Choice based Credit System (CBCS)

Scheme and course structure for

M.A/M.Sc Mathematics 1st semester effective from academic session 2014 and onwards

Course Code	***Course Name***	***Credits***
MM14101CR	Advanced Abstract Algebra-I	4
MM14102CR	Real Analysis-I	4
MM14103CR	Topology	4

OPTIONAL COURSES (SEMESTER –I)

Course Code	***Course Name***	***Credits***
MM14104EA	Theory of Numbers-I	4
MM14105EA	Matrix Algebra	4
MM14106EA	Computational Mathematics	4
MM14107EA	Advanced Calculus	2
MM14108EA	Probability Theory	2
MM14109EO	Other Allied + Open	4

General Instructions for the Candidates

1. The two year (4 semester) PG programmes is of 96 credit weightage i.e., 24 credits/semester (24x4=96).
2. A candidate has compulsory to opt for 12 credits from the core component in each semester.
3. A candidate has a choice to opt for any 12 credits(3 papers) out of minimum of 16 credits(4 papers) offered as Electives(Allied), except for a particular semester as mentioned by the Department where a candidate is required to gain a minimum of 4 credits(1 paper) from Elective(Open) offered by any other Department.
4. A candidate has compulsorily to obtain a minimum of 4 credits (1 paper) from Elective (Open) from outside the parent Department in any of the semesters.
5. A candidate can earn more than the minimum required credits (i.e., more than 96 credits for four semester programme) which shall be counted towards the final result of the candidate.

Course No: **MM14101CR**		Max. Marks:	100
Course Name:- **Advanced Abstract Algebra-I**			
Duration of Examination: 2:30 Hrs.		External Exam:	80
No. of Credits: **04**		Internal Assessment:	20

CREDIT-I

Definitions and examples of Semi-groups and Monoids. Criteria for the semi-groups to be a group; Cyclic groups; Structure theorem for cyclic groups. Endomorphism, Automorphism, Inner Automorphism and Outer Automorphism, Center of a group, Cauchy's and Sylow's theorem for abelian groups. Permutation groups, Symmetric groups, Alternating groups, Simple groups, Simplicity of the Alternating group A_n for $n \geq 5$.

CREDIT-II

Normalizer, conjugate classes, Class equation of a finite group and its applications, Cauchy's theorem and Sylow's theorems for finite groups. Double cosets, Second and third parts of Sylow's theorem. Direct product of groups, Finite abelian groups, normal and subnormal series, Composition series. Jordan Holder theorem for finite groups. Zassenhaus Lemma, Schreir's Refinement theorem, Solvable groups.

CREDIT-III

Brief review of Rings, Integral domain, Ideals. The field of quotients of an Integral domain. Embedding of an Integral domain. Euclidean rings with examples such as $Z[\sqrt{-1}]$, $Z[\sqrt{2}]$, Principal ideal rings(PIR) Unique factorization domains(UFD) and Euclidean domains, Greatest common divisor, Lowest common multiple in rings, Relationships between Euclidean rings, P.I.R.'s and U.F.D.

CREDIT-IV

Polynomial rings: The Division algorithm for polynomials, Irreducible polynomials, Polynomials and the rational field, Primitive polynomials, Contract of a polynomials, Gauss Lemma, Integer monic polynomial, Eisenstein's irreducibility criterion, cyclotomic polynomials; Polynomial rings and Commutative rings.

Recommended Books

1. I.N.Heristein : Topics in Algebra.
2. K.S.Miller : Elements of Modern Abstract Algera.
3. Surjeet Singh and Qazi Zameer-ud-din: Modern Algebra, Vikas Publishing House Private Limited.
4. P.B,.Bhatacharaya and S.K.Jain : Basic Abstract Algebra.
5. J.B. Fragleigh : A First Course in Abstract Algebra.
6. J.A.Gallian : Contemporary Abstract Algebra.

Course No: **MM14102CR** Max. Marks: 100

Course Name:- **Real Analysis - I**

Duration of Examination: 2:30 Hrs.	External Exam: 80
No. of Credits: **04**	Internal Assessment: 20

CREDIT-I

Integration : Definition and existence of Riemann – Stieltje's integral , behavior of upper and lower sums under refinement , Necessary and sufficient conditions for RS-integrability of continuous and monotonic functions, Reduction of an RS-integral to a Riemann integral , Basic properties of RS-integrals , Differentiability of an indefinite integral of a continuous functions , The fundamental theorem of calculus for Riemann integrals .

