COURSE: B.Sc(H) MATHEMATICS

PAPER: Algebra

SEMESTER: I

SESSION: 2021 – 2022 (Odd Semester)

TEACHER NAME: Dr. Anubha Bhargava

SYLLABUS as per guidelines

Course Contents:

Unit 1: Theory of Equations and Complex Numbers , Elementary theorems on the roots of an equation, Polynomials, The remainder and factor theorem, Synthetic division, Factored form of a polynomial, The Fundamental theorem of algebra, Relations between the roots and the coefficients of polynomial equations, Imaginary roots occur in pairs, Integral and rational roots; Polar representation of complex numbers, The nth roots of unity, De Moivre's theorem for integer and rational indices and its applications.

Unit 2: Equivalence Relations and Functions , Equivalence relations, Functions, Composition of functions, Invertibility and inverse of functions, One-to-one correspondence and the cardinality of a set.

Unit 3: Basic Number Theory , The division algorithm, Divisibility and the Euclidean algorithm, The fundamental theorem of arithmetic, Modular arithmetic and basic properties of congruences; Principles of mathematical induction and well ordering principle.

Unit 4: Row Echelon Form of Matrices and Applications, Systems of linear equations, Row reduction and echelon forms, Vector equations, The matrix equation Ax = b, Solution sets of linear systems, Linear independence, The rank of a matrix and applications; Introduction to linear transformations, The matrix of a linear transformation; Matrix operations, The inverse of a matrix, Characterizations of

invertible matrices, Applications to Computer Graphics, Eigenvectors and eigenvalues, The characteristic equation and the Cayley-Hamilton theorem.

LESSON PLAN 14 weeks (Approximately)

Weeks 1 and 2: Elementary theorems on the roots of an equation, Polynomials, The remainder and factor theorem, Synthetic division, Factored form of a polynomial, The Fundamental theorem of algebra, Relations between the roots and the coefficients of polynomial equations, Imaginary roots occur in pairs, Integral and rational roots.

Weeks 3 and 4: Polar representation of complex numbers, The nth roots of unity, De Moivre's theorem for integer and rational indices and its applications.

Weeks 5 and 6: Equivalence relations, Functions, Composition of functions, Invertibility and inverse of functions, One-to-one correspondence and the cardinality of a set.

Weeks 7 and 8: The division algorithm, Divisibility and the Euclidean algorithm, The fundamental theorem of arithmetic (statement only), Modular arithmetic and basic properties of congruences. Principles of mathematical induction and well ordering principle.

Weeks 9 and 10: Systems of linear equations, Row reduction and echelon forms, Vector equations, The matrix equation Ax = b, Solution sets of linear systems, Linear independence, The rank of a matrix and applications (Definition and examples

Week 11: Introduction to linear transformations, The matrix of a linear transformation.

Weeks 12 and 13: Matrix operations, The inverse of a matrix, Characterizations of invertible matrices, Applications to Computer Graphics.

Week 14: Eigenvectors and eigenvalues, The characteristic equation and the Cayley-Hamilton theorem.

ASSESSMENT

Internal Assessment: 25 Marks (Two Assignments, Class Tests and Attendance)

References:

1. Andreescu, Titu & Andrica Dorin. (2014). Complex Numbers from A to...Z.

2. Dickson, Leonard Eugene (2009). First Course in The Theory of Equations.

3. Goodaire, Edgar G., & Parmenter, Michael M. (2005). Discrete Mathematics with Graph Theory

4. Kolman, Bernard, & Hill, David R. (2001). Introductory Linear Algebra with Applications

5. Lay, David C., Lay, Steven R., & McDonald, Judi J. (2016). Linear Algebra and its Applications

COURSE: B.Sc(H) Mathematics

PAPER: Real Analysis

SEMESTER: II SESSION: Jan 202-April 2022

TEACHER NAME: Dr. Anubha Bhargava

Syllabus as per Guidelines

Unit 1: Real Number System $\mathbb{R}$ Algebraic and order properties of $\mathbb{R}$, Absolute value of a real number; Bounded above and bounded below sets, Supremum and infimum of a nonempty subset of $\mathbb{R}$.

Unit 2: Properties of $\mathbb{R}$ The completeness property of $\mathbb{R}$, Archimedean property, Density of rational numbers in $\mathbb{R}$; Definition and types of intervals, Nested intervals property; Neighbourhood of a point in $\mathbb{R}$, Open and closed sets in $\mathbb{R}$.

Unit 3: Sequences in $\mathbb{R}$ Convergent sequence, Limit of a sequence, Bounded 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 4: 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; Alternating series, Leibniz test, Absolute and conditional convergence.

LESSON PLAN: 14 weeks (Approximately)

Weeks 1 and 2: Algebraic and order properties of $\mathbb{R}$. Absolute value of a real number; Bounded above and bounded below sets, Supremum and infimum of a nonempty subset of $\mathbb{R}$.

