density property of rational numbers in  $\mathbb{R}$ .
- Learn to define sequences in terms of functions from  $\mathbb{N}$  to a subset of  $\mathbb{R}$  and find the limit.
- Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate the limit superior and limit inferior of a bounded sequence.
- Apply limit comparison, ratio, root, and alternating series tests for convergence and absolute convergence of infinite series of real numbers.

**SYLLABUS OF DSC - 2**

**Theory  
Unit – 1**

**(16 hours)**

## **Real Number System**

Algebraic and order properties of  $\mathbb{R}$ , Absolute value of a real number, Bounded above and bounded below sets, Supremum and infimum of a non-empty subset of  $\mathbb{R}$ , The completeness property of  $\mathbb{R}$ , Archimedean property, Density of rational numbers in  $\mathbb{R}$ .

### **Unit – 2**

**(24 hours)**

#### **Sequences**

Sequences and their limits, Convergent sequence, Limit theorems, Monotone sequences, Monotone convergence theorem, Subsequences, Bolzano-Weierstrass theorem for sequences, Limit superior and limit inferior for bounded sequence, Cauchy sequence, Cauchy's convergence criterion.

### **Unit – 3**

**(20 hours)**

#### **Infinite Series**

Convergence and divergence of infinite series of real numbers, Necessary condition for convergence, Cauchy criterion for convergence, Tests for convergence of positive term series, Integral test, Basic comparison test, Limit comparison test, D'Alembert's ratio test, Cauchy's nth root test, Raabe's test, Alternating series, Leibniz test, Absolute and conditional convergence.

**Practical component (if any) – NIL**

#### **Essential Readings**

1. Bartle, Robert G., & Sherbert, Donald R. (2011). Introduction to Real Analysis (4th ed.). John Wiley & Sons. Wiley India Edition 2015.
2. Bilodeau, Gerald G., Thie, Paul R., & Keough, G. E. (2010). An Introduction to Analysis (2nd ed.). Jones and Bartlett India Pvt. Ltd. Student Edition. Reprinted 2015.
3. Denlinger, Charles G. (2011). Elements of Real Analysis. Jones and Bartlett India Pvt. Ltd. Student Edition. Reprinted 2015.

#### **Suggestive Readings**

- Aliprantis C. D., & Burkinshaw, O. (1998). Principles of Real Analysis (3rd ed.). Academic Press.
- Ross, Kenneth A. (2013). Elementary Analysis: The Theory of Calculus (2nd ed.). Undergraduate Texts in Mathematics, Springer. Indian reprint.
- Thomson, B. S., Bruckner, A. M., & Bruckner, J. B. (2001). Elementary Real Analysis. Prentice Hall.

**Note:** Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

**DISCIPLINE SPECIFIC CORE COURSE – 3:  
PROBABILITY AND STATISTICS**

**CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE**

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Probability and Statistics	4	3	0	1	Class XII pass with Mathematics	NIL

**Learning Objectives**

The Learning Objectives of this course are as follows:

- To make the students familiar with the basic statistical concepts and tools which are needed to study situations involving uncertainty or randomness.
- To render the students to several examples and exercises that blend their everyday experiences with their scientific interests to form the basis of data science.

**Learning Outcomes**

This course will enable the students to:

- Understand some basic concepts and terminology - population, sample, descriptive and inferential statistics including stem-and-leaf plots, dotplots, histograms and boxplots.
- Learn about probability density functions and various univariate distributions such as binomial, hypergeometric, negative binomial, Poisson, normal, exponential and lognormal.
- Understand the remarkable fact that the empirical frequencies of so many natural populations, exhibit bell-shaped (i.e., normal) curves, using the Central Limit Theorem.
- Measure the scale of association between two variables, and to establish a formulation helping to predict one variable in terms of the other, i.e., correlation and linear regression.

**SYLLABUS OF DSC – 3**

**Theory**

**Unit – 1**

**(15 hours)**

**Descriptive Statistics, Probability, and Discrete Probability Distributions**

Descriptive statistics: Populations, Samples, Stem-and-leaf displays, Dotplots, Histograms, Qualitative data, Measures of location, Measures of variability, Boxplots; Sample spaces and events, Probability axioms and properties, Conditional probability, Bayes' theorem and independent events; Discrete random variables and probability

distributions, Expected values; Probability distributions: Binomial, geometric, hypergeometric, negative binomial, Poisson, and Poisson distribution as a limit.

**Unit – 2 (15 hours)**

**Continuous Probability Distributions**

Continuous random variables, Probability density functions, Uniform distribution, Cumulative distribution functions and expected values, The normal, exponential and lognormal distributions.

**Unit – 3 (15 hours)**

**Central Limit Theorem and Regression Analysis**

Sampling distribution and standard error of the sample mean, Central Limit Theorem and applications; Scatterplot of bivariate data, Regression line using principle of least squares, Estimation using the regression lines; Sample correlation coefficient and properties.

**Practical (30 hours)**

Software labs using Microsoft Excel or any other spreadsheet.

- 1) Presentation and analysis of data (univariate and bivariate) by frequency tables, descriptive statistics, stem-and-leaf plots, dotplots, histograms, boxplots, comparative boxplots, and probability plots ([1] Section 4.6).
- 2) Fitting of binomial, Poisson and normal distributions.
- 3) Illustrating the Central Limit Theorem through Excel.
- 4) Fitting of regression line using the principle of least squares.
- 5) Computation of sample correlation coefficient.

**Essential Reading**

1. Devore, Jay L. (2016). Probability and Statistics for Engineering and the Sciences (9th ed.). Cengage Learning India Private Limited. Delhi. Indian Reprint 2020.

**Suggestive Reading**

- Mood, A. M., Graybill, F. A., & Boes, D. C. (1974). Introduction to the Theory of Statistics (3rd ed.). Tata McGraw-Hill Pub. Co. Ltd. Reprinted 2017.

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