JSS MAHAVIDYAPEETA

JSS COLLEGE OF ARTS, COMMERCE & SCIENCE

(Affiliated to University of Mysore)

Autonomous, NAAC 'A' grade and College with Potential for Excellence

B N Road, Mysuru – 570025

PROPOSED SCHEME of INSTRUCTION

and

SYLLABUS

for

M.Sc. MATHEMATICS

under

CHOICE BASED CREDIT SYSTEM (CBCS)

PG DEPARTMENT OF MATHEMATICS

2017 – 18

onwards

1. **Scheme of Admission**:
   - 50% seats of the total intake for M.Sc. Mathematics Programme of the College will be filled by the University of Mysore through Centralized Admission Cell as per University regulations.
   - Remaining 50% seats will be filled by the College under College Quota.

2. **Eligibility**: B.Sc. degree with Mathematics as Major/Optional subject with 45% or B.Sc.Ed., degree of Regional Institute of Education with Mathematics as a special subject.

3. **Scheme of Examination**:
   (i) Theory paper of 03 hours duration (C_3 component) : **70** marks
   (ii) Internal Assessment: **30** marks
   (C_1 Component: 15 marks, C_2 Component: 15 marks)

4. **Pattern of Question Paper**: **Theory paper**: There are 5 questions. All questions must be answered. Each question carries 14 marks.

5. Minimum Marks for Securing Credits: 40% (with minimum of 30% in C_1 and C_2 and minimum of 30% in C_3).

6. Minimum Credits for getting the M.Sc. Mathematics degree: 76 credits.

7. Scheme of study for Masters:

Total No. of credits to be earned	76 credits
Minimum No. of credits to be earned from Hard Core papers	44 credits
Minimum No. of credits to be earned from Soft Core papers	28 credits
Minimum No. of credits to be earned from Open elective papers	4 credits

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PG DEPARTMENT OF MATHEMATICS

CBCS - M.Sc. Mathematics

List of courses with credit pattern

Sl. No.	Code	Type of the paper	Title of the Paper	Credit pattern in L:T:P	Credit Value	No. of hrs
			FIRST SEMESTER			
1	MAA 010	HC	Algebra I	3 : 1 : 0	4	5
2	MAA 020	HC	Real Analysis I	3 : 1 : 0	4	5
3	MAA 030	HC	Real Analysis II	3 : 1 : 0	4	5
4	MAA 040	HC	Complex Analysis I	3 : 1 : 0	4	5
5	MAA 210	SC	Linear Algebra	3 : 1 : 0	4	5
			SECOND SEMESTER			
6	MAB 010	HC	Algebra II	3 : 1 : 0	4	5
7	MAB 020	HC	Real Analysis III	3 : 1 : 0	4	5
8	MAB 030	HC	Complex Analysis II	3 : 1 : 0	4	5
9	MAB 210	SC	Ordinary and Partial Differential Equations	3 : 1 : 0	4	5
10	MAB 230	SC	Graph Theory	3 : 1 : 0	4	5
			THIRD SEMESTER			
11	MAC 010	HC	Elements of Functional Analysis	3 : 1 : 0	4	5
12	MAC 020	HC	Topology I	3 : 1 : 0	4	5
13	MAC 210	SC	Commutative Algebra	3 : 1 : 0	4	5
14	MAC 220	SC	Theory of Numbers	3 : 1 : 0	4	5
15	CSC/MCC/ZOC/ BTC/BOC/BCC 580	OE (For others)	Basic Mathematics	3 : 1 : 0	4	5
			FORTH SEMESTER			
16	MAD 010	HC	Measure and Integration	3 : 1 : 0	4	5
17	MAD 020	HC	Topology-II	3 : 1 : 0	4	5
18	MAD 220	SC	Theory of Partitions	3 : 1 : 0	4	5
19	MAD 230	SC	Differential Geometry	3 : 1 : 0	4	5
Total Credits					76	

Program Outcomes

After completion of this course, students will be able to

PO1: Apply the underlying unifying structures of mathematics (i.e. sets, relations and functions, logical structure) and the relationships among them

PO2: Include methods of facilitating learning such as projects, group work and participative learning.

