DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD

DEPARTMENT OF MATHEMATICS

Syllabus for M.A. / M. Sc. (Mathematics) Semester I, II, III, and IV Under Academic Flexibility of the Department

W.E.F. JUNE – 2010

The M. A. / M. Sc. (Mathematics) course consists of four semesters.

In Semesters I and II a student has to study four compulsory and one optional papers. In Semesters III and IV he/she has to study two compulsory and three optional papers. Unitwise distribution of the syllabus for the papers currently taught is given. For other papers it will be given as and when the papers are introduced.

SEMESTER- I

12101 Paper – I (A)	-	Advanced Abstract Algebra -I
12102 Paper – II (A)	-	Real Analysis -I
12103 Paper – III (A)	-	Topology -I
12104 Paper – IV (A)	-	Complex Analysis -I

Optional Paper (Any one of the following)

121051 Paper – V- a (A)	-	Differential Equations -I.
12105 2 Paper – V- b (A)	-	Advanced Discrete Mathematics -I.
12105 3 Paper – V- c (A)	-	Differential Geometry of Manifolds -I.

SEMESTER -II

12201 Paper – I (B)	-	Advanced Abstract Algebra -II
12202 Paper – II (B)	-	Real Analysis -II
12203 Paper – III (B)	-	Topology -II
12204 Paper – IV (B)	-	Complex Analysis -II

Optional Paper (Any one of the following)

122051 Paper– V -a(B)	-	Differential Equations -II
122052 Paper– V -b (B)	-	Advanced Discrete Mathematics -II.
122053 Paper– V -c (B)	-	Differential Geometry of Manifolds -II.

SEMESTER III

12301 Paper – VI (A) - Functional Analysis - I

12302 Paper – VII (A) - Partial Differential Equations

Optional Papers (Any three of the following).

12303 Paper – VIII (A) - Programming in C Theory and practical- I

12304 Paper – IX (A) - Fluid Mechanics -I

12305 Paper – X (A) - Integral Equations

12306 Paper – XI (A) - Numerical Analysis -I.

12307 Paper – XII (A) - Lattice Theory -I

12308 Paper – XIII (A) - Advanced Functional Analysis -I.

12309 Paper –XIV (A) - Advanced Theory of Partial Differential Equations -I

12310 Paper –XV (A) - Theory of Ordinary Differential equations -I

12311 Paper –XVI (A) - Difference Equations -I

12312 Paper –XVII (A) - Computational Fluid Dynamics -I

12313 Paper –XVIII (A) - Algebraic Coding Theory -I

12314 Paper –XIX (A) - Algebraic Topology -I

12315 Paper –XX (A) - Operations Research -I.

12316 Paper –XXI (A) - Banach Algebra -I

12317 Paper –XXII (A) - Wavelets -I

12318 Paper –XXIII (A) - Fundamentals of Applied Functional Analysis -I

12319 Paper –XXIV (A) - Algebraic Number Theory -I

12320 Paper –XXV (A) - Combinatorics -I.

12321 Paper –XXVI (A) - Reaction diffusion theory - I

SEMESTER IV

12401 Paper – VI (B) - Functional Analysis - II

12402 Paper – VII (B) - Mechanics.

Optional Papers (Any three of the following).

12403 Paper – VIII (B) - MATLAB Programming

12404 Paper – IX (B) - Fluid Mechanics -II

12405 Paper – X (B) - Boundary Value Problems

12406	Paper – XI (B)	-	Fuzzy Mathematics
12407	Paper – XII (B)	-	Linear Algebra
12408	Paper – XIII (B)	-	Advanced Functional Analysis -II.
12409	Paper –XIV (B)	-	Advanced Theory of Partial Differential Equations -II
12410	Paper –XV (B)	-	Theory of Ordinary Differential equations -II
12411	Paper –XVI (B)	-	Difference Equations -II
12412	Paper –XVII (B)	-	Computational Fluid dynamics -II
12413	Paper –XVIII (B)	-	Algebraic Coding Theory -II
12414	Paper –XIX (B)	-	Algebraic Topology -II
12415	Paper –XX (B)	-	Operations Research -II.
12416	Paper –XXI (B)	-	Banach Algebra -II
12417	Paper –XXII (B)	-	Wavelets -II
12418	Paper –XXIII (B)	-	Fundamentals of Applied Functional Analysis -II
12419	Paper –XXIV (B)	-	Algebraic Number Theory -II
12420	Paper –XXV (B)	-	Combinatorics -II.
12421	Paper –XXVI (B)	-	Reaction diffusion theory - II

