St. Xavier's College – Autonomous Mumbai

Syllabus
For 5th Semester Courses in Mathematics
(June 2013 onwards)

Contents:

Theory Syllabus for Courses:

T.Y. B.Sc. Maths **Course: S.Mat. 5.01**

Title: REAL ANALYSIS and MULTIVARIABLE CALCULUS

Learning Objectives:

1. To understand Riemann Integrability of bounded functions .
2. first and second Fundamental Theorem of Calculus and fubini's theorem of rectangles

Number of lectures: 45

UNIT 1

Riemann Integration, Double and Triple Integrals **(12 lectures)**

(a) Uniform continuity of a real valued function on a subset of R
(i) Definition.
(ii) a continuous function on a closed and bounded interval is uniformly continous (only statement).
(b) Riemann Integration.
(i) Partition of a closed and bounded interval [a; b], Upper sums and Lower sums of a bounded real valued function on [a; b]. Refinement of a partition, Definition of Riemann integrability of a function. A necessary and sufficient condition for a bounded function on [a; b] to be Riemann integrable.(Riemann's Criterion)
(ii) A monotone function on [a; b] is Riemann integrable.
(iii) A continuous function on [a; b] is Riemann integrable.
A function with only finitely many discontinuities on [a; b] is Riemann integrable.
Examples of a Riemann integrable function which is discontinuous at all rational numbers.
(c) Algebraic and order properties of Riemann integrable functions.
(i) Riemann Integrability of sums, scalar multiples and products of integrable functions. The formulae for integrals of sums and scalar multiples of Riemann integrable functions.
(ii) If f is Riemann integrable on [a; b], and $a < c < b$, then f is Riemann integrable on [a; c] and [c; b]

Unit 2 **(11 lectures)**

(a) First and second Fundamental Theorem of Calculus.
(b) Integration by parts and change of variables formula.
(c) Mean Value Theorem for integrals.
(d) The integral as a limit of a sum, examples.
(e) Double and Triple Integrals
(i) The definition of the Double (respectively Triple) integral of a bounded function on a rectangle (respectively box).
(ii) Fubini's theorem over rectangles.
(iii) Properties of Double and Triple Integrals:
(1) Integrability of sums, scalar multiples, products of integrable functions, and formulae for integrals of sums and scalar multiples

of integrable functions.
(2) Domain additivity of the integrals.
(3) Integrability of continuous functions and functions having only finitely (countably) many discontinuities.
(4) Double and triple integrals over bounded domains.
(5) Change of variables formula for double and triple integrals (statement only).

UNIT 3

Sequences and series of functions: **(11 lectures)**

(a) Pointwise and uniform convergence of sequences and series of real valued functions. Weierstrass M-test. Examples.
(b) Continuity of the uniform limit (resp: uniform sum) of a sequence (resp: series) of real-valued functions. The integral and the derivative of the uniform limit (resp: uniform sum) of a sequence (resp: series) of real-valued functions on a closed and bounded interval. Examples.

UNIT 4 **(11 lectures)**

(a) Power series in R. Radius of convergence. Region of convergence. Uniform convergence. Term-by-term differentiation and integration of power series. Examples.
(b) Taylor and Maclaurin series. Classical functions defined by power series: exponential, trigonometric, logarithmic and hyperbolic functions, and the basic properties of these functions.

List Of Recommended Reference Books

1. Real Analysis Bartle and Sherbet.
2. Calculus, Vol. 2: T. Apostol, John Wiley.
3. Richard G. Goldberg, Methods of Real Analysis, Oxford & IBHPublishing Co. Pvt. Ltd., New Delhi.

Practical:

I) Riemann Integration.
II) Fundamental Theorem of Calculus.