PO3: Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.

PO4: Impart knowledge of some basic concepts and principles of the discipline.

PO5: Establish inter-disciplinarily between mathematics and other subjects from Humanities and the Social Sciences.

PO6: Encourage collaborative learning through group activities and hands-on learning.

PO7: Provide in-service training for school teachers. To learn to apply mathematics to real life situations and help in problem solving

Program Specific Outcomes

After completion of this course, students will be able to

PSO1 : Explain the importance of mathematics and its techniques to solve real life problems and provide the limitations of such techniques and the validity of the results

PSO2 : Propose new mathematical and statistical questions and suggest possible software packages and/or computer programming to find solutions to these questions

PSO3 : Continue to acquire mathematical and statistical knowledge and skills appropriate to professional activities and demonstrate highest standards of ethical issues in mathematics

PSO4 : Ability to use computer calculations as a tool to carry out scientific investigations and develop new variants of the acquired methods, if required by the problem at hand.

PSO5 : Crack lectureship and fellowship exams approved by UGC like CSIR – NET and SLET.

PSO6 : Apply knowledge of Mathematics, in all the fields of learning including higher research and its extensions.

First Semester

Course Code MAA 010	Algebra I

Course Outcome

Students are able to

CO1 Write down the characteristics of congurencess

CO2 Write down the details of reciprocity law

CO3 Specify in details with examples groups

CO4 Specify in depth Isomorphism

CO5 Learn in depth Sylows theorems

CO6 Deliberate in details with application, if applicable, Permutation groups

COURSE CONTENT

Unit I

Number theory - Congruences, residue classes, theorems of Fermat, Euler and Wilson, linear congruences, elementary arithmetical functions, primitive roots, quadratic residues and the law of quadratic reciprocity.

Unit II

Groups - Lagrange's Theorem, homomorphism and isomorphism, normal subgroups and factor groups.

Unit III

The fundamental theorem of homomorphism, two laws of isomorphism.

Unit IV

Permutation groups and Cayley's theorem, Sylow's theorems.

Books for Reference:

1. D. M. Burton – Elementary Number Theory, Tata McGraw-Hill, New Delhi, 6th Ed.,

2. I. Niven, H. S. Zuckerman and H. L. Montgomery – An Introduction to the Theory of Numbers, New York, John Wiley and Sons, Inc., 2004, 5th Ed.,

3. G. A. Jones and J. M. Jones – Elementary Number Theory, Springer, 1998.

4. Thomas W. Hungerford – Algebra, Springer International Edition, New York.

5. Michael Artin – Algebra, Prentice-Hall of India, New Delhi.

6. J. A. Gallian – Contemporary Abstract Algebra, Narosa Publishing House, 4th Ed.,

7. D. S. Dummit and R. M. Foote – Abstract Algebra, John Wiley and Sons, 1999.

8. I. N. Herstein – Topics in Algebra, Vikas Publishing House, New Delhi.

9. J. B. Fraleigh – A First course in Abstract Algebra, Addison-Wesley,

10. N. S. Gopalakrishnan – University Algebra, New Age International, 2nd Ed.

Course code MAA020	**Real Analysis I**

Course Outcome

Students are able to

CO1 Understand the characteristics of extended real number system, the n-dimensional Euclidean space

CO2 Identify the details of the binomial inequality

CO3 Understand the details of arithmetic and geometric means

CO4 Identify in details with application, if applicable, arithmetic and geometric means

CO5 Specify in details with application, if applicable, Cauchy's, Holder's inequality and Minkowski's inequality

CO6 Learn the characteristics of sequences, convergent sequences

CO7 Deliberate in details with examples upper and lower limits

CO8 Write down the details of Series of real numbers, series of non-negative terms

CO9 Understand in details with examples Multiplications of series

CO10 Learn in details with examples re-arrangements. Double series, infinite products.

COURSE CONTENT

Unit I

The extended real number system, the n-dimensional Euclidean space, the binomial inequality, the inequality of the arithmetic and geometric means, the inequality of the power means, Cauchy's, Holder's inequality and Minkowski's inequality.

Unit II

Numerical sequences, convergent sequences, Cauchy sequences, upper and lower limits.