CREDIT-II

Improper Integrals: Integration of unbounded functions with finite limit of integration. Comparison tests for convergence, Cauchy's test. Infinite range of integration. Absolute convergence. Integrand as a product of functions. Abel's and Dirichlet's test.
Inequalities: Arithmetic-geometric means equality, Inequalities of Cauchy Schwartz, Jensen, Holder &Minkowski. Inequality on the product of arithmetic means of two sets of positive numbers**.**

CREDIT-III

Infinite series: Carleman's theorem. Conditional and absolute convergence, multiplication of series, Merten's theorem, Dirichlet's Theorem, Riemann's rearrangement theorem. Young's form of Taylor's theorem, generalized second derivative. Bernstein's theorem and Abel's limit theorem.

CREDIT-IV

Sequence and series of functions: Point wise and uniform convergence, Cauchy criterion for uniform convergence, M_n -test, Weiestrass M-test, Abel's and Dirichlet's test for uniform convergence, uniform convergences and continuity, R- integration and differentiation, Weiestrass Approximation theorem. Example of continuous nowhere differentiable function.

Recommended Books:

1. R. Goldberg : Methods of Real Analysis.
2. W. Rudin : Principles of Mathematical Analysis.
3. J. M. Apostol : Mathematical Analysis.
4. S.M.Shah and Saxena: Real Analysis.
5. A.J.White :Real Analysis , An Introduction.
6. L.Royden :Real Analysis.

Course No: **MM14103CR** Max. Marks: 100
Course Name:- **Topology**

Duration of Examination: 2:30 Hrs.	External Exam: 80
No. of Credits: **04**	Internal Assessment: 20

CREDIT-I

Review of countable and uncountable sets, Schroeder-Bernstein theorem, Axiom of Choice and its various equivalent forms, Definition and examples of metric spaces, Open and Closed sets, completeness in metric spaces, Baire's Category theorem, and applications to the (1) Non-existence of a function which is continuous precisely at irrationals (ii) Impossibility of approximating the characteristic of rationals on [0, 1] by a sequence of continuous functions.

CREDIT-II

Completion of a metric space ,Cantor's intersection theorem, with examples to demonstrate that each of the conditions in the theorem is essential, Uniformly continuous mappings with examples and counter examples, Extending Uniformity continuous maps, Banach's contraction principle with applications to the inverse function theorem in R.

CREDIT-III

Topological spaces; Definition and examples, elementary properties, Kuratowski's axioms, continuous mappings and their characterizations ,pasting Lemma, convergence of nets and continuity in terms of nets, Bases and sub bases for a topology, Lower limit topology, concepts of first countability, second countability, separability and their relationships, counter examples and behavior under subspaces, product topology and weak topology, compactness and its various characterizations.

CREDIT-IV

Heine-Borel theorem, Tychnoff's theorem, compactness, sequential compactness and total bounded ness in metric spaces. Lebesgue's covering lemma, continuous maps on a compact space. Separation axioms T_i (i=1,2,3,31/2,4) and their permanence properties, connectedness, local connectedness, their relationship and basic properties, Connected sets in R. Urysohn's lemma. Urysohn's metrization theorem. Tietize's extension theorem, one point compactification.

Recommended Books:

1. G.F.Simmons : Introduction to topology and Modern Analysis.
2. J. Munkres : Topology.
3. K.D. Joshi : Introduction to General Topology.
4. J.L.Kelley : General Topology.
5. Murdeshwar ; General Topology .
6. S.T. Hu : Introduction to General Topology.

Course No. **MM14104EA**	Max. Marks: 100
Course Name:- **Theory of Numbers-I**	
Duration of Examination: 2:30 Hrs.	External Exam: 80

No. of Credits: **04** Internal Assessment: 20

CREDIT-I

Divisibility, the division algorithm and its uniqueness, Greatest common divisor and its properties. The Euclidean algorithm, Prime numbers. Euclid's first theorem, Fundamental Theorem of Arithmetic, Divisor of n, Radix-representation Linear Diophantine equations. Necessary and sufficient condition for solvability of linear Diophantine equations, Positive solutions.

CREDIT-II

Sequence of primes, Euclid's Second theorem, Infinitude of primes of the form 4n+3 and of the form 6n+5. No polynomial f(x) with integral coefficients can represent primes for all integral values of x or for all sufficiently large x. Fermat Numbers and their properties. Fermat Numbers are relatively prime. There are arbitrary large gaps in the sequence of primes. Congruences, Complete Residue System (CRS), Reduced Residue System (RRS) and their properties. Fermat and Euler's theorems with applications.