III) Double and Triple Integrals; Fubini's theorem, Change of VariablesFormula.
IV) Pointwise and uniform convergence of sequences and series of functions.
V) Illustrations of continuity, differentiability, and integrability for pointwise and uniform convergence.
VI) Power series in R. Term by term differentiation and integration.
VII) Miscellaneous Theoretical questions based on Unit 1.
VIII) Miscellaneous Theoretical questions based on Unit 2.

T.Y. B.Sc. Maths **Course: S.Mat. 5.02**
Title: ALGEBRA

Learning Objectives:

1. To understand Cyclic groups, Lagrange's theorem and Group homomorphisms and isomorphisms.

2. To understand Normal groups.

Number of lectures: 45

UNIT 1

Groups and subgroups **(12 lectures)**

(a) Definition and properties of a group. Abelian group. Order of a group, finite and infinite groups. Examples of groups including
(i) Z, Q, R, C under addition.
(ii) Q*, R* under multiplication.
(iii) Z_n, the set of residue classes modulo n under addition.
(iv) U(n), the group of prime residue classes modulo n under multiplication.
(v) The symmetric group S_n.
(vi) The group of symmetries of a plane figure. The Dihedral group D_n as the group of symmetrices of a regular polygon of n sides.
(vii) Quaternion group.
(viii) Matrix groups $M_n(R)$ under addition of matrices, $GL_n(R)$, the set of invertible real matrices, under multiplication of matrices.
(b) Subgroups
Subgroups of $GL_n(R)$ such as $SL_n(R)$, $O_n(R)$, $SO_n(R)$, $SO_2(R)$ as group of 2 x 2 real matrices representing rotations, subgroup of n-th roots of unity.

Unit 2 **(11 lectures)**

(a)(i) Cyclic groups (examples of Z, Z_n) and cyclic subgroups.
(ii) Groups generated by a finite set, generators and relations.
Examples such as Klein's four group V_4, Dihedral group, Quaternion group.
(iii) The Center Z(G) of a group G, and the normalizer of an element of G as a subgroup of G.
(iv) Cosets, Lagrange's theorem.
(b) Group homomorphisms and isomorphisms. Examples and properties. Automorphisms of a group, inner automorphisms.

UNIT 3

Normal subgroups: **(11 lectures)**

(a) (i) Normal subgroups of a group. Definition and exmaples including center of a group. (ii) Quotient group.
(iii) Alternating group A_n, cycles. Listing normal subgroups of A_4, S_3.
(b) Isomorphisms theorems. (i) First Isomorphism theorem (or Fundamental Theorem of homomorphisms of groups). (ii) Second Isomorphism theorem. (iii) Third Isomorphism theorem.

Unit 4

(a) Cayley's theorem. **(11 lectures)**

(b) External direct product of a group. Properties of external direct products. Order of an element in a direct product, criterion for direct product to be cyclic. The groups Z_n and U(n) as external direct product of groups.

(c) Classification of groups of order 7.

List Of Recommended Reference Books

1. I.N. Herstein. Topics in Algebra, Wiley Eastern Limited, Second
2. N.S. Gopalakrishnan, University Algebra, Wiley Eastern Limited.
3. M. Artin, Algebra, Prentice Hall of India, New Delhi.
4. W.B. Fraleigh, A first course in Abstract Algebra, Third edition,Narosa, New Delhi.
5. J. Gallian. Contemporary Abstract Algebra. Narosa, New Delhi.
6. P.B. Bhattacharya, S.K. Jain, S. Nagpaul. Abstract Algebra.

Practical:

I) Groups Definitions and properties.

II) Subgroups, Lagrange's Theorem and Cyclic groups..

III) Groups of Symmetry and the Symmetric group S_n.

IV) Group homomorphisms, isomorphisms.

V) Normal subgroups and quotient groups.

VI) Cayley's Theorem and external direct product of groups.

VII) Miscellaneous Theoretical questions based on Unit 1 and 2.

VIII) Miscellaneous Theoretical questions based on Unit 3 and 4.