Unit III

Series of real numbers, series of non-negative terms, the number `e', tests of convergence.

Unit IV

Multiplications of series, re-arrangements. Double series, infinite products.

Books for Reference:

1. W. Rudin – Principles of Mathematical Analysis, International Student edition, McGraw Hill, 3rd Ed.

2. T. M. Apostal – Mathematical Analysis, Addison Wesley, Narosa, New Delhi, 2nd Ed.

3. R. R. Goldberg – Methods of real Analysis, Oxford and IBH, New Delhi.

4. Torence Tao – Analysis I, Hindustan Book Agency, India, 2006.

5. Torence Tao – Analysis II, Hindustan Book Agency, India, 2006.

6. Kenneth A. Ross – Elementary Analysis: The Theory of Calculus, Springer International Edition, 2004.

Course code MAA 030	Real Analysis II

Course Outcome

Students are able to

CO1 Deliberate in depth Finite, countable and uncountable sets

CO2 Understand in details with examples Continuity

CO3 Deliberate the details of Differentiability, mean value theorems

CO4 Learn the details of The Riemann-Stieltje's integral

CO5 Identify in details with examples Integration and differentiation

COURSE CONTENT

Unit I

Finite, countable and uncountable sets, the topology of the real line.

Unit II

Continuity, uniform continuity, properties of continuous functions, discontinuities, monotonic functions.

Unit III

Differentiability**,** mean value theorems, L' Hospital rule, Taylor's theorem, maxima and minima, Functions of bounded variation.

Unit IV

The Riemann-Stieltje's integral, criterion for integrability. Properties of the integral, classes of integrable functions. The integral as the limit of a sum. First and second mean value theorems. Integration and differentiation.

Books for Reference:

1. W. Rudin – Principles of Mathematical Analysis, International Student edition, McGraw-Hill, 3rd Ed..

2. Torence Tao – Analysis I, Hindustan Book Agency, India, 2006.

3. Torence Tao – Analysis II, Hindustan Book Agency, India, 2006.

4. T. M. Apostal – Mathematical Analysis, Addison Wesley, Narosa, 2nd Ed.,

5. R. R. Goldberg – Methods of real Analysis, Oxford and IBH Publishing Company, New Delhi.

6. Kenneth A. Ross – Elementary Analysis: The Theory of Calculus, Springer International Edition, 2004.

Course code MAA 040	Complex Analysis I

Course Outcome

Students are able to

CO1 Understand the characteristics of Represent complex numbers algebraically and geometrically

CO2 Deliberate the details of Riemann sphere and Stereographic projection

CO3 Understand the classification and characteristics of Lines, Circles

CO4 Learn the characteristics of Cauchy-Riemann equations

CO5 Identify the characteristics of Harmonic functions

CO6 Learn in depth sequences, series, uniform convergence of power series, Abel's limit theorem

CO7 Understand the classification and characteristics of The elementary functions

CO8 Learn in details with examples Linear fractional transformations, Cross-ratio, Symmetry

CO9 Identify the details of Elementary conformal mappings

CO10 Understand in details with application, if applicable, Cauchy's theorems

CO11 Understand in details with application, if applicable, Cauchy's theorems

CO12 Identify the classification and characteristics of Local properties of analytic functions

COURSE CONTENT

Unit I

Algebra of complex numbers, geometric representation of complex numbers. Riemann sphere and Stereographic projection, Lines, Circles. Limits and Continuity.

Unit II

Analytic functions, Cauchy-Riemann equations, Harmonic functions, Polynomials and Rational functions. Elementary theory of power series - sequences, series, uniform convergence of power series, Abel's limit theorem, The elementary functions.

Unit III

Topology of the complex plane. Linear fractional transformations, Cross-ratio, Symmetry, Elementary conformal mappings. Complex integration – Line integrals, Rectifiable arcs.

Unit IV

Cauchy's theorem for a rectangle. Cauchy's theorem in a Circular disk, Cauchy's integral formula. Local properties of analytic functions.

