St. Aloysius College (Autonomous), Jabalpur

Reaccredited 'A+' by NAAC (CGPA – 3.68/4.00)

College with Potential for Excellence by UGC

DST FIST Supported

Department of Mathematics

Syllabus

M.Sc. I to IV Semester

To be implemented in 2021-23

CHOICE BASED CREDIT SYSTEM (CBCS)

(For PG Programme in Mathematics from the academic year 2021-2023 onwards)

1. Eligibility

(i) Admission: Candidates who have passed the qualifying examination (UG) with Mathematics shall be given in admission to M.Sc. Mathematics Degree Programme.

(ii) Degree : The candidates shall have subsequently undergone the prescribed course of study in the college affiliated to the University for a period of not less than two academic years, passed the examinations prescribed and fulfilled such conditions as have been prescribed.

2. Duration

The course is for a period of two years. Each academic year shall comprise of two Semester, viz. Odd and Even Semester. Odd semesters shall be from July to November and Even Semesters shall be from January to April. There shall be not less than 90 working days which shall comprises of minimum 375 teaching clock hours for each semester. (Exclusive of the days for the conduct of Odd and Even Semester examinations).

3. Programme

M.Sc. Mathematics

4. The CBCS System

The Programme will run on Choice Based Credit System (CBCS). It is an instructional package developed to suit the needs of students to keep pace with the developments in higher education and the quality assurance expected of it in the light of globalization in higher education.

5. Paper Offered

Semester I

	Paper	Title of the Paper
Core	I	Advanced Abstract Algebra- I
Core	II	Real Analysis-I
Core	III	Topology- I
Core	IV	Complex Analysis – I
Core	V	A. Functional Analysis – I
Elective		B. Integral Transform

Semester II

	Paper	Title of the Paper
Core	I	Advanced Abstract Algebra- II
Core	II	Real Analysis-II
Core	III	Ordinary and Partial Differential Equations
Core	IV	Complex Analysis – II
Core	V	A. Number Theory
Elective		B. Topology- II

Semester III

	Paper	Title of the Paper
Core	I	Operation Research – I
Core	II	Special Functions
Core	III	Numerical Methods - I
Core	IV	A. Programming in C
Elective		B. Functional Analysis – II
Open	V	A. Advanced Discrete Mathematics
Elective		B. Mathematical Statistics

Semester IV

	Paper	Title of the Paper
Core	I	Operation Research – II
Core	II	Numerical Methods - II
Core Elective	III	A. Divergent Series B. Programming in C++
Core Elective	IV	A. Integration Theory B. Fuzzy Sets and Their Applications
Open Elective	V	A. Mathematical Modeling B. Wavelets

CVV- Comprehensive Viva-Voce with maximum marks 100 and minimum marks 40.

6. Details of the Number of Papers / Credits per Paper / No. of Hours in the PG Programme

Theory					
Semester	**No. of Papers**	**Credits per Paper**	**Total Credits**	**Total Hours per Week**	**Total Hours per Semester**
I	4 Core	5	25+ 1(Skill Development) = 26	5 x 6 = 30 Including Presentation for Viva-	30 x 15 = 450
	1 E Core	5			

II	4 Core	5	25+ 1(Skill Development) = 26	Voce 5 x 6 = 30	30 x 15 = 450
	1 E Core	5			
III	4 Core	5	25+ 1(Skill Development) = 26	5 x 6 = 30	30 x 15 = 450
	1 Open Elec.	5			
IV	4 Core	5	25+ 1(Skill Development) = 26	5 x 6 = 30	30 x 15 = 450

ST. ALOYSIUS COLLEGE (AUTO), JABALPUR
DEPARTMENT OF MATHEMATICS 2021-22
M. Sc. (MATHEMATICS)
FIRST SEMESTER
CORE PAPER I: ADVANCED ABSTRACT ALGEBRA-I

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

To make the students see and understand the connection and transition between previously studied mathematical concepts and more advanced mathematics.

COURSE LEARNING OUTCOMES:

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

CLO1 Provide the knowledge of important mathematical concepts in abstract algebra such as groups, Abelian groups, subgroups, cyclic groups, and normal subgroups of a group.

CLO2 Introduce many mathematical concepts such as Cauchy Abelian theorem, Sylow's theorems and various applications of Sylow's theorems.

CLO3 Confer knowledge of series of groups: Normal and Subnormal series, Composition series and their properties.

CLO4 Make the students participate actively in the vital concepts of abstract mathematics like Solvable groups, Nilpotent groups and their characteristics.

CLO5 Appreciate the concepts of Extension field, Splitting field, Finite field, and related theorems.

