PROF. RAJENDRA SINGH (RAJJU BHAIYA) UNIVERSITY, PRAYAGRAJ

PROPOSED STRUCTURE

AND

DETAILED SYLLABUS

FOR

PROGRAM: M.A./M.Sc.

SUBJECT: MATHEMATICS

Session: 2022-2023 onwards

PROF. RAJENDRA SINGH (RAJJU BHAIYA) UNIVERSITY, PRAYAGRAJ

Structure of Syllabus

Program: M.A./M.Sc. Subject: Mathematics

Structure of Syllabus Developed by			
Name of BoS Convener/BoS Member	**Designation**	**Department**	**College/ University**
Prof. Archana Sinha	Professor & Convener		K. A. P.G. College, Prayagraj
Prof. P.K. Singh	Professor & Subject Expert- Member	Department of Mathematics	University of Allahabad
Dr. B. K. Sharma	Assistant Professor & Subject Expert-Member	Department of Mathematics	University of Allahabad
Dr. Sapna Devi	Assistant Professor & Subject Expert-Member	Department of Mathematics	University of Allahabad
Dr. Iftekhar Ahamad Ansari	Assistant Professor & Member	Department of Mathematics	H.N.B Govt. P. G. College, Prayagraj
Dr. Rajendra Prasad	Assistant Professor & Member	Department of Mathematics	Govt. P. G. College, Saidabad, Prayagraj

Course Code		**Course Title**	**Credits**	**T/P**	**Evaluation**	
					CIE	**ETE**
A	B	C	D	E	F	G
SEMESTER I (YEAR I)						
B030701T	CORE	Algebra I	5	T	25	75
B030702T	CORE	Analysis	5	T	25	75
B030703T	CORE	Differential Geometry	5	T	25	75
B030704T	FIRST ELECTIVE (Select any one)	Partial Differential Equations and Integral Equations	5	T	25	75
B030705T		Basic Number Theory				
B030706P	SECOND ELECTIVE (Select any one)	Project Presentation	4	P	50	50
B030707P		Computational Techniques using C				
SEMESTER II (YEAR I)						
B030801T	CORE	Algebra II	5	T	25	75
B030802T	CORE	Topology	5	T	25	75
B030803T	CORE	Classical Mechanics	5	T	25	75

B030804T	THIRD ELECTIVE (Select any one)	Tensors and Riemannian Geometry	5	T	25	75
B030805T		Hydrodynamics				
B030806P	FOURTH ELECTIVE (Select any one)	Project Presentation	4	P	50	50
B030807P		Introduction to Latex				
SEMESTER III (YEAR II)						
B030901T	CORE	Measure and Integration	5	T	25	75
B030902T	CORE	Ordinary Differential Equations and Boundary Value Problems	5	T	25	75
B030903T	CORE	Differential Geometry of Manifolds	5	T	25	75
B030904T	FIFTH ELECTIVE (Select any one)	Mathematical Modelling	5	T	25	75
B030905T		Advanced Linear Algebra				
B030906P	SIXTH ELECTIVE (Select any one)	Project presentation based on Survey/Seminar/Assignment	4	P	50	50
B030907P		Introduction to SCILAB/ MATLAB				
SEMESTER IV (YEAR II)						
B031001T	CORE	Functional Analysis	5	T	25	75
B031002T	CORE	Advanced Fluid Mechanics	5	T	25	75
B031003T	SEVENTH ELECTIVE (Select any one)	Wavelets	4	T	25	75
B031004T		Representation Theory of Finite Groups				
B031005T		Algebraic Number Theory				
B031006T		Special Functions				
B031007T		Galois Theory				
B031008R	RESEARCH PROJECT/ DISSERTATION	Major Research Project/ Dissertation	10	R	50	50

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Detailed Syllabus for

Program: M.A./M.Sc. Subject: MATHEMATICS
(w.e.f. 2022-23)

M.A./M.Sc. SEMESTER I (YEAR I)

PAPER-I: ALGEBRA-I

Unit-I: Life and Contributions of Srinivasa Ramanujan.
Isomorphism theorems for groups, Symmetric and alternating groups, Dihedral groups, Normal subgroups of Sn and A_n, Internal and external direct products of groups, Indecomposable groups.

Unit-II: Action of a group on a set, Stabilizer subgroups and orbit decomposition, core of a subgroup, class equation of an action, Sylow's first, second and third theorems, Applications of Sylow's theorems, Groups of order pq.