Books for Reference:

1. L. V. Ahlfors – Complex Analysis, McGraw-Hill, Kogakusha, 1979.

2. J. B. Conway – Functions of one complex variable, Narosa, New Delhi.

3. R. P. Boas – Invitation to Complex Analysis, The Random House, 1987

4. B. C. Palka – An Introduction to Complex Function Theory, Springer, 1991.

5. S. Ponnusamy – Foundations of Complex Analysis, Narosa, 1995.

Course code MAA 210	Linear Algebra

Course Outcome

Students are able to

CO1 Learn in depth Vector Spaces

CO2 Understand the classification and characteristics of Determinants

CO3 Learn in details with examples Inner Products and Norms

CO4 Deliberate the details of normal and Self-Adjoint Operators

CO5 Write down the classification and characteristics of The Diagonal form, The Triangular form

COURSE CONTENT

Unit I

Vector Spaces, Subspaces, Linear Combinations and Systems of Linear Equations, Linear Dependence and Linear Independence, Bases and Dimension, Maximal Linearly Independent Subsets; Linear Transformations, Null Spaces, and Ranges, The Matrix Representation of a Linear Transformation, Composition of Linear Transformations and Matrix Multiplication, Invertibility and Isomorphisms, The Change of Coordinate Matrix, The Dual Space; Elementary Matrix Operations and Elementary Matrices, The Rank of a Matrix and Matrix Inverses, Systems of Linear Equations.

Unit II

Properties of Determinants, Cofactor Expansions, Elementary Operations and Cramer's Rule, Eigenvalues and Eigenvectors, Diagonalizability, Invariant Subspaces and the Cayley-Hamilton Theorem; Inner Products and Norms, The Gram-Schmidt Orthogonalization Process and Orthogonal Complements.

Unit III

The Adjoint of a Linear Operator, Normal and Self-Adjoint Operators, Unitary and Orthogonal Operators and Their Matrices, Orthogonal Projections and the Spectral Theorem; Bilinear and Quadratic Forms;

Unit IV

The Diagonal form, The Triangular form; The Jordan Canonical Form; The Minimal Polynomial; The Rational Canonical Form.

Books for Reference:

1. S. Friedberg, A. Insel, and L. Spence - Linear Algebra, Fourth Edition, PHI, 2009.

2. Jimmie Gilbert and Linda Gilbert – Linear Algebra and Matrix Theory, Academic Press, An imprint of Elsevier.

3. I. N. Herstein – Topics in Algebra, Vikas Publishing House, New Delhi.

4. Hoffman and Kunze – Linear Algebra, Prentice-Hall of India, 1978, 2nd Ed.,

5. P. R. Halmos – Finite Dimensional Vector Space, D. Van Nostrand, 1958.

6. S. Kumeresan – Linear Algebra, A Geometric approach, Prentice Hall India, 2000.

SECOND SEMESTER

Course code MAB 010	Algebra II

Course Outcome

Students are able to

CO1 Write down the classification and characteristics of Rings

CO2 Understand the characteristics of Rings

CO3 Learn the details of Euclidean and Principal Ideal rings

CO4 Understand in details with examples Fields

CO5 Specify the classification and characteristics of Separable and Perfect fields

CO6 Understand the characteristics of Separable and Perfect fields

COURSE CONTENT

Unit I

Rings, Integral domains and Fields, Homomorphisms, Ideals and Quotient Rings, Prime and Maximal ideals.

Unit II

Euclidean and principal ideal rings, Polynomials, Zeros of a polynomial, Factorization, Irreducibility criterion.

Unit III

Adjunction of roots, algebraic and transcendental extensions, Finite fields.

Unit IV

Separable and inseparable extensions, Perfect and imperfect fields. Theorem on the primitive element.

