M. Sc. (Mathematics)

Course Structure & Syllabi

Department of Mathematics & Computer Science
School of Applied Sciences
Babu Banarasi Das University, Lucknow226 028

BABU BANARASI DAS UNIVERSITY, LUCKNOW

M. Sc. (Mathematics)

COURSE STRUCTURE

(Effective from 2017-18)

Course	Code	Title	Teaching			Evaluation					Credits
						Theory		Lab/Seminar/ Viva Voce/ Thesis		Total	
			L	T	P	CIA	ESE	CIA	ESE		
SEMESTER – I											
Core	MM 1101	Algebra	3	1	-	40	60	-	-	100	4
Core	MM1102	Real Analysis	3	1	-	40	60	-	-	100	4
Core	MM 1103	Topology	3	1	-	40	60	-	-	100	4
Core	MM 1104	Ordinary and Partial Differential Equations	3	1	-	40	60	-	-	100	4
Core	MM 1105	Programming in C	4	-	-	40	60	-	-	100	4
Lab	MM 1151	Programming in C Lab	-	-	2	-	-	40	60	100	1
											21
SEMESTER – II											
Core	MM 1201	Advance Algebra	3	1	-	40	60	-	-	100	4
Core	MM1202	Advance Real Analysis	3	1	-	40	60	-	-	100	4
Core	MM 1203	Functional Analysis	3	1	-	40	60	-	-	100	4
Core	MM 1204	Discrete Mathematics	3	1	-	40	60	-	-	100	4
Core	MM 1205	Numerical Analysis	3	1	-	40	60	-	-	100	4
											20

SEMESTER – III											
Core	MM 1301	Complex Analysis	3	1	-	40	60	-	-	100	4
Core	MM1302	Special Functions	3	1	-	40	60	-	-	100	4
Core	MM 1303	Differential Geometry of Manifolds	3	1	-	40	60	-	-	100	4
Core	MM 1304	Mathematical Methods	3	1	-	40	60	-	-	100	4
DSE		Discipline Specific Elective - I	3	1	-	40	60	-	-	100	4
Lab	MM S13	Seminar	-	-	-	-	-	100	-	100	1
											21
SEMESTER – IV											
Core	MM 1401	Theory of Operators	3	1	-	40	60	-	-	100	4
Core	MM1402	Fluid Mechanics	3	1	-	40	60	-	-	100	4
DSE		Discipline Specific Elective – II	3	1	-	40	60	-	-	100	4
DSE		Discipline Specific Elective - III	3	1	-	40	60	-	-	100	4
Lab	MM T14	Thesis						50	50	100	4
Lab	MM V14	Viva Voce	-	-	-	-	-	-	100	100	2
											22

Discipline Specific Elective - I

MM E1301	Probability & Statistics
MM E1302	Numerical Solution of PDE
MM E1303	Classical Mechanics
MM E1304	Graph Theory

Discipline Specific Elective - II

MM E1401	Operations Research
MM E1402	Mathematical Modeling
MM E1403	Fuzzy Mathematics
MM E1404	Structures on Even Dimensional Differentiable manifolds

Discipline Specific Elective - III

MM E14023	Artificial Intelligence
MM E14024	Dynamical System
MM E14025	Financial Mathematics
MM E14026	Structures on Odd Dimensional Differentiable manifolds

Semester	First		
Course Name	**Algebra**		
Category: Core	Code: **MM 1101**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Structure theorems of groups; Direct product, Finitely generated abelian groups, Invariants of a finite abelian group, Sylow's theorems, Groups of orders p^2, pq ([1] Chapter 8).

Module II: Ideals; Sum and direct sum of ideals, Maximal and prime ideals, Nilpotent and nil ideals, Zorn's lemma. ([1] Chapter 10).

Module III: Unique factorization domains and Euclidean domains**;**Principal ideal domains, Euclidean domains, Polynomial rings over UFD.
([1] Chapter 11).

Module IV: Ring of fraction, Ring with ore condition,Modules;Definition and examples.([1] Chapter 12 &14).