Unit-I: Another Counting Principle, Conjugacy Relation, Normalizer of an element of a Group, Class Equation and its theorems, Cauchy theorem for Finite Group (both Abelian and Non-Abelian), Sylow's first and second theorem, Double Coset, Application of Sylow's third theorem in Finite Groups.

Unit-II: Series of Groups: Normal and Subnormal Series, Composition Series, Zassenhaus lemma, Schreir Refinement theorem, Jordon Holder theorem.

Unit-III: Solvable Group and its properties, Commutator Subgroup and its theorem, Nilpotent Group and its properties.

Unit-IV: Fields: Extension Field and its theorem, Finite Extension, Algebraic element and its theorem, Algebraic and Transcendental Extension, Roots of Polynomials, Remainder theorem, Factor theorem, Splitting field and its theorems.

Unit-V: More about Roots: Derivative of a Polynomials and its theorems, Simple Extension and its theorems, Primitive element, Separable Extension, Perfect Field and its theorems, Finite Field and its theorems.

Text Books:

1. I.N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975 (For Units I, III, IV,V).
2. Vivek Sahai and Vikas Bist, Algebra, Narosa Publishing House, 1999 (For Unit-II).

Reference Books:

1. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra (2nd Ed.) , Cambridge University Press, Indian Edition, 1997.
2. I.S. Luther and I.B.S. Passi, Algebra, Vol. I, Groups, Narosa Publishing House, 1996.
3. Surjeet Singh and Quazi Zameeruddin, Modern Algebra, Vikas Publishing House Pvt. Ltd., 1990.

4. N. Jacobson, Basic Algebra, Vol. I & II, Hindustan Publishing Company, 1980.
5. S. Lang, Algebra, 3rd Edition, Addition-Wesley, 1993.

ST. ALOYSIUS COLLEGE (AUTO), JABALPUR
DEPARTMENT OF MATHEMATICS 2021-22
M. Sc. (MATHEMATICS)
FIRST SEMESTER
CORE PAPER II : REAL ANALYSIS - I

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

To make the students see and understand the connection and transition between previously studied Real analysis mathematical concepts and more advanced mathematics.

COURSE LEARNING OUTCOMES:

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

CLO1 The basic properties of the field of real numbers.

CLO2 The series of real numbers and convergence.

CLO3 Provide the knowledge of Bolzano- Weirstrass theorem and ability to apply the theorem in a correct mathematical way.

CLO4 Introduce many mathematical concepts studied in Real mathematics such as the real functions

CLO5 limits, continuity, differentiability of real functions and its related theorems.

Unit-I: Definition and existence of Riemann-Stieltjes integral and its Properties, Integration and differentiation, The fundamental theorem of Calculus.

Unit-II: Integration of vector-valued functions, Rectifiable curves. Rearrangements of terms of a series. Riemann's theorem.

Unit-III: Sequences and series of functions, pointwise and uniform convergence, Cauchy criterion for uniform convergence, Weierstrass M-test, Abel's and

Dirichlet's tests for uniform convergence, uniform convergence and continuity, uniform convergence and Riemann-Stieltjes integration, uniform convergence and differentiation, Weierstrass approximation theorem.

Unit-IV: Power series, uniqueness theorem for power series, Abel's and Tauber's theorems.Functions of several variables, linear transformations.

Unit-V: Derivatives in an open subset of Rn, Chain rule, Partial derivatives, interchange of the order of differentiation, Derivatives of higher orders, Taylor's theorem, Inverse function theorem.

Text Book: Water Rudin, Principles of Mathematical Analysis, McGraw Hill, 1978.

Reference Books: 1. T.M. Apostal, Mathematical Analysis, Narosa.

2. H.L. Royden, Real Analysis, Macmillan (Indian Edition)

ST. ALOYSIUS COLLEGE (AUTO), JABALPUR
DEPARTMENT OF MATHEMATICS 2021-22
M. Sc. (MATHEMATICS)
FIRST SEMESTER
CORE PAPER III: TOPOLOGY-I

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

To classify sets with various properties like finiteness, infiniteness, countability, unaccountability, etc. To present an introduction to the essentials of general topology with an emphasis on those aspects which are basic to higher mathematics. To stress on ideas of abstraction and aesthetics, development of mathematical tools and use of mathematical language.

COURSE LEARNING OUTCOMES:

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

CLO1. Develop their abstract thinking skills.
CLO2. Understand the concept of cardinality.
CLO3. Gain knowledge of basic concepts of topology.
CLO4. Gain in mathematical maturity.
CLO5. Gain competency in writing proofs.