Semester –I
Paper- I (A) - Advanced Abstract Algebra- I

Unit- I
Preliminaries and related concepts from algebra and field theory. (15 lectures)

Unit- II
Irreducible polynomials, Eisenstein criterion, adjunction of roots, algebraic extension of a field, algebraically closed field and related results. (15 lectures)

Unit- III
Splitting fields, normal extensions, multiple roots, finite fields and separable extensions and their properties. (15 lectures)

Unit – IV
Galois theory, automosphism groups and fixed fields, fundamental theorem of Galois theory, fundamental theorem of algebra. (15 lectures)

Unit- V
Applications of Galois theory to classical problems roots of unity and cyclotomic polynomials, cyclic extensions, polynomial solvable by radicals, ruler and compass constructions (15 lectures)

Text Book:
P. B. Bhattacharya, S. K. Jain and S. R. NagPaul, Basic Abstract Algebra,
Cambridge University Press, Indian Edition, 1997
Chapter 15, 16, 17 and 18 complete

Reference Books:

1. I. N. Herstein: Topics in algebra, Wiley Eastern Ltd., New Delhi, 1975.
2. S. Lang: Algebra, 3rd edition, Addison-Wesley, 1993.
3. I. S. Luther and I.B.S. Passi: Algebra, Vol. I and Vol. II Narosa, New Delhi.
4. D. S. Malik, J. N. Mordeson and M. K. Sen: Fundamentals of Abstract Algebra, Mc Graw-Hill, and International Edition, 1997.
5. S. K. Jain, A. Gunawardena and P. B. Bhattacharya: Basic Linear Algebra with MATLAB, Key College Publishing (Springer-Verlag), 2001.
7. J. B. Fraleigh, a first curse in Abstract Algebra, Narosa Publications.

Semester – I
Paper – II (A) Real Analysis- I

Unit – I
Definition and existence of Riemann-Stieltjes integral, Properties of the integral, Integration and Differentiation, The fundamental theorem of calculus, Examples. (15 lectures)

Unit – II
Integration of vector valued functions. Rectifiable curve. Examples. Sequences and series of functions. Point wise and uniform convergence. Cauehy criterion for uniform convergence. Weierstrass M-test, uniform convergence and continuity, uniform convergence and Riemann-Stielljes integration. Examples. (15 lectures)

Unit – III
Uniform convergence and Differential, The Stone – Weierstrass theorem, Examples. Power series, Abel's and Taylor's theorems, Uniqueness theorem for power series. Examples. (15 lectures)

Unit – IV
Functions of several variables, Linear transformations, Derivatives in an open subset of R^n, Chain rule, Examples (15 lectures)

Unit – V
Partial derivations. Interchange of the order of differentiation, The inverse function theorem, The implicit function theorem Jacobins, Derivatives of higher order, Differentiation of integrals. Examples, (15 lecturer)

Text Book:
Walter Rudin, Principles of Mathematical Analysis, (3^{rd} Edition) McGraw Hill, Kogakusha 1976.

Articles:
6.1 to 6.27, 7.1 to 7.18, 7.26, 7.27, 8.1 to 8.5, 9.1 to 9.21, 9.24 to 9.29, 9.38 to 9.42

Reference Books:

1. T. M. Apostol, mathematical Analysis, Narosa, New Delhi, 1985.

2. J. C. Burkill and H. Burkill, A second course in Mathematical Analysis, Cambridge University Press, 1970.

3. S. L. Lang, Analysis- I and II, Addison Wesley, 1969.

Semester - I
Paper – III (A) – Topology - I

Unit – I
Prerequisites: Partially ordered sets, Maximal and minimal elements, cardinality, special cardinals countable and uncountable sets, Axiom of choice continuum hypothesis, principle of inductions metric spaces, definition and Examples, continuous map, open sets properties of open sets, characterizations of continuity. (15 lectures)