T.Y. B.Sc. Maths **Course: S.Mat.5.03**

Title: Topology of metric spaces.

Learning Objectives:

1. Inrtroduction to Metric Spaces.

Number of lectures: 45

UNIT 1

Metric spaces **(12 lectures)**

(a) (i) Metrics spaces: Definition, Examples, including R with usual distance, discrete metric space.

(ii) Normed linear spaces: Definition, the distance (metric) induced by the norm, translation invariance of the metric induced by the norm. Examples including

(1) $\mathbb{R}^n$ with sum norm $||\ ||_1$, the Euclidean norm $||\ ||_2$, and the sup norm $||\ ||_\infty$.

(2) $C[a,b]$, the space of continuous real valued functions on $[a,b]$ with norms $||\ ||_1$, $||\ ||_2$, $||\ ||_\infty$, where $||f||_1 = \int_a^b |f(t)|dt$, $||f||_2 = \left(\int_a^b |f(t)|^2 dt\right)^{\frac{1}{2}}$, $||f||_\infty = \sup\{|f(t)|, t \in [a,b]\}$.

(3) ℓ_1, ℓ_2, ℓ_∞, the spaces of real sequences with norms $||\ ||_1$, $||\ ||_2$, $||\ |_\infty$, where $||x||_1 = \sum_{n=1}^{\infty} |x_n|$, $||x||_2 = (\sum_{n=1}^{\infty} |x_n|^2)^{\frac{1}{2}}$, $||x||_\infty = \sup\{|x_n|, n \in \mathbb{N}\}$, for $x = (x_n)$.

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(iii) Subspaces, product of two metric spaces.

(b) (i) Open ball and open set in a metric space (normed linear space) and subspace Hausdorff property. Interior of a set.

(ii) Structure of an open set in R, namely any open set is a union of a countable family of pairwise disjoint intervals.

(iii) Equivalent metrics, equivalent norms.

(c) (i) Closed set in a metric space (as complement of an open set), limit point of a set (A point which has a non-empty intersection with each deleted neighbourhood of the point), isolated point. A closed set contains all its limit points.

(ii) Closed balls, closure of a set, boundary of a set in a metric space.

UNIT 2 **(11 lectures)**

(a)(i) Distance of a point from a set, distance between two sets, diameter of a set in a metric space.

(ii) Dense subsets in a metric space. Separability, Rn is separable.

(b) (i) Sequences in a metric space.

(ii) The characterization of limit points and closure points in terms of sequences.

(iii) Cauchy sequences and complete metric spaces. Rn with Euclidean metric is a complete metric space.

(c) Cantor's Intersection Theorem.

UNIT 3

Continuity: **(11lectures)**

(a) Definition of continuity at a point of a function from one metric space to another.

(i) Characterization of continuity at a point in terms of sequences, open sets.

(ii) Continuity of a function on a metric space. Characterization in terms of inverse image

of open sets and closed sets.

UNIT 4 **(11 lectures)**

(iii) Urysohn's lemma.
(iv) Uniform continuity in a metric space, definition and examples (emphasis on R), open maps, closed maps.

List Of Recommended Reference Books

1. S. Kumaresan, Topology of Metric spaces.
2. W. Rudin, Principles of Mathematical Analysis.
3. R.G. Goldberg Methods of Real Analysis, Oxford and IBH Publishing House, NewDelhi.
4. P.K. Jain, K. Ahmed. Metric spaces. Narosa, New Delhi, 1996.
5. G.F. Simmons. Introduction to Topology and Modern Analysis. McGraw Hill, New York, 1963.