Books for Reference:

1. Thomas W. Hungerford – Algebra, Springer International Edition, New York.

2. Michael Artin – Algebra, Prentice-Hall of India, New Delhi.

3. Joseph A. Gallian – Contemporary Abstract Algebra, Narosa, 4th Ed.,

4. D. S. Dummit and R. M. Foote – Abstract Algebra, John Wiley and Sons,1999, 2nd Ed.,

5. I. N. Herstein – Topics in Algebra, Vikas Publishing House, New Delhi.

6. J. B. Fraleigh – A First course in Abstract Algebra, Addison-Wesley,

7. N. S. Gopalakrishnan – University Algebra, New Age International, 2nd ed.,

Course code MAB 020	**Real Analysis III**

Course Outcome

Students are able to

CO1 Deliberate in details with examples Sequences and series of functions

CO2 Understand the characteristics of Uniform convergence and differentiation

CO3 Identify in details with examples Improper integrals and their convergence

CO4 Understand in depth Functions of several variables

CO5 Specify the details of Taylor's theorem, the Maxima and Minima

COURSE CONTENT

Unit I

Sequences and series of functions, Uniform convergence, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation.

Unit II

Power series, the exponential and logarithmic functions, The trigonometric functions. Improper integrals and their convergence.

Unit III

Functions of several variables, partial derivatives, continuity and differentiability, the chain rule, Jacobians.

Unit IV

The Implicit function theorem, Taylor's theorem, the Maxima and Minima, Lagrange's multipliers.

Books for Reference:

1. W. Rudin – Principles of Mathematical Analysis, International Student edition, McGraw-Hill, 3rd Ed.

2. T.M. Apostal – Mathematical Analysis, Addison Wesley, Narosa, 2nd Ed.

3. R.R. Goldberg – Methods of Real Analysis, Oxford and IBH, New Delhi.

4. D.V. Widder – Advanced Calculus, Prentice Hall of India, New Delhi, 2nd Ed.,

5. Torence Tao – Analysis I, Hindustan Book Agency, India, 2006.

6. Torence Tao – Analysis II, Hindustan Book Agency, India, 2006.

7. Kenneth A. Ross – Elementary Analysis: The Theory of Calculus, Springer International Edition, 2004.

Course code MAB 030	Complex Analysis II

Course Outcome

Students are able to

CO1 Understand in details with application, if applicable, The residue theorem, argument principle

CO2 Learn in depth Evaluation of definite integrals

CO3 Specify in details with application, if applicable, Harmonic functions – Definition and basic properties, mean value property

CO4 Learn the details of Poisson’s formula, Schwarz’s theorem, reflection principle.

CO5 Understand the classification and characteristics of Power series expansions

CO6 Write down in depth The Weierstrass theorem

CO7 Learn in details with examples Partial fractions, Mittag - Leffer’s theorem

CO8 Specify the classification and characteristics of Infinite products, Canonical products

CO9 Understand the characteristics of The Gamma and Beta functions, Sterling’s formula

CO10 Learn the characteristics of Jensen's formula, Hadamard's theorem

COURSE CONTENT

Unit I

The Calculus of Residues – The residue theorem, argument principle, Evaluation of definite integrals.

Unit II

Harmonic functions – Definition and basic properties, mean value property, Poisson's formula, Schwarz's theorem, reflection principle.

Unit III

Power series expansions – The Weierstrass theorem, The Taylor series, The Laurent series.

Unit IV

Partial fractions and factorization – Partial fractions, Mittag - Leffer's theorem, Infinite products, Canonical products, The Gamma and Beta functions, Sterling's formula. Entire functions – Jensen's formula, Hadamard's theorem.

Books for Reference:

1. L. V. Ahlfors – Complex Analysis, McGraw-Hill, Kogakusha, 1979.

2. J. B. Conway – Functions of one complex variable, Narosa, New Delhi.

3. R. P. Boas – Invitation to Complex Analysis, The Random House, 1987.

4. B. C. Palka – An Introduction to the Complex Function Theory, Springer, 1991.

5. S. Ponnusamy – Foundations of Complex Analysis, Narosa, 1995.

Course code MAB 210	Ordinary and Partial Differential Equations

Course Outcome

Students are able to

CO1 Deliberate the details of Linear second order equations

CO2 Learn the characteristics of separations and comparison theorem

CO3 Specify in details with application, if applicable, Power series solutions

CO4 Learn in depth Partial differential equations

CO5 Learn in details with application, if applicable, separations of variables

CO6 Deliberate the characteristics of Sturm Liouvile system, Greens functions method

COURSE CONTENT

Unit 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.

Unit 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.

Unit 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.