Unit – II
Definition and examples of topological spaces, closed sets, closure of a set, properties of closure of sets, interior of a set and their properties, frontier of sets and its relation ship with closure and interior of sets neighbourhood of a point, Neighbourhood system, accumulation point and derived set. (15 lectures)

Unit – III
Bases and sub bases and related theorems new spaces from old. Sub spaces, continuous functions product spaces, weak topologies and related theorems open closed maps projection maps. (15 lectures)

Unit – IV
Evaluation map and related results Quotient spaces sequences in a topological space, Inadequacy of sequences, first countable spaces. (15 lectures)

Unit – V
Directed sets, nets, convergence of nets, cluster point, subnet, ultra net, filter, convergence of filters, ultra filters, fixed and free filters, results on these concepts.
(15 lectures)

Textbook: Stephan Willard: General Topology, Addison Wesley (1970)

Chapter 1 (Sec. 1.8 to 1.21 and Sec, 2.1 to 2.8)
Chapter 2 (Complete),
Chapter 3 (up to sec. 9.3)
Chapter 4 (Complete)

Reference Books:

1. Steen & J. Seecatch: Counter examples in Topology, Holt, Rinehart and instant, N, Y. (1970).
2. W. J. Pervin: Foundation of general Topology Academic press N.Y.
3. S. T. Hu. : Elements of general Topology, Holden.
4. James Munkres: Topology, A first course, Prentice Hall of India Pvt. Ltd.

Semester – I
Paper – IV (A) - Complex Analysis - I

Unit- I
The Complex number system:
The field of complex numbers, The complex plane, Rectangular and polar representation of complex numbers; Intrinsic function on the complex field; The Complex plane. (15 lectures)

Unit - II
Metric spaces and Topology of C:
Definition and examples of metric spaces; connectedness; sequence and completeness; compactness; continuity; Uniform convergence. (15 lecturer)

Unit- III
Elementary properties and examples of Analytic functions:
Power series; The exponential function; Trigonometric and hyperbolic functions; Argument of nonzero complex number; Roots of unity; Branch of logarithm function. Analytic functions; cauchy Riemann Equations; Harmonic function; (15 lectures)

Unit - IV
Analytic functions as a mapping; Mobius transformations; linear transformations; The point at infinity; Bilinear transformations,
Complex Integration: power series representation of analytic functions; zeros of an analytic function. (15 lectures)

Unit – V
The index of a closed curve; cauchy's theorem and integral formula; Gaursat's Theorem; Singularities: Classification of singularities; Residues; The argument principle. (15 lectures)

Text Books:
1. John B. Conway; Functions of one complex variable, Narosa Publishing House, 2002.
2. J. V. Deshpande; Complex Analysis, Tata McGraw- Hill Publishing Company Limited, 1989.

Unit-I: Chapter-I: § 2,3,4 in [1] & 1.3 & 1.4 in [2]
Unit-II: Chapter – II: §1,2,3,4,5,6 in [1]
Unit – III: Chapter –VI: § 6.1,6.2,6.3,6.4,6.5,6.6 in [2] & Chapter - VII: § 7.1,7.2,7.3, in [2]
Unit- IV: Chapter- III: § 3 in [1] & Chapter – IV: § 2, 3 & 4 in [1] &
Chapter – 2: § 2.1,2.2,2.3, in [2]
Unit – V: Chapter – IV: § 5 & 8 in [1] & Chapter V: § 1,2 & 3 in [1].

References:
1. Herb Silverman; Complex Variables, Haughton Mifflin Company Boston, 1975.
2. Ruel V. Churchill; Complex variables and applications, McGraw – Hill Publishing Company 1990.

Semester – I
Paper – V -a- (A)-Differential Equations - I

Unit – I
Existence, uniqueness and Continuation of solutions: Introduction, Method of successive approximations for the initial value problem $y^1=f(x,y)$, $y(x_0)=y_0$, The Lipschitz condition. Notation and Definitions, Peano's existence theorem, maximal and minimal solutions, continuation of solutions. (15 lectures)

Unit – II
Existence theorems for system of differential equations: Picard-Lindelof theorem, Peano's existence theorem, Dini's derivatives, differential inequalities. (15 lectures)