CREDIT-III

Euler's ф-function, ф (mn) = ф (m) ф (n) where (m, n) =1, $\sum_{d/m}\phi(d)=n$ and $\phi(m)=m\prod_{p}\left(1-\frac{1}{p}\right)$ for m>1. Wilson's theorem and its application to the solution the congruence of $x^2 \equiv -1 \pmod p$, Solutions of linear Congruence's. The necessary and sufficient condition for the solution of $a_1x_1+a_2x_2+\ldots+a_nx_n \equiv c \pmod m$. Chinese Remainder Theorm.Congruences of higher degree F(x) ≡ 0 (mod m), where F(x) is a Polynomials. Congruence's with prime power, Congruences with prime modulus and related results. Lagrange's theorem, viz , the polynomial congruence F(x) ≡ 0 (mod p) of degree n has at most n roots.

CREDIT-IV

Factor theorem and its generalization. Polynomial congruences $F(x_1,x_2\ldots x_n) \equiv 0 \pmod p$ in several variables. Equivalence of polynomials. Theorem on the number of solutions of congruences: Chevalley's theorem, Warning's theorem. Quadratic forms over a field of characteristic ≠ 2 Equivalence of Quadratic forms. Witt's theorem. Representation of Field Elements. Hermite's theorem on the minima of a positive definite quadratic form and its application to the sum of two, three and four squares.

Recommended Books:

1. Topics in number theory by W. J . Leveque, Vol. I and II Addition Wesley Publishing Company, INC.

2. An introduction of the Theory of numbers by I. Niven and H.S Zuckerman.
3. Number Theory by Boevich and Shaferivich, I.R, Academic Press.

Suggested Readings:

1. Analytic Number Theory by T.M Apostal, Springer Verlag.
2. An introduction to the theory of Numbers by G.H Hardy and Wright.
3. A course in Arithmetic, by J.P. Serre, GTM Vol. springer Verlag 1973.
4. An elementary Number theory of E. Landau.

Course No: **MM14105EA**		Max. Marks:	100
Course Name:- **Matrix Algebra**			
Duration of Examination: 2:30 Hrs.		External Exam:	80
No. of Credits: **04**		Internal Assessments:	20

CREDIT-I

Eigen values and eigen vectors of a matrix and their determination.. The eigen values of a square matrix A are the roots of its characteristic equation and conversely.Similarity of matrices. Two similar matrices have the same eigen values. Algebraic and geometric multiplicity of a characteristic root. Necessary and sufficient condition for a square matrix of order n to be similar to a diagonal matrix. Orthogonal reduction of real matrices.

CREDIT-II

Orthogonality of the eigen vectors of a hermetion matrix. The necessary and sufficient condition for a square matrix of order n to be a similar diagonal matrix is that it has a set n linearly independent eigen vectors. If A is a real symmetric matrix then there exists an orthogonal matrix P such that $P^{-1}AP$ = P`AP ia a diagonal matrix whose diagonal elements are the eigen values of A.Semi – diagonal or triangular form. Schur's theorem. Normal matrices, Necessary and sufficient condition for a square matrix to be unitarily similar to a diagonal matrix

CREDIT-III

Quadratic forms: The Kroneckers and Lagranges reduction .Reduction by orthogonal transformation of real quadratic forms .Necessary and sufficient condition for a quadratic form to be positive definite. Rank , Index and signature of a quadratic form. If A=[a_{ij}] is a positive definite matrix of order n , then $|A| \le a_{11} a_{22} \ldots a_{nn}$.

CREDIT-IV

Gram matrices. The Gram matrix BB` is always positive definite or positive semi-definite. Hadmard's inequality. If B=[b_{ij}]is an arbitrary non- singular real square matrix of order n, then $|B| \le \prod_{i=1}^{n}[\sum_{k=1}^{n} b_{ik}]$ Functions of symmetric matrices: Positive definite square root of a positive definite matrix. The infinite n-fold integral

$$I_n = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\cdots\int_{-\infty}^{\infty} e^{-X'AX}\,dX \ ,$$

where $dX = dx_1 dx_2 \cdots dx_n$. If A is a positive definite matrix , then $I_n = \dfrac{\pi^{n/2}}{|A|^{1/2}}$

If A and B are positive definite matrices, then

$$|\lambda A + (1-\lambda)B| \ge |A|^{\lambda}|B|^{1-\lambda} \qquad \text{for} \quad 0 \le \lambda \le 1$$

REFERENCES

1 Introduction to Matrix Analysis by Richard Bellman , McGraw Hill Book Company.
2 Elementary Matrix Algebra by Franz E. Hohn, American Publishing company Pvt.ltd.
3 A Text Book of Matrices by Shanti Narayan, S. Chand and company Ltd.
4 Matrix Anaylsis by Rajendra Bhatia , Springer.