Text Book:

[1] Bhattacharya, Jain and Nagpal: Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian Edition, 1997.

References Books:

[1] I. N. Herstein: Topics in algebra, Wiley Eastern Limited, 1975.

[2] John B. Fraleigh: A first course in Abstract Algebra (3rd Edition), Narossa Publishing House.

[3] I. S. Luther and I.B.S. Passi: Algebra, Vol. I- Groups, Vol. II- Rings, Narossa Publishing House, (Vol. I -1996, Vol. II-1999).

[4] N. Jacbson: Basic Algebra, Hind. Pub. Corp, 1984.

[5] VivekSahai and VikasBist: Algebra, Narosa Publishing House, 1997.

[6] M. Artin: Algebra, Prentice-Hall of India, 1991.

Semester	First		
Course Name	**Real Analysis**		
Category: Core	Code: **MM 1102**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Metric spaces, Compact sets, Perfect sets, Connected sets ([1] Chapter 2)

Module II: Limits of functions, Continuous functions, Continuity and compactness Continuity and connectedness, Discontinuities, Monotone functions. ([1] Chapter 4)

Module III: Definition and existence of the Riemann, Stieltjes integral. Properties of theintegral.Integration of vector, valued functions. Rectifiable curves. ([1] Chapter 6)

Module IV: Sequences and series of functions: Uniform convergence, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation, Approximation of a continuous function by a sequence of polynomials. ([1] Chapter 7)

Text Book:

[1] Walter Rudin, *Principle of Mathematical Analysis* (3rd edition) McGraw-HillKgakusha, 1976, International Student Edition.

References Books:

[1] K. Knopp, *Theory and Application of Infinite Series*.

[2] T. M. Apostol, *Mathematical Analysis*, Narosa Publishing House, New Delhi, 1985.

[3] I. P. Natanson: Theory of Functions of a Real Variable, Volume 1, Frederick Pub. Co., 1964

[4] H. L. Royden: Real Analysis, McMillan Publication Co. Inc. New York.

Semester	First		
Course Name	**Topology**		
Category: Core	Code: **MM 1103**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Topological Spaces; The Definition and examples, Elementary concepts, Open bases and open subbases, Weak topologies. ([1] Chapter 3).

Module II: Compactness; Compact spaces, Products of spaces, Tychonoff's theorem and locally compact spaces, Compactness for metric spaces, Ascoli's theorem. ([1] Chapter 4).

Module III: Separation; T_1 spaces and Hausdorff spaces, Completely regular spaces and normal spaces, Urysohn's lemma and the Tietze extension theorem, The Urysohn imbedding theorem. ([1] Chapter 5).

Module IV: Connectedness; Connected spaces, The components of a spaces, Totally disconnected spaces, Locally connected spaces. ([1] Chapter 6).

Text Book:

[1] G.F. Simmon's: *Introduction to Topology and Modern Analysis*, Tata McGraw Hill Edition.

References Books:

[1] W. J. Pervin: *Foundations of General Topology*.

[2] Willard: *Topology*, Academic press.

[3] Vicker: *Topology via logic*, (School of Computing, Imperial College, London).

[4] J. R. Munkers: *Topology, A First Course*, Prentice Hall of India Pvt. Ltd.

Semester	First		
Course Name	**Ordinary and Partial Differential Eqautions**		
Category: Core	Code: **MM 1104**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Linear Second Order Equations; Initial value problem, Existence and Uniqueness by Picard's Theorem, Wronskian, Separation and comparison theorems, Poincare phase plane, Variation of parameters. ([1] Chapter 3, 4, 8, 11).

Module II: Power series solutions; Solution near ordinary and regular singular point, Convergence of the formal power series, Applications to Legendre, Bessel, Hermite, Laguerre and hypergeometric differential equations with their properties. ([1] Chapter 5,6).

Module III: Partial Differential Equations; Cauchy problems and characteristics, Classification of Second order PDE's, Reduction to canonical forms, Derivation of the equations of mathematical physics and their solutions by separation of variables.([2] Chapter 2).