Unit – III
Integral Inequalities: Gronwall- Reid-Bellman inequality and its generalization, Applications: Zieburs theorem, Peron's criterion, Kamke's uniqueness theorem. (15 lectures)

Unit – IV
Linear systems: Introduction, superposition principle, preliminaries and Basic results, Properties of linear homogeneous system, Theorems on existence of a fundamental system of solutions of first order linear homogeneous system, Abel-Liouville formula. (15 lectures)

Unit – V
Adjoint system, Periodic linear system, Floquet's theorem and its consequences, Applications, Inhomogeneous linear systems, applications. (15 lectures)

Text Book:

1. E. A. Coddington: An Introduction to Ordinary Differential Equations. Prentice-Hall international, Inc. Englewood Cliffs (1961).

   Chapter 6: Article 4&5.

2. Shair Ahmad and M. Rama Mohana Rao: Theory of Ordinary Differential Equations with Applications in Biology and Engineering, Affiliated East-West Press (1999)
   Chapter – 1: Article 1.1 to 1.5
   Chapter – 2: Article 2.1 to 2.3

References:

1. P. Hartman: Ordinary differential Equations, 2nd edition, SIAM, (2002.)
2. W. T. Reid: Ordinary Differential Equations, John Wiley, New York, (1971).
3. E. A. Coddington and N. Levinson: Theory of Ordinary Differential Equations, McGraw-Hill, New York, (1955).

Semester – I

Semester - I
PAPER V-b-(A): ADVANCED DISCRETE MATHEMATICS - I

Unit – I
Formal Logic: Statements, symbolic representation, tautologies. Semi groups and monoids: Definitions and examples of semi groups and Monoids (15 Lecture)

Unit- II
Homomorphism of semigroups and monoids, congruence relation and quotient semigroups, Sub semigroups and submonoids, direct products, basic homomorphism theorem. (15 Lecture)

Unit- III
Lattices: Lattices as partially ordered sets, their properties, lattices as algebraic systems, sub lattices, direct products and homomorphism, some special lattices eg complete, complemented and distributive lattices. (15 Lecture)

Unit- IV
Boolean algebras: Boolean algebras as lattices, various Boolean identities, the switching algebra example, sub algebra, direct product and homomorphism, join-irreducible elements (15 Lecture)

Unit- V
Atoms and midterms, Boolean forms and their equivalence, midterm Boolean forms, (excluding free Boolean algebras), sum and products of canonical forms. Minimization of Boolean functions, applications of Boolean algebra to switching theory (using AND, ok and NOT gates), the Karnaugh Map method. (15 Lecture)

Reference Books:

1. **J. P. Tremblay and R. Manohar**: Discrete Mathematical structures with Applications to Computer science, McGraw-Hill Book Co., 1997.
2. **Seymour Lepschutz**: Finite Mathematics, McGraw-Hill, New York.
3. **S. Wiitala**: Discrete Mathematics - A Unified Approach, McGraw-Hill.
4. **J. E. Hhopcroft and J.D. Ullman**: Introduction to Automata Theory, Languages and Computation, Narosa, New Delhi.
5. **C. L. Liu**: Elements of discrete Mathematics, McGraw-Hill Book Co.

Semester – I
Paper – V-c (A)- Differential Geometry of Manifolds - I

Definition and examples of differentiable manifolds. Tangent spaces. Jacobean map. One parameter group of transformations. Lie derivatives. Immersions and imbedding. Distributions. Exterior algebra. Exterior derivative.

Topological groups. Lie groups and lie algebras. Product of two Liegroups. One parameter subgroups and exponenitial maps. Examples of Liegroups. Homomorphism and Isomorphism. Lie transformation groups. General linear groups. Principal fibre ;bundle. Linear frame bundle. Associated fibre bundle. Vector bundle. Induced bundle. Bundle homomorphisms.

Reference Books:

1. R.S. Mishra, A course in tensors with applications to Riemannian Geometry, Pothishala (pvt.) Ltd., 1965.

2. R.S. Mishra, Structures on a differentiable manifold and their applications, Chandrama Prakashan, Allahabad, 1984.
3. B. B. Sinha, An Introduction to Modern Differential Geometry, Kalyani Publishers, New Delhi, 1982.
4. K. Yano and M. Kon, Structure of manifolds. World Scientific, 1984