Unit-III: Composition series of a group, Commutator series of groups, Solvable groups, Solvability of finite p-groups, Upper and lower central series of groups, Nilpotent groups, Structure theorem of finite abelian groups.

Unit-IV: Factorization in integral Domains, Primes and irreducible elements, Euclidean domains, Principal ideal domains, Unique factorization domains, gcd, Polynomial rings over domains, Chinese remainder theorem, Eisenstein's irreducibility criterion, Unique factorization in polynomial rings over UFD.

Unit-V: Modules over ring, Submodules, Module homomorphisms and quotient modules, isomorphism theorems and correspondence theorem, Internal and external direct sums, Exact sequences, Split exact sequences, Five lemma.

Books Recommended:

1. Ramji Lal, Algebra I, Infosys Foundation Series in Mathematical Sciences, Springer, 2017.
2. V. Sahai and V. Bist, Algebra, Narosa Publishing House, 2008.
3. D. S. Dummit and R. M. Foote, Abstract Algebra, Wiley, 2002.
4. J. A. Gallian, Contemporary Abstract Algebra, Cengage India Pv. Ltd., 2019
5. T. W. Hungerford, Algebra, Springer, 1974.
6. R. Kanigel, The Man Who Know Infinity, C. Scribner's, 1991.
7. Suggested digital platforms: NPTEL/SWAYAM/MOOCS.

PAPER-II: ANALYSIS

Unit-I: Equivalent sets, Countable and uncountable sets, Uncountability of $\mathbb{R}$ and P(N), Cardinality and cardinal arithmetic, Schröder-Bernstein theorem, Euclidean space $\mathbb{R}^n$, Structure of open sets in $\mathbb{R}$, Bolzano-Weierstrass theorem, Cantor intersection theorem.

Unit-II: Pointwise and uniform convergences of sequence and series of functions, Cauchy's criterion for uniform convergence, Weierstrass M-test, Abel's and Dirichlet's tests for uniform convergence, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation, Statements of Weierstrass approximation theorem and Abel's limit theorem.

Unit-III: Partial derivatives, direcional derivatives and total derivatives of functions of several real variables, Chain rule, Mean value theorems, Taylor's theorems, Jacobian, Inverse function theorem and Implicit function Theorem.

Unit-IV: Evaluation of improper integral and integrals of trigonometric functions by contour integration, Zeros of analytic functions, Identity theorem for analytic functions, Maximum modulus theorem, Schwarz' lemma, Argument principle, Rouche's theorem, Open mapping theorem,

Unit-V: Hurwitz's Theorem, Infinite products, Weierstrass' factorization theorem, Mittag-Leffler's Theorem, Gamma function and its properties, The Riemann zeta function, Order and genus of entire functions, Hadamard's factorization theorem.

Books Recommended:

1. Rudin, W., Principles of Mathematical Analysis, 3rd ed., McGraw-Hill, 1983.
2. Apostol, T., Mathematical Analysis, 2nd ed., Narosa Publishing House , 2002.
3. Ponnusamy, S., Foundations of Complex Analysis, 2nd ed., Narosa Publishing House, 2005.
4. Conway, J. B. , Functions of One Complex Variable, 2nd ed., Narosa Publishing House, 2000.
5. Suggested digital platforms: NPTEL/SWAYAM/MOOCS.

PAPER-III: DIFFERENTIAL GEOMETRY

UNIT I: Curves in space R^3, parameterized curves, regular curves, helices, arc length, reparametrization (by arc length), tangent, principal normal, binormal, osculating plane, normal plane, rectifying plane, curvature and torsion of smooth curves, Frenet-Serret formulae, Frenet approximation of a space curve.

UNIT II: Osculating circle, osculating sphere, spherical indicatrices, involutes and evolutes, intrinsic equations of space curves, isometries of R^3, fundamental theorem of space curves, surfaces in R^3, regular surfaces, co-ordinate neighborhoods, parameterized surfaces, change of parameters, level sets of smooth functions on R^3, surfaces of revolution, tangent vectors, tangent plane, differential of a map.

UNIT III: Normal fields and orientability of surfaces, angle between two intersecting curves on a surface, Gauss map and its properties, Weingarten map, second and third fundamental forms, classification of points on a surface.