Module IV: Boundary Value Problems; Sturm–Liouville system, Eigen values and eigen functions, Simple properties, Expansion in eigen functions, Green's function method.([3] Chapter 5,6).

Text Book:

[1] G. F. Simmons, *Ordinary Differential Equations with Applications and Historical Notes*. Tata McGraw Hill Edition, **2003**.
[2] I. N. Sneddon: *Theory of Partial differential equations*, McGraw-Hill, International Student Edition.
[3] R. Courant and D. Hilbert: *Methods of Mathermatical Physics*, Vol. I. & II, Tata McGraw-Hill, New Delhi, 1975.

References BooksBooks:

[1] G.F. Simmons and S.G. Krantz: *Differential Equations Theory, Technique and Practice*. (The Walter Rudin Student Series in Advanced Mathematics), Tata McGraw Hill Edition, 2006.
[2] E.A. Coddington: *An Introduction to Ordinary Differential Equations*, Prentice-Hall, Englewood Cliffs, N.J., 1961.
[3] E. A. Coddington and N. Levinson: *Theory of Ordinary Differential equations*, Tata McGraw-Hill, New Delhi.

Semester	First		
Course Name	**Programming in C**		
Category: Core	Code: **MM 1105**	Credits: 4	
L-4 T-0 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Programming environment, Strategy for designing algorithms, Top-down development, Stepwise refinement, Concept of algorithm, Flowchart.

Types of programming languages, Types of translators: Assembler, Compiler, Interpreter.

Systematic development of programs, Program writing and execution, Structured Programming Concept.

Working with Binary, Octal and hexadecimal numbers.

Introduction to C language, C Tokens: Identifiers, Keywords, Constants and Variables in C, Fundamental data types in C, integer, short, long, char, single and double precision floating point.

Module II: Storage Classes in C: Automatic, register, static, extern.

Operators and Expressions in C: Arithmetic, Relational, Logical, Assignment, Bitwise, Conditional, Increment and Decrement, Special operators such as comma, sizeof etc. Operator precedence and associativity, Mixed mode operations.

Type conversion and Type casting in C, Standard Input/Output functions: printf(), scanf(), getch(), getchar(), getche(), etc.

Control Statements: Conditional - if statement, if-else statement, nested if-else statement, else if ladder, switch statements, restrictions on switch values, Use of break and default statement with switch. Iteration - while, for and do-while loops, nesting of loops. Jump statements - use of break and continue statements.

Module III: Array, notation and representation using one dimensional, two dimensional and multi-dimensional arrays, Arrays of unknown and varying size, Sparse matrices. Searching and sorting in arrays.

Strings: String declaration and initialization, String taxonomy, String manipulation.

Structures: Utility and usage, Array of structures, Arrays within structures.

Union: Utility and usage, Union of structures. Enumerated data types.

Pointers: Introduction to Pointers, Declaration and initialization of pointer variables, Null pointer, Wild pointer, Generic pointer, Accessing the address of the variable, Pointer arithmetic, Pointers and arrays.

Dynamic Memory Allocation: Memory allocation process, Allocating a block of memory, Releasing the used space, Stack, Linked list.

Module IV: Function declaration, Function definition, Function call, Return statement, Scope of variables, Passing values between functions, Call by value and call by reference. Recursive function and their types. Pointers to functions, Declaration of a pointer to a function, Initialization of function pointers, Calling a function using a function pointer, Passing a function to another function, returning a function pointer.

Standard C library functions: Math functions, String handling functions.

The C preprocessor: Preprocessor directives, Defining and calling macros, Conditional compilation, Passing values to the compiler.

File Handling in C: Types of files, defining, opening and closing of a file, Reading data from files, Writing data to files, Multiple file handling in C, Function for selecting a record randomly.

Text Book:

[1] E Balaguruswamy, Computer Concepts and Programming in C, TataMcGraw Hill Publications
[2] Yashavant P. Kanetkar, ‖Let UsC , BPB Publications

Reference Books:

[1] Jeri R. Hanly, Elliot B.Koffman, Problem Solving and ProgramDesign in C, Pearson Addison-Wesley.
[2] BehrouzA.Computer Science-A Structured Programming Approach Using C.

Semester	First		
Course Name	**Programming in C Lab**		
Category: Lab	Code: **MM 1151**	Credits: 1	
L-0 T-0 P-2	Exam Duration: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

Suggested Lab Exercises:

1. WAP to print the sum and product of digits of an integer.
2. WAP to compute the sum of the first n terms of the following series S = 1+1/2+1/3+1/4+……
3. Write a function that checks whether a given string is Palindrome or not. Use this function to find whether the string entered by user is Palindrome or not.
4. Write a function to find whether a given no. is prime or not. Use the same to generate the prime numbers less than 100.
5. Write a program to swap two numbers using function and pointers.
6. WAP to compute the factors of a given number.
7. WAP to print a triangle of stars as follows (take number of lines from user):
   *
   ***
   *****
   ****
   ****
8. WAP to perform following actions on an array entered by the user:
   i) Print the even-valued elements
   ii) Print the odd-valued elements
   iii) Calculate and print the sum and average of the elements of array
   iv) Print the maximum and minimum element of array
   v) Remove the duplicates from the array
   vi) Print the array in reverse order
   The program should present a menu to the user and ask for one of the options. The menu should also include options to re-enter array and to quit the program.
9. WAP that prints a table indicating the number of occurrences of each alphabet in the text entered as command line arguments.
10. Write a program that swaps two numbers using pointers.
11. Write a program which takes the radius of a circle as input from the user, passes it to another function that computes the area and the circumference of the circle and displays the value of area and circumference from the main() function.
12. Write a program to find sum of n elements entered by the user. To write this program, allocate memory dynamically using malloc() /calloc() functions.
13. Write a menu driven program to perform following operations on strings:
    a) Show address of each character in string
    b) Concatenate two strings without using strcat() function.
    c) Concatenate two strings using strcat() function.
    d) Compare two strings
    e) Calculate length of the string .
    f) Convert all lowercase characters to uppercase
    g) Convert all uppercase characters to lowercase
    h) Calculate number of vowels
    i) Reverse the string

14. Given two ordered arrays of integers, write a program to merge the two-arrays to get an ordered array.
15. WAP to display Fibonacci series using iteration.
16. WAP to calculate Factorial of a number using iteration.
17. WAP to calculate GCD of two numbers .
18. Write a program which takes 10 numbers as input and search a particular number using binary search.
19. Create Matrix using arrays. Write a menu-driven program to perform following Matrix operations (2-D array implementation): a) Sum b) Difference c) Product d) Transpose .
20. Create a structure Student containing fields for Roll No., Name, Class, Year and Total Marks. Create 10 students and store them in a file.
21. Write a program to retrieve the student information from file created in previous question and print it in following format:
    Roll No. Name Marks
22. Copy the contents of one text file to another file, after removing all whitespaces.
23. Write a function that reverses the elements of an array in place. The function must accept only one pointer value and return void
24. Write a program that will read 10 integers from user and store them in an array. Implement array using pointers. The program will print the array elements in ascending and descending order.
25. Write a C Program to illustrate reading of data from a File.
26. Write a C Program delete a specific line from a Text File.
27. Write a C Program to append the content of one File at the end of another.
28. Write a C Program to evaluate polynomial f(x) = a4x + a x 3 + a x 2 + a1x + a0, for a given value of x and its coefficients using Horner's method.
29. Write a C program that reads N integer numbers and arrange them in ascending order using Bubble Sort.
30. Given two university information files "studentname.txt" and "usn.txt" that contains students Name and USN respectively. Write a C program to create a new file called "output.txt" and copy the content of files "studentname.txt" and "usn.txt" into output file in the sequence show. Display the contents of output file "output.txt" on to the screen.