Unit –I: Equivalent Sets, Denumerable, Countable, infinite and uncountable sets. The Continuum, Schoreder-Bernstein theorem, Concept of cardinality, equivalence of $(0,1),(0,1],[0,1),[0,1]$,

Cantor's theorem and Continuum Hypothesis, Partially ordered sets, First and the last elements, Maximal & Minimal elements, upper and lower bounds, Zorn's Lemma, Axiom of Choice and Well-ordering principle . (As given in chapter -1, Article No. 1.7, 1.9, 1.10 of J. R. Munkre's book, chapter 3 of Seymour Lipschitz's book)

Unit – II: The definition and some examples of topological space, Topological Subspaces, limit point, derived set, Elementary concepts of open sets, closed sets, closure of a set, dense set, everywhere dense and nowhere dense set. Neighborhood of a point on a set in a topological spaces, isolated point of a set, Interior and boundary of a set. (Chapter 5- S.L. Book)

Unit – III: Continuous maps and homeomorphism of topological spaces, an open base and open sub-base for topological space (As given in the Chapter-II of G.F. Simmons Book, chapter 6-7, of Seymour Lipschitz's book)

Unit – IV: First and Second Countable spaces, Lindelof's theorems, Separable spaces (As given in the Chapter-III of G.F. Simmons Book, chapter 9 of Seymour Lipschitz's book)

Unit – V: Disconnected and Connected sets and spaces, Connectedness on Real line, Components, totally disconnected spaces, Locally connected spaces, Topologist's sine curve (As given in the Chapter-VI of G.F. Simmons Book, chapter 13 of Seymour Lipschitz's book)

Text Book:

1. Seymour Lipschitz, Theory and Problem of general Topology, Schaum Publishing co. N.Y., 1965.
2. G. F. Simmons, Topology and Modern Analysis , McGraw Hill International Edition, 1963.
3. James R. Munkres, Topology, A First Course, Prentice Hall of India Pvt. Ltd. New Delhi., 1988.

Reference Books:

1. K. D. Joshi, Introduction to General Topology, Wiley Eastern Ltd, New Delhi, 1983.
2. I. Kelly, General Toplogy, Van Nostrand, New York, 1995.
3. K. Chandra Shekhara Rao, Topology, Narosa Publications, 2009.
4. J. P. Chauhan and J. N. Sharma, Topology, Krishana Publications, 2015.

ST. ALOYSIUS COLLEGE (AUTO), JABALPUR
DEPARTMENT OF MATHEMATICS 2021-22
M. Sc. (MATHEMATICS)
FIRST SEMESTER

CORE PAPER IV: COMPLEX ANALYSIS -I

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

Understand complex numbers provide a satisfying extension of the real numbers, a function of complex variable and carry out basic mathematical operations with complex numbers.

COURSE LEARNING OUTCOMES:

On completion of syllabus student will be able to

CLO 1 – Understand the significance of differentiability for complex functions and be familiar with the Cauchy –Riemann equations.

CLO 2- Evaluate integrals along a path in the complex plane and understand the statement of Cauchy's theorem.

CLO 3- Compute the Taylor and Laurent expansions of simple functions, determining the nature of singularities and calculating residues.

CLO 4- Use the Cauchy Residue theorem to evaluate integrals and sum series.

CLO 5 - Understand about Bilinear transformations, cross ratio and fixed points.

UNIT I : Complex integration, Rectifiable arcs, Contours, Complex line integrals, Evaluation of some integrals by direct definition, Complex integral as sum of two real line integrals, The absolute value of a complex integral,The Elementary form of Cauchy's Theorem, Extension of the Cauchy's Theorem,

UNIT II : Cauchy integral formula,Cauchy's Integral formula for the derivative of an analytic function, Cauchy's Integral formula for Higher order Derivatives. Morera's theorem, Cauchy's inequality theorem, Liouville's theorem, Taylor's theorem.

UNIT III : Laurent Theorem, Singularities,Poles and zeros of a Meromorphic function, The argument principle, Rouche'stheorem,The fundamental Theorem of algebra, The maximum modulus principle, Schwartz lemma.

UNIT IV : Residues, Cauchy's residue theorem,Evaluation of certain integrals,

Integrals of type $\int_0^{2\pi} R(\cos\theta, \sin\theta)\, d\theta$, *Integrals of type* $\int_{-\infty}^{\infty} f(x)\, dx$,

Integrals of type $\int_{-\infty}^{\infty} \frac{P(x)}{Q(x)} \sin mx\, dx$, $\int_{-\infty}^{\infty} \frac{P(x)}{Q(x)} \cos mx\, dx$, Case of poles on the real axis.

UNIT V : Bilinear transformations, Elementary Transformations,Product of two Bilinear transformations, The linear group, Cross Ratio, Preservation of Cross Ratio under Bilinear transformations, Two important families of circles, Fixed point of a Bilinear transformations, Normal form of a Bilinear transformation.