Weeks 3 and 4: The completeness property of $\mathbb{R}$, Archimedean property, Density of rational numbers in $\mathbb{R}$, Definition and types of intervals, Nested intervals property; Neighborhood of a point in $\mathbb{R}$, Open and closed sets in $\mathbb{R}$.

Weeks 5 and 6: Sequences and their limits, Bounded sequence, Limit theorems.

Week 7: Monotone sequences, Monotone convergence theorem and applications.

Week 8: Subsequences and statement of the Bolzano−Weierstrass theorem. Limit superior and limit inferior for bounded sequence of real numbers with illustrations only.

Week 9: Cauchy sequences of real numbers and Cauchy's convergence criterion.

Week 10: Convergence and divergence of infinite series, Sequence of partial sums of infinite series, Necessary condition for convergence, Cauchy criterion for convergence of series.

Weeks 11 and 12: Tests for convergence of positive term series: Integral test statement and convergence of p-series, Basic comparison test, Limit comparison test with applications, D' Alembert' s ratio test and Cauchy's nth root test.

Weeks 13 and 14: Alternating series, Leibniz test, Absolute and conditional convergence.

ASSESSMENT

Internal Assessment: 25 Marks (Two Assignment, 2 Class Tests and Attendance)

ESSENTIAL READINGS

[1] Bartle, Robert G., &Sherbert, Donald R. (2015). Introduction to Real Analysis (4thed.). Wiley India Edition. New Delhi.

[2] Bilodeau, Gerald G., Thie, Paul R., &Keough, G. E. (2010). An Introduction to Analysis (2nd ed.). Jones & Bartlett India Pvt. Ltd. Student Edition. Reprinted 2015.

[3] Denlinger, Charles G. (2011). Elements of Real Analysis. Jones & Bartlett India Pvt. Ltd. Student Edition. Reprinted 2015.

PAPER: Probability and Statistics

SEMESTER: VI SESSION: Jan 2022 – May 2022 (Even Semester)

TEACHER NAME: Dr.AnubhaBhargava

SYLLABUS as per guidelines

Course Contents:

Unit 1: Probability Functions and Moment Generating Function, Sample space, Probability set function, Real random variables - Discrete and continuous, Cumulative distribution function, Probability mass/density functions, Transformations, Mathematical expectation, Moments, Moment generating function, Characteristic function.

Unit 2: Univariate Discrete and Continuous Distributions ,Discrete distributions: Uniform, Bernoulli, Binomial, Negative binomial, Geometric and Poisson; Continuous distributions: Uniform, Gamma, Exponential, Chi-square, Beta and normal; Normal approximation to the binomial distribution.

Unit 3: Bivariate Distribution, Joint cumulative distribution function and its properties, Joint probability density function, Marginal distributions, Expectation of function of two random variables, Joint moment generating function, Conditional distributions and expectations

Unit 4: Correlation, Regression and Central Limit Theorem, The Correlation coefficient, Covariance, Calculation of covariance from joint moment generating function, Independent random variables, Linear regression for two variables, The method of least squares, Bivariate normal distribution, Chebyshev's theorem, Strong law of large numbers, Central limit theorem and weak law of large numbers

LESSON PLAN 14 weeks (Approximately)

Weeks 1 and 2: Sample space, Probability set function and examples, Random variable, Probability mass/density function, Cumulative distribution function and its properties.

Week 3 and 4: Discrete and continuous random variables, and Transformations. Expectation of random variables, and some special expectations: Mean, Variance, Standard deviation, Moments and moment generating function, Characteristic function.

Week 5: The discrete distributions - Uniform, Bernoulli and binomial.

Week 6: The discrete distributions - negative Binomial, Geometric and Poisson

Week 7: The continuous distributions - Uniform, Gamma, Exponential, Chi-square and Beta

Week 8: Normal distribution, and normal approximation to the binomial distribution

Weeks 9 and 10: Random vector: Discrete and continuous, Joint cumulative distribution function and its properties, Joint probability mass/density function, Marginal probability mass function, and expectation of two random variables, Joint moment generating function, Conditional distributions and expectations

Week 11: The Correlation coefficient, Covariance, Calculation of covariance from joint moment generating function, Independent random variables

Week 12: Linear regression for two variables, and the method of least squares

Week 13: Bivariate normal distribution; Chebyshev's theorem

Week 14: Statement and interpretation of the strong law of large numbers, Central limit theorem and the weak law of large numbers.

ASSESSMENT

Internal Assessment: 25 Marks (Two Assignments, Class Tests and Attendance)

References:

1. Hogg, Robert V., McKean, Joseph W., & Craig, Allen T. (2013). Introduction to Mathematical Statistics

2. Miller, Irwin & Miller, Marylees. (2014).John E. Freund's Mathematical Statistics with Applications

3. Ross, Sheldon M. (2014). Introduction to Probability Models