Unit IV

Boundary value problems - Transforming Boundary value problem of PDE and ODE, Sturm - Liouvile system, eigen values and eigen functions, simple properties, expansion in eigen functions, Parseval's identity, Green's function method.

Books for Reference:

1. E. A. Coddington and N. Levinson – Theory of Ordinary Differential equations, Tata McGraw-Hill, New Delhi.

2. R. Courant and D. Hilbert – Methods of Mathermatical Physics, Vol. I. & II, Tata McGraw-Hill, New Delhi, 1975.

3. G. F. Simmons – Differential Equations with applications and Historical Notes, Tata McGraw-Hill, New Delhi, 1991.

4. I. N. Sneddon – Theory of Partial differential equations, McGraw-Hill, International Student Edition.

5. S. G. Deo and V. Raghavendra – Ordinary Differential Equations and Stability Theory, Tata McGraw-Hill, New Delhi.

Course code MAB 230	Graph Theory

Course Outcome

Students are able to

CO1 Learn in depth Types of Graphs, Walk and connectedness

CO2 Learn the classification and characteristics of degrees, Extremal graphs

CO3 Understand the characteristics of Intersection graph, Operations on graphs.

CO4 Specify in depth Cutpoints, Bridges

CO5 Write down in details with examples Blocks, Block graphs and cutpoints

CO6 Specify the characteristics of Characterization of trees, Centers and Centroids, Spanning Tree.

CO7 Identify the details of Connectivity and line connectivity

CO8 Deliberate in details with application, if applicable, Menger's theorem

CO9 Deliberate in details with application, if applicable, Coverings Independence, Critical points and lines

COURSE CONTENT

Unit I

Types of Graphs, Walk and connectedness, degrees, Extremal graphs, Intersection graph, Operations on graphs.

Unit II

Cutpoints, Bridges and Blocks, Block graphs and cutpoints.

Unit III

Characterization of trees, Centers and Centroids, Spanning Tree.

Unit IV

Connectivity and line connectivity, Menger’s theorem, Coverings Independence, Critical points and lines.

Books for Reference:

1. F. Harary – Graph Theory, Addition Wesley Reading Mass, 1969.

2. N. Deo – Graph Theory with Applications to Engineering and Computer Science, Prentice Hall of India, 1987.

3. K. R. Parthasarathy – Basic Graph Theory, Tata McGraw-Hill, New Delhi, 1994.

4. G. Chartand and L. Lesniak – Graphs and Diagraphs, Qwadsworth and Brooks, 2nd Ed.,

5. Clark and D. A. Holton – A First Look at Graph Theory, Allied publishers.

6. D. B. West – Introduction to Graph Theory, Pearson Education Inc., 2001, 2nd Ed.,

7. J. A. Bondy and U. S. R. Murthy – Graph Theory with applications, Elsevier, 1976.

THIRD SEMESTER

Course code MAC 010	Elements of Functional Analysis

Course Outcome

Students are able to

CO1 Write down in details with examples Banach's contraction mapping theorem and applications

CO2 Specify in details with examples Baire' category theorem, Ascoli - Arzela theorem

CO3 Understand the characteristics of The Hahn – Banach extension theorem

CO4 Understand in depth Stone - Weirstrass theorem

CO5 Deliberate in details with application, if applicable, Open mapping and Closed Graph theorems

CO6 Learn in details with application, if applicable, Hilbert spaces

COURSE CONTENT

Unit I

Metric completion. Banach's contraction mapping theorem and applications, Baire' category theorem, Ascoli - Arzela theorem.

Unit II

Linear spaces and linear operators, Norm of a bounded operator, The Hahn – Banach extension theorem, Stone - Weirstrass theorem.

Unit III

Open mapping and Closed Graph theorems. The Banach - Steinhaus Principle of Uniform Boundedness.

Unit IV

Hilbert spaces- The orthogonal projection, Nearly orthogonal elements, Riesz's lemma, Riesz's representation theorem.

Books for Reference:

1. G. F. Simmons – Introduction to Topology and Modern Analysis, Tata McGraw-Hill, New Delhi.

2. A. E. Taylor – Introduction to Functional Analysis, Wiley, New York, