Dr. Ram Manohar Lal Avadh University Faizabad
Syllabus of B.A. /B.Sc. Mathematics (for affiliated colleges)

B.A.I /B.Sc. I (Mathematics)
(From 2018-19 onwards)

There shall be three compulsory papers as follows-

Paper I: Algebra and Trigonometry	Marks: 65
Paper II: Calculus	Marks: 65
Paper III: Geometry and Vector Calculus	Marks: 70

B.A.II /B.Sc. II (Mathematics)
(From 2019-20 onwards)

There shall be three compulsory papers as follows-

Paper I: Linear Algebra and Matrices	Marks: 65
Paper II: Differential Equations and Integral Transforms	Marks: 65
Paper III: Mechanics	Marks: 70

B.A.III /B.Sc. III (Mathematics)
(From 2020-21 onwards)

There shall be three compulsory, one optional and one practical as follows-

Paper I: Real Analysis	Marks: 60
Paper II: Complex Analysis	Marks: 60
Paper III: Numerical Analysis and Programming in C	Marks: 60
Paper IV: Optional Paper- Any **one** of the following papers:	
Paper IV(a) : Number Theory and Cryptography	Marks: 60
Paper IV(b) : Linear Programming	Marks: 60
Paper IV(c) : Differential Geometry and Tensor Analysis	Marks: 60
Paper IV(d) : Discrete Mathematics	Marks: 60
Paper V: **Practical**	Marks: 60

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B.A.III /B.Sc.III (Mathematics)
(From 2020-21 onwards)

Paper I: Real Analysis **Marks: 60**

Unit 1. Axiomatic study of real numbers, Bounded set, Archimedean property , Completeness property in R, Denseness property, Countable and uncountable sets, Neighbourhood, Interior points, Interior set, Open sets, Limit points, Derived set, Closed sets, Closure set, Dense sets, Perfect sets , Bolzano-Weierstrass theorem.

Unit 2. Sequential continuity, Boundedness and intermediate value properties of continuous functions, Uniform continuity, Meaning of sign of derivative, Darboux theorem. Limit and continuity of functions of two variables, Taylor's theorem for functions of two variables, Maxima and minima of functions of three variables, Lagrange's method of undetermined multipliers.

Unit 3. Riemann integral, Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, Mean value theorems of integral calculus, Improper integrals and their convergence, Comparison test, μ-test, Abel's test, Dirichlet's test.

Unit 4. Uniform convergence of sequences and series of functions. Cauchy's Convergence, Weierstrass M-test, M_n -test, Abel's and Dirichlet's tests. Weierstrass approximation theorem.

Unit 5. (Metric space) Definition and examples of metric spaces, Neighbourhoods, Interior points, Exterior points, Frontier points, Boundary points, Limit points, Open and closed sets, Subspaces, Convergent and Cauchy sequences, Completeness, Cantor's intersection theorem.

B.A.III /B.Sc.III (Mathematics)

Paper II: Complex Analysis **Marks: 60**

Unit 1. Functions of a complex variable, Concepts of limit, continuity and differentiability of complex functions, Analytic functions, Cauchy- Riemann equations (Cartesian and polar form), Harmonic functions, Orthogonal system, Power series as an analytic function.

Unit 2. Elementary functions, Mapping by elementary functions, Linear and bilinear transformations, Fixed points, Cross ratio, Inverse points and critical points. Conformal transformations.

Unit 3. Complex Integration, Line integral, Cauchy's fundamental theorem, Cauchy's integral formula, Morera's theorem, Liouville theorem, Maximum Modulus theorem, Taylor and Laurent series.

Unit 4. Singularities and zeros of an analytic function, Rouche's theorem, Fundamental theorem of algebra, Analytic continuation.

Unit 5. Residue theorem and its applications to the evaluation of definite integrals, Argument principle.

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Paper III: Numerical Analysis and Programming in C **Marks: 60**

Numerical Analysis

Unit 1. Shift operator, Forward and backward difference operators and their relationships, Fundamental theorem of difference calculus, Interpolation, Newton-Gregory's forward and backward interpolation formulae.

Unit 2. Divided differences, Newton's divided difference formula, Lagrange's interpolation formula, Central differences, Formulae based on central differences: Gauss, Striling's, Bessel's and Everett's interpolation formulae. Numerical differentiation.