Text Book:

1. J.B. Convey, Function of one complex variable, Springer-Verlag, 1980.

Reference Books:

1.S. Ponnuswamy, Foundation of complex analysis, Narosa Publishing House,1997.
2. L.V. Ahlfors, complex analysis, McGraw Hill,1979.
3. M.L. Khanna, Complex Analysis
4. H.K. Pathak, Complex Analysis

ST. ALOYSIUS COLLEGE (AUTO), JABALPUR
DEPARTMENT OF MATHEMATICS 2021-22
M. Sc. (MATHEMATICS)
FIRST SEMESTER

CORE ELECTIVE PAPER V(A) :FUNCTIONAL ANALYSIS - I

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

To get familiar with concepts of a normed linear spaces. To achieve knowledge and understanding of Banach spaces and their various properties. To give a working knowledge of the basic properties of Quotient spaces, bounded linear operators and functionals. To show the use of abstract algebraic/topological structures in studying spaces of functions.

COURSE LEARNING OUTCOME:

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

CLO1. Appreciate how functional analysis uses and unifies ideas from vector spaces, the theory of metrics, and complex analysis.

CLO2. Work comfortably with Banach spaces.

CLO3. Understand normed linear spaces and their compatibilities.

CLO4. Enhance the knowledge regarding Quotient spaces.

CLO5. Understand basic theorems including Hahn Banach Theorem.

CLO6. Acquire knowledge of bounded operators and functionals.

Unit-I: Normed linear spaces, Banach spaces and examples, Properties of Normed linear spaces, Basic properties of finite dimensional normed linear spaces.

Unit-II: Finite dimensional Normed linear spaces & Sub spaces, Equivalent norms, Riesz Lemma and Compactness.

Unit-III: Definition and properties of cosets in normed linear spaces. Quotient space of normed linear spaces and its completeness.

Unit-IV: Bounded linear operators & continuous operators, Normed Linear spaces operators.

Unit-V: Linear functional, bounded linear functional, Dual spaces with examples. Hahn-Banach theorem.

Text Book:

1. G. F. Simmons, Topology and Modern Analysis , McGraw Hill International Edition, 1963.

2. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 1978.

Reference Books:

1. R. E. Edward, Functional Analysis, Dover Publication, New York, 1995.
2. P. K. Jain, O. P. Ahuja and Khalil Ahmed, Functional Analysis, New Age International (P) Ltd. Publ, 2004.

ST . ALOYSIS COLLEGE (AUTO.), JABALPUR
DEPARTMENT OF MATHEMATICS 2021-22
M. SC. (MATHEMATICS) FIRST SEMESTER

CORE ELECTIVE PAPER V(B): INTEGRAL TRANSFORM

CREDIT: 5
MAX MARKS: 40
MIN MARKS: 14

COURSE OBJECTIVE:

The course is aimed at exposing the students to Laplace and Fourier Transforms of different functions and their applications in solving Differential equations, Partial Differential equations, Initial Value and Boundary Value Problems.

COURSE LEARNING OUTCOMES:

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

CLO 1 Calculate the Laplace Transform and Inverse Laplace Transform of standard functions.

CLO 2 Select and use the appropriate shift theorems in finding Laplace and Inverse Laplace transforms of elementary functions.

CLO 3 Will be able to find the solution of Heat Conduction Equation, Boundary Value Problems and electric circuits. Also they will be able to apply the Laplace Transform to beam and dynamics.

CLO 4 Calculate the Fourier transform, Complex Fourier Transform, Fourier Sine transform and Fourier cosine transform of elementary functions.

CLO 5 Calculate the Fourier Transform of the derivatives.

Unit –I:

Laplace Transform, Properties of Laplace Transform, Laplace Transform of Derivatives of function, Inverse Laplace Transform, Properties of Inverse Laplace Transform, Inverse Laplace Transform of Derivatives, Convolution theorem.

Unit – II:

Application of Laplace Transforms to solution of differential equations, solution of initial value problem, Laplace's equations, Laplace wave equation. Application of Laplace Transforms in Heat Conduction equation.

Unit – III:

Application of Laplace Transforms to Boundary Value Problems, Electric Circuits, and Application to Beams.

Unit – IV:

The Fourier Transform, The complex Fourier Transform, Inversion Formula, Fourier Cosine and Sine transform properties of Fourier transforms, Convolution &Parseval's identity.

Unit – V:

Fourier Transform of the derivatives, Finite Fourier sine & Cosine Transform, Inversion Operational and combined Fourier transform.

Books recommended:

Text Book:

1. J.K. Goyal& K. P. Gupta, Integral Transform, PragatiPrakashan, Meerut.
2. A. R. Vashishtha& R. K. Gupta, Integral Transform, Krishna Prakashan Media(P), Limited.

Reference Book:

1. I. N. Sneddon, Integral Transform, Tata McGraw-Hill, New York.