Semester	Second		
Course Name	**Advance Algebra**		
Category: Core	Code: **MM 1201**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

SYLLABUS

Module I: Algebraic extensions of fields; Irreducible polynomials and Eisenstein criterion, Adjunction of roots-Algebraic extensions, Algebraically closed fields. ([1] Chapter 15).

Module II: Normal and separable extensions;Splitting fields, Normal extensions, Multiple roots, Finite fields-Separable extensions. ([1] Chapter 16).

Module III: Galois theory;Automorphism groups and fixed fields, Fundamental theorem of Galois theory, Fundamental theorem of Algebra. ([1] Chapter 17).

Module IV: Roots of unity, Polynomials solvable by radicals, Ruler and Compass constructions. ([1] Chapter 18).

Text Book:

[1] Bhattacharya, Jain and Nagpal: *Basic Abstract Algebra* (2nd Edition), Cambridge University Press, Indian Edition, 1997.

References Books:

[1] I.N. Herstein: *Topics in Algebra*, Wiley Eastern Limited, 1975.

[2] John B. Fraleigh: *A first course in Abstract Algebra*, (3rd Edition), Narossa Publishing House.

[3] I.S. Luther and I.B.S. Passi: *Algebra*, Vol. I- Groups, Vol. II- Rings, Narossa Publishing House, (Vol. I -1996, Vol. II-1999).

[4] N. Jacbson: *Basic Algebra*, Hind. Pub. Corp, 1984.

[5] VivekSahai and VikasBist: *Algebra*, Narosa Publishing House, 1997.

[6] M. Artin: Algebra, Prentice-Hall of India, 1991.

Semester	Second		
Course Name	**Advance Real Analysis**		
Category: Core	Code: **MM 1202**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

Syllabus

Module I: Algebra of sets, Borel sets, Outer measure, Measurable sets and Lebesgue measure, A non-measurable set, Measurable functions, Little word's three principles. ([1] Chapter 3).

Module II: The Lebesgue integral of a bounded function over a set of finite measure, The integral of a non-negative function, The general Lebesgue integral. ([1] Chapter 4).

Module III: Convergence in measure, Differentiation of a monotone functions, Functions of bounded variation. ([1] Chapter 5).

Module IV: Differentiation of an integral, Absolute continuity, The Lp-spaces, The Minkowski and Holder's inequalities, Convergence and completeness. ([1] Chapter 4 & 5).

Text Book:

[1] H. L. Royden: *Real Analysis* , Pearson Education (3rd Edition) (Low Price Edition).

References BooksBooks:

[1] P. R. Halmos: *Measure Theory*, Van Nostrand, 1950.

[2] G. de Barra: *Measure Theory and Integration*, Wiley Eastern, 1981.

[3] E. Hewitt and K. Stromberg: *Real and Abstract Analysis*, Springer, 1969.

[4] P. K. Jain and V. P. Gupta: *Lebesgue Measure and Integration*, New Age International, New Delhi, 2000.

[5] Walter Rudin: *Principle of Mathematical Analysis* (3rd edition) McGraw-Hill

Kogakusha, International Student Edition, 1976.

Semester	Second		
Course Name	**Functional Analysis**		
Category: Core	Code: **MM 1203**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

Syllabus

Module I: Banach Spaces; The definition and some examples, continuous linear transformations,The Hahn-Banach theorem.([1] Chapter 9).

Module II: The natural imbedding of N in N**, the open mapping theorem,the conjugate of anoperator.([1] Chapter 9).

Module III: Hilbert spaces; The definition and some simple properties, Orthogonalcomplements,orthogonal sets, the conjugate space H*.([1] Chapter 10).

ModuleIV: The adjoint of an operator, Self adjoint operators, normal and unitaryoperators,Projections. Finite dimensional spectral theory; Spectrum of an operator, the spectral theorem.([1] Chapter 10& 11).

Text Book:

[1] G F Simmons: Introduction to Topology & Modern Analysis (McGraw Hill).

References Books:

[1] B.V.Limaye: *Functional Analysis*, 2nd Edition.

[2] A. L. Brown and Page: Elements of Functional Analysis.

[3] P.K.Jain, O.P.Ahuja and Khalil Ahmed: Functional Analysis.