UNIT IV: Curvature of curves on surfaces, normal curvature, Meusnier theorem, principal curvatures, geometric interpretation of principal curvatures, Euler theorem, mean curvature, lines of curvature, umbilical points, minimal surfaces, definition and examples, Gaussian curvature, intrinsic formulae for the Gaussian curvature, isometries of surfaces, Gauss Theorem Egregium (statement only).

UNIT V: Christoffel symbols, Gauss formulae, Weingarten formulae, Gauss equations, Codazzi-Mainardi equations, curvature tensor, geodesics, geodesics on a surface of evolution, geodesic curvature of a curve, Gauss-Bonnet Theorem (statement only).

Books Recommended:

1. M. P. Do Carmo, Differential Geometry of Curves and Surfaces, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1976.
2. B. O' Neill, Elementary Differential Geometry, Academic Press, 1997.
3. A. Pressley, Elementary Differential Geometry, Springer (Undergraduate Mathematics Series), 2001.
4. D. Somasundaram, Differential Geometry, A First Course, Narosa Publishing House, New Delhi, 2005.
5. Suggested digital platforms: NPTEL/SWAYAM/MOOCS.

PAPER-IV: Any one of the following :

PAPER-IV(a): PARTIAL DIFFERENTIAL EQUATIONS AND INTEGRAL EQUATIONS

Unit-I: Preliminaries of PDE's, Linear PDE's with constant coefficients, Reduction to canonical forms, Classification of second order P.D.E.'s.

Unit-II: Method of separation of variables: Laplace, Diffusion and Wave equations in Cartesian, cylindrical and spherical polar coordinates, D'Alembert and Riemann-Volterra solutions of one-dimensional wave equation.

Unit-III: Boundary value problems for transverse vibrations of strings and heat diffusion in a finite rod, Non-linear PDE's of second order: Monge's method of solution.

Unit-IV: Classification of linear integral equations: Volterra and Fredholm integral equations, Relation between differential and integral equations,Conversion of initial and boundary value problems into integral equations; Conversion of integral equations into differential equations

Unit-V: Fredholm equations of second kind with separable kernels, Fredholm alternative theorem, Eigen values and eigen functions, Method of successive approximation for Fredholm and Volterra equations, Neumann's Series, Resolvent kernel.

Books recommended:

1. I.N. Sneddon: Elements of Partial Differential Equations, McGraw-Hill Pub.,1957.
2. T. Amaranath: An Elementary Course in Partial Differential Equations, Narosa Pub. 2005.
3. R.P. Kanwal: Linear Integral Equations, Birkhauser Verlag Pub.,1997.

4. Suggested digital platforms: NPTEL/SWAYAM/MOOCS.

PAPER-IV(b): BASIC NUMBER THEORY

Unit-I: Fundamental theorem of arithmetic, Arithmetic functions, Dirichlet product of arithmetic functions, Ring of Arithmetic functions, Multiplicative arithmetic functions, Multiplicativity of $\sigma(n)$, $\tau(n)$, $\phi(n)$ and $\mu(n)$, Möbius inversion formula and its applications.

Unit-II: Quadratic residues, Euler's criterion, The Legendre symbol and its properties, Gauss lemma, Guass quadratic reciprocity law, Quadratic congruences with composite moduli.

Unit-III: Primitive roots, Structure of groups U_n of units modulo n, Existence of primitive roots, Representation of integers as sum of squares.

Unit-IV: Finite continued fractions, Infinite continued fractions, Approximations to irrational numbers, Periodic continued fractions, Pell's equation.

Unit-V: Algebraic Numbers, Algebraic number fields, Algebraic integers, Quadratic fields, Units and primes in quadratic fields, Euclidean quadratic fields, Primes in quadratic fields having unique factorization property.

Books Recommended:

1. D. M. Button, Elementary Number Theory, 7th edition, McGraw Hill Education, 2017
2. I. Niven, H. S. Zuckerman and H. L. Montgomery, An introduction to the Theory of Numbers, John Wiley and Sons, Inc., 2008.
3. Ramji Lal, Algebra I, Infosys Foundation Series in Mathematical Sciences, Springer, 2017.
4. K. Ireland and M. Rosen, A Classical Introduction to Modern Number Theory, ,GTM-84, Springer, 1990.
5. Suggested digital platforms: NPTEL/SWAYAM/MOOCS.

PAPER-V: Any one of the following

PAPER-V(a): PROJECT PRESENTATION

PAPER-IV(b): Computational Techniques Using C