Unit 3. Numerical integration, General quadrature formula, Trapezoidal and Simpson's rules, Weddle's rule, Cote's formula, Numerical solution of first order differential equations: Euler's method, Picard's method, Runge-Kutta method and Milne's method, Numerical solution of linear, homogeneous and simultaneous difference equations, Generating function method.

Unit 4. Solution of transcendental and polynomial equations by iteration, bisection, Regula-Falsi and Newton-Raphson methods, Algebraic eigen value problems: Power method, Jacobi's method, Given's method, Householder's method and Q-R method.

Programming in C

Unit 5. Programmer's model of computer, Algorithms, Data type, Arithmetic and input/out instruction, Decisions, Control structures. Decision statements, Logical and conditional operators, Loop case control structures, Functions, Recursion, Preprocessors, Arrays, Puppetting of strings Structures, Pointers, File formatting.

B.A.III /B.Sc.III (Mathematics)

Paper IV (a): NUMBER THEORY and CRYPTOGRAPHY **Marks: 60**

Unit 1. Divisibility. gcd, lcm, prime numbers, fundamental theorem of arithmetic, perfect numbers, floor and ceiling functions, Congruence' properties, complete and reduced residue systems, Fermat's theorem, Euler functions, Chinese remainder theorem.

Unit 2. Primaliry testing and factorization algorithms, Pseudo-primes, Fermat's pseudo-primes, Pollard's rho method for factorization.

Unit 3. Introduction to cryptography Attacks, services and mechanisms, Security services, Conventional encryption - Classical techniques: Model, Stegnanography, Classical encryption technique, Modem techniques. DES, cryptanalysis, block cipher principles and design, Key distribution problem, Random number generation.

Unit 4. Hash functions, Public key cryptography, Diffie-Hellmann key exchange, Discrete logarithm-based crypto-systems, RSA crypto-system, Signature schemes, Digital signature standard (DSA), RSA signature schemes, Knapsack problem.

Unit 5. Elliptic curve cryptography: Introduction to elliptic curves, Group structure, Rational points on elliptic curves, Elliptic curve cryptography, Applications in cryptography and factorization, Known attacks.

B.A.III /B.Sc.III (Mathematics)

Paper IV (b): LINEAR PROGRAMMING **Marks: 60**

Unit 1. Linear programming problems, Statement and formation of general linear programming problems, Graphical method, Slack, and surplus variables, Standard and matrix forms of linear programming problem, Basic feasible solution.

Unit 2. Convex sets, Fundamental theorem of linear programming, Simplex method, Artificial variables, Big-M method, Two phase method.

Unit 3. Resolution of degeneracy, Revised simplex method, Sensitivity "Analysis.

Unit 4. Duality in linear programming problems, Dual simplex method, Primal-dual method Integer programming.

Unit 5. Transportation problems, Assignment problems.

B.A.III /B.Sc.III (Mathematics)

Paper IV (c): DIFFERENTIAL GEOMETRY and TENSOR ANALYSIS **Marks: 60**

Differential Geometry

Unit 1. Local theory of curves- Space curves, Examples, Plane curves, tangent and normal and binormal, Osculating plane, normal plane and rectifying plane, Helices, Serret-Frenet apparatus, contact between curve and surfaces, tangent surfaces, involutes and evolutes of curves, Intrinsic equations, fundamental existence theorem for space curves, Local theory of surfaces- Parametric patches on surface curve of a surface, surfaces of revolutions, Helicoids, metric-first fundamental form and arc length.

Unit 2. Local theory of surfaces (Contd.), Direction coefficients, families of curves, intrinsic properties. geodesics, canonical geodesic equations, normal properties of geodesics, geodesics curvature, geodesics polars, Gauss-Bonnet theorem, Gaussian curvature, normal curvature, Meusneir's theorem, mean curvature, Gaussian curvature, umbilic points, lines of curvature, Rodrigue's formula, Euler's theorem.

Unit 3. The fundamental equation of surface theory - The equation of Gauss, the equation of Weingarten, the Mainardi-Codazzi equation, Tensor algebra: Vector spaces, the dual spaces, tensor product of vector spaces, transformation formulae, contraction, special tensor, inner product, associated tensor.

Unit 4. Differential Manifold-examples, tangent vectors, connexions, covariant differentiation. Elements of general Riemannian geometry-Riemannian metric, the fundamental theorem of local Riemannian Geometry, Differential parameters, curvature tensor, Geodesics, geodesics curvature, geometrical interpretation of the curvature tensor and special Riemannian spaces.

Tensor Analysis

Unit 5. Contravariant and covariant vectors and tensors, Mixed tensors, Symmetric and skew-symmetric tensors, Algebra of tensors, Contraction and inner product, Quotient theorem, Reciprocal tensors, Christoffel's symbols, Covariant differentiation, Gradient, divergence and curl in tensor notation.

B.A.III /B.Sc.III (Mathematics)

Paper IV (d): DISCRETE MATHEMATICS **Marks: 60**

Unit 1. Propositional Logic - Proposition logic, basic logic, logical connectives, truth tables, tautologies, contradiction, normal forms (conjunctive and disjunctive), modus ponens and modus tollens, validity, predicate logic, universal and existential quantification. Method of Proof - Mathematical induction, proof by implication, converse, inverse, contrapositive, negation, and contradiction, direct proof by using truth table, proof by counter example.

Unit 2. Relation - Definition, types of relation, composition of relations, domain and range of a relation, pictorial representation of relation, properties of relation, partial ordering relation.

Posets, Hasse Diagram and Lattices - Introduction., ordered set, Hasse diagram of partially ordered set, isomorphic ordered set, well ordered set, properties of lattices, and complemented lattices.

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Boolean Algebra - Basic definitions, Sum of products and product of sums, Logic gates and Karnaugh maps.

Unit 3. Graphs - Simple graph, multi graph, graph terminology, representation of graphs, Bipartite, regular, planar and connected graphs, connected components in a graph, Euler graphs, Hamiltonian path and circuits, Graph colouring, chromatic number, isomorphism and homomorphism of graphs.
Tree - Definition, Rooted tree, properties of trees, binary search tree, tree traversal.

Unit 4. Combinatorics - Basics of counting, permutations, combinations, inclusion-exclusion, recurrence relations (nth order recurrence relation with constant coefficients, Homogeneous recurrence relations, Inhomogeneous recurrence relations), generating function (closed form expression, properties of G.F., solution of recurrence relation using, G.F, solution of combinatorial problem using G.F.).

Unit 5. Finite Automata - Basic concepts of automation theory, Deterministic finite automation (DFA), transition function, transition table, Non deterministic finite automata (NDFA), Mealy and Moore machine. Minimization of finite automation.

B.A.III-/B.Sc.III (Mathematics)

~~Paper V: Practical~~ ~~Marks: 60~~

B.A.III /B.Sc.III (Mathematics)

Paper V: Practical **Marks: 60**

There shall be two programs(one from section A and other from section B) of 40 marks and viva of 20 marks .

Section-A :List of Practicals (using any software)

1. Plotting of graphs of function e^{ax+b}, log(ax + b), 1/(ax + b), sin(ax + b), cos(ax + b), |ax + b| and be able to find the effect of a and b on the graph.
2. Tracing of conics in Cartesian coordinates/ polar coordinates
3. Sketching parametric curves (Eg. Trochoid, cycloid, epicycloids, hypocycloid).
4. Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic paraboloid,hyperbolic paraboloid using Cartesian co-ordinates.
5. Matrix operation (addition, multiplication, inverse, transpose).
6. Plotting of second order solution family of differential equation.
7. Plotting of recursive sequences.
8. Study the convergence of sequences through plotting.
9. Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + ————→ 1/ N.
10. To find the absolute value of an integer.
11. Enter 100 integers into an array and sort them in an ascending order.
12. Bisection Method.
13. Newton Raphson Method
14. Newton Interpolation
15. Simpson's rule

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Section-B : List of Practicals (using C Program)

1. WAP to print the sum and product of digits of an integer.
2. WAP to reverse a number.
3. WAP to compute the sum of the first n terms of the following series
S = 1+1/2+1/3+1/4+.....
4. WAP to compute the sum of the first n terms of the following series
S =1-2+3-4+5.....
5. 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.
6. Write a function to find whether a given no. is prime or not. Use the same to generate the prime numbers less than 100.
7. WAP to compute the factors of a given number.
8. Write a macro that swaps two numbers. WAP to use it.
9. WAP to print a triangle of stars as follows (take number of lines from user):

*
***
*****

10. Write a program that swaps two numbers using pointers.
11. Write a program in which a function is passed address of two variables and then alter its contents
12. 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.
13. WAP to display Fibonacci series (i)using recursion, (ii) using iteration
14. WAP to calculate Factorial of a number (i)using recursion, (ii) using iteration
15. WAP to calculate GCD of two numbers (i) with recursion (ii) without recursion.