Course No. **MM14106EA**		Max. Marks:	100
Course Name:- **Computational Mathematics**			
Duration of Examination: 2:30 Hrs.		External Exam:	80
No. of Credits: **04**		Internal Assessment:	20

CREDIT-I

Introduction to Programming and Problem Solving – The Basic Model of Computation, Algorithms, Flow-charts, Programming Languages, Compilation, Linking and Loading, Testing and Debugging, Documentation.

Programming in c Language – Character set, Variables and Identifiers, Built-in Data Types, Variable Definition, Arithmetic Operators and Expressions, Constants and Literals, Simple Assignment Statement, Basic Input/Output statements, Simple C Programs.

Conditional Statements and Loops – Decision making with a program, Conditions, Relational Operators, Logical Connectives, *if* statement, *if-else* statement, Loops: *while* loop, *do-while* loop, *for* loop, Nested Loops, Infinite Loops, switch Statement, Structured Programming.

CREDIT-II

Arrays – One Dimensional Arrays: Array Manipulation; Searching, Insertion, Deletion of an element from an Array, Finding the largest/smallest element in an array, Two Dimensional Arrays: Addition/Multiplication of two matrices, Transpose of a square Matrix, Null Terminated Strings as Array of Characters, Representation of Sparse Matrices.

Pointers - Address operators, Pointer type declaration, Pointer assignment, Pointer Initialization, Pointer arithmetic, Function and pointers, Arrays and pointers, Pointer Arrays.

CREDIT-III

Introduction to MATLAB, Basic features, Array and Array Operations: simple Array, Array construction and orientation, Array mathematics, Standard Arrays, manipulation and sorting, Multi Dimensional Arrays: Array construction, Array construction, Array mathematics and manipulation, Relational and Logical operations, Control flow, Functions: M-file function construction rules, I/O arguments, Function workspaces, Functions and the MATLAB search path.

CREDIT-IV

Matrix Algebra: sets of linear equations, matrix functions, special matrices, Data analysis and Statistical functions, Polynomials: roots, multiplications, addition, division, Derivatives and Integrals, evaluation, Fourier analysis: Discrete Fourier transform, Fourier series, Integration and Differentiation, Differential Equations: IVP Format, ODE suit solvers, basic use.

Books Recommended:

1. E.Balagurusamy, Programming in ANSI c.
2. The C Programming Language, Brian W. Kernighan, Dennis M. Ritchie.
3. S.G.Kochan, Programming in c.
4. Mastering MATLAB, Duane Hanselman, Bruce Little field.
5. MATLAB, A Practical approach, Stormy Attaway.

Course No: **MM14107EA**	Max. Marks: 50
Course Name:-**Advanced Calculus**	
Duration of Examination: 1:15 Hrs.	External Exam: 40
No. of Credits: **02**	Internal Assessment: 10

CREDIT-I

Functions of several variables in R^n, the directional derivative, directional derivative and continuity, total derivative, Matrix of a linear function. Jacobian matrix, chain rule, mean value theorem for differentiable functions.

CREDIT-II

Sufficient conditions for differentiability and for the equality of mixed partials, Taylor's theorem for functions from R^n and R. Inverse and Implicit function theorem in R^n. Extremum problems for functions on R^n. Lagrange's multiplier's, Multiple Riemann Integral and change of variable formula for multiple Riemann integrals.

Recommended Books:

1. Rudin, W. Principles of Mathematical Analysis.
2. T.M.Apostol : Mathematical Analysis.
3. S.M.Shah and Saxena : Real Analysis.

Course No: **MM14108EA**		Max. Marks:	50
Course Name:- Probability Theory			
Duration of Examination: 1:15 Hrs.		External Exam:	40
No. of Credits: **02**		Internal Assessment:	10

CREDIT-I

The probability set functions, its properties, probability density function, the distribution function and its properties. Mathematical Expectations, some special mathematical expectations, Inequalities of Makov, Chebyshev and Jensen.

CREDIT-II

Conditional probability, independent events, Baye's theorem, Distribution of two and more random variables, Marginal and conditional distributions, conditional means and variances, Correlation coefficient, stochastic independence and its various criteria.

Recommended Books:

5 Hogg and Craig : An Introduction to the Mathematical Statistics.
2 Mood and Grayball : An Introduction to the Mathematical Statistics.

Course No: **MM14109EO**		Max. Marks:	100
Course Name:-Open Elective			
Duration of Examination: 2:30 Hrs.		External Exam:	80
No. of Credits: **04**		Internal Assessment:	20