[4] G. Bachman and Narici: Functional Analysis, Academic Press, 1964.

[5] E.Kreyszig: Introductory Functional Analysis, John-wiley and Sons, New York, 1978.

Semester	Second		
Course Name	**Discrete Mathematics**		
Category: Core	Code: **MM 1204**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

Syllabus

Module I: Lattices; Partial Ordering, Lattices as Posets, Some properties of Lattices, Lattices as Algebraic Systems, Sublattices, Direct products and Homomorphisms, Some special Lattices, Complete, Complemented and distributive lattices. ([1] Chapter 2, 4).

Module II: Boolean Algebra; Boolean Algebras as Lattices, Bolean Identities, The switching Algebra, Sub algebra, Direct product and homomorphism, Join irreducible elements, Atoms (minterms), Boolean forms and their equivalence, minterm Boolean forms, Sum of products canonical forms, Values of Boolean expressions and Boolean functions, Minimization of Boolean functions, The Karnaugh map method.([1] Chapter 4).

Module III: Graphs And Planer Graphs**;**Directed and undirected graphs, Isomorphism of graphs,Subgraph, Complete graph, Multigraphs and weighted graphs, Paths, Simple and elementary paths, Circuits, Connectedness, Shortest paths in weighted graphs, Eulerian paths and circuits, Incoming degree and outgoing degree of a vertex, Hamiltonian paths and circuits, Planar graphs, Euler's formula for planar graphs. ([2] Chapter 4).

Module IV: Trees And Cut-Sets; Properties of trees, Equivalent definitions of trees, Rooted trees, Binary trees, Path lengths in rooted trees, Prefix codes, Binary search trees, Spanning trees and Cut-sets, Minimum spanning trees. ([2] Chapter 5).

Text Books:-

[1] J P Tremblay and R. Manohar: *Discrete Mathematical Structures with applications to Computer Science*, McGraw Hill Book Company.

[2] C. L. Liu and D P Mohapatra: *Elements of Discrete Mathematics*, Tata McGraw Hill Publishing Company Ltd. New Delhi.

Semester	Second		
Course Name	**Numerical Analysis**		
Category: Core	Code: **MM 1205**	Credits: 4	
L-3 T-1 P-0	Theory Exam: 3 Hrs	ESE: 60 Marks	CIA: 40 Marks

Syllabus

Module I: Transcendental & Polynomial Equations; Bisection method, Iteration methods based on First degree equation (Secant method, RegulaFalsi method, Newton Raphson method), Rate of Convergence, Iteration methods, Birge –Vieta method, Bairstow method. ([1] Chapter 2).

Module II: System of Linear Algebraic Equations and Eigen Value Problems; Iteration methods (Jacobi iteration method, Gauss seidel iteration method), Convergence analysis, Matrix factorization methods (Doo little reduction, Crout reduction), Eigen values and eigenvectors, Householder's method for symmetric matrices, Power method. ([1] Chapter 4, 5).

Module III: Finite difference operators, Newton's formulae forinterpolation, Gauss formula for Interpolation, Lagranges and Newtons divided difference formulae for interpolation, Numerical differentiation; Methods based on interpolation, Numerical integration; Newton cotes methods, Trapezoidal rule, Simpson's 1/3 rd, 3/8thrule. ([1] Chapter 6).

Module IV: Numerical Solution of Differential Equations; Euler's method, Analysis of Euler's method, Backward Euler's method, Order of Euler's method, Explicit Runge–Kutta method of order two and four, Taylor series method, Convergence and stability of numerical methods. ([1] Chapter 3, 7).

Text Book:

[1] M. K. Jain, S. R. K. Iyengar and R. K. Jain: *Numerical methods for scientific and Engineering Computation*, New Age International Limited Publishers, 2012.

References Books:

[1] M. K. Jain: *Numerical Mathematics, Numerical solutions of Differential Equations*.

[2] S. S. Sastry: *Introductory methods of Numerical Analysis*, Prentice Hall of India New Delhi