Practical:

I) Metric spaces and normed linear spaces. Examples.
II) Open balls, open sets in metric spaces, subspaces and normed linear spaces.
III) Limit points: (Limit points and closure points, closed balls, closed sets, closure of a set, boundary of a set, distance between two sets).
IV) Sequences
V) Continuity.
VI) Uniform continuity in a metric space.
VII) Miscellaneous Theoretical Questions based on Unit 1 and 2
VIII) Miscellaneous Theoretical Questions based on Unit 3 and 4

T.Y. B.Sc. Maths **Course: S.Mat.5.04**
Title: Numerical Methods

Learning Objectives:

1. Newton – Raphson method Chebyshev method etc & their rate of convergence
2. Different types of interpolation methods

Number of lectures: 45

UNIT 1

Transcendental and Polynomial equations **(12 lectures)**

(a) Iteration methods based on first and second degree equation
- (i) The Newton – Raphson method
- (ii) Secant method
- (iii) Muller method
- (iv) Chebyshev method
- (v) Multi-point iteration metbod

(b) Rate of convergence and error analysis
- (i) Secant method
- (ii) The Newton – Raphson method
- (iii) Methods of multiple roots

UNIT 2 **(11 lectures)**

(a) Polynomial equations
- (i) Birge-Vieta method
- (ii) Bairstow method
- (iii)Graeffe's Method

UNIT 3

Interpolation and approximation **(11 lectures)**

(a) Higher order interpolation
(b) Finite difference operators and fundamental theorem of difference calculus
(c) Interpolating polynomial using finite differences, factorial notation
(d) Hermite interpolation

UNIT 4 **(11 lectures)**

(a)Piecewise and spline interpolation
(b)Bivariate interpolation – Lagrange bivariate interpolation, Newton`s bivariate interpolation for equispaced points
(c)Least square approximation

List Of Recommended Reference Books

1. M.K.Jain , S.R.K. Iyengar and R.K.Jain. Numerical methods for Scientific and Engineering Computation, New age International publishers,Fourth Edition, 2003
2. S.D.Comte and Carl de Boor, Elementary Numerical analysis- An algorithmic approach, 3rd edition., McGraw Hill, International Book Company,1980.
3. F.B.Hildebrand, Introduction to Numerical Analysis, McGraw Hill, New York, 1956.

Practical:

I) Iteration methods based on first degree equation-Newton Raphson method , Secant method.
II) Iteration methods based on second degree equation-Muller method , Chebyshev method, Multi-point iteration metbod
III) Polynomial equations
IV) Higher order Interpolation/finite difference operators
V) Interpolating polynomial using finite differences / Hermite interpolation
VI) Piecewise and spline interpolation / Bivariate interpolation

VII) Miscellaneous Theoretical questions based on Unit 1and 2
VIII)Miscellaneous Theoretical questions based on Unit 3 and 4

T.Y. B.Sc. Maths **Course: S.Mat.5.AC.01**

Title: COMPUTER PROGRAMMING AND SYSTEM ANALYSIS (JAVA PROGRAMMING & SSAD)

Learning Objectives:

1. To learn about OOP through java programming
2. Intro. to DBMS & RDBMS, SQL Commands & Functions, and C-languag

UNIT 1

Java Programming

(20 lectures)

Introduction to JAVA Programming

What is java, history of java, different types of java programmes, java virtual machine, JDK tool.

Object oriented programming

Object oriented approach, Object oriented programming, objects and classes, behavior and attributes, fundamental principles of OOPs (encapsulation, inheritance – polymorphism. data abstraction).

Java Basics (Data Concepts)

Variables and data types, declaration variables, literals. numeric literals, Boolean literal, character literals, string literals, keywords, type conversion and casting ,shift operators.

Java Operators

Assignment operator, arithmetic operators ,relational operators, logical operators, bitwise operators , incrementing and decrementing operators , conditional operator, precedence and order of evaluation, statement and expressions

Exception handling

Command line arguments, Parsing , try – catch blocks , types of exception & how to handle them.

Loops and Controls

Control statement for decisions making: selection statements (if statement, if- else statement, if-else - if statement, switch statement), goto statement ,looping (while loop and do while loop and for loop), nested loops, breaking out of loops(break and continue statements),
return statement.

Introduction to Classes and Methods

Defining classes, creating- instance and class variables, creating objects of a class, accessing instance variables of a class, Creating methods, naming methods, accessing methods of class, constructor methods, overloading methods.

UNIT 2

Structured System Analysis and Design: **(05 lectures)**

What is a system, characteristics system, types of information system – Transaction Processing System (TPS), Management Information System (MIS), Decision Support System (DSS).

System Development Strategies

System Development Life Cycle (SDLC) method. Structured analysis development method. Element of structured analysis – Data Flow Diagrams (DFD), data dictionary.

Tools for determining System Requirements

What is requirement determination. fact finding techniques tools for documenting procedures and decisions – decision tree, decision table.

List Of Recommended Reference Books

1. Analysis and Design of Information System – James A. Senn (McGraw – Hill International Editions)------ (Chapters –1 & 3)

2. The complete reference - Java 2 :- Herbert schildt (TMH). (Chapters 1 to 7,10)

Practical:

Java programs that illustrate

I) the different types of operators
II) the concept of casting and shift operators.
III) the concept of selection statements.
IV) the concept of looping , nested loops, jumping statements
V) the concept of command line arguments ,parsing and try – catch blocks(exception handling)
VI) the concept of java class.
VII) the concept of java class that includes constructor with and without parameters.
VIII) the concept of java class that includes overloading methods

UNIT 3

SQL Commands and Functions **(16 lectures)**

Handling data

Selecting data using SELECT statement. FROM clause, WHERE clause, HAVING clause,

ORDER BY, GROUP BY, DISTINCT and ALL predicates. Adding data with INSERT statement. Changing data with UPDATE statement. Removing data with DELETE statement.
Joining Tables
Inner joins, outer joins, cross joins, union.
Functions
Aggregate functions-AVG, SUM, MIN, MAX and COUNT. Date functions - DATEADD(), DATEDIFF(), GETDATE(), DATENAME(), YEAR, MONTH, WEEK, DAY. String functions - LOWER(), UPPER(), TRIM(), RTRIM(), PATINDEX(), REPLICATE(), REVERSE(), RIGHT(), SPACE().
Creating and Altering tables
CREATE statement, ALTER statement, DROP statement.
Views
Simple views, complex views, creating and editing views.
Constraints
Types of constraints, KEY constraints, CHECK constraints, DEFAULT constraints, disabling constraints.
Indexes
Understanding indexes, creating and dropping indexes, maintaining indexes.

UNIT 4

Basics in C- Language : (09 lectures)

Program Structure
Header and body, use of comments, construction of the program.
Data Concepts
Variables, constants, and data types, declaring variables.
Simple Input/Output Operations
Character strings: printf(), scanf(), single characters: getchar(), putchar()
Operators
Assignment operators, compound assignment operators, arithmetic operators, relational operators, logical operators, increment and decrement operators, conditional operator, precedence and order of evaluation, statements and expressions.
Type conversions
Automatic and explicit type conversions.

List Of Recommended Reference Books

1. Professional SQL Server 2000 Programming - Rob Vieira, Wrox Press Ltd, Shroff Publishers & Distributors Pvt Ltd, NewDelhi.(Chapters 4-10).
2. SQL Server 2000 Black Book - Patrick Dalton & Paul Whitehead, Dreamtech Press.

Practical:

- **I)** Single table queries using operators with select columns and restricting rows of output.
- **II)** Supply queries using SELECT command.
- **III)** Supply queries using SELECT with FROM, WHERE and HAVING clauses.
- **IV)** Supply queries using SELECT with ORDER BY, GROUP BY, DISTINCT, ALL and queries along with different clauses.
- **V)** Queries using aggregate functions, string functions, date functions.
- **VI)** Creating, updating, altering and deleting tables and views.

VII) Creating tables with defaults, integrity constraints, referential integrity constraints and check constraints both at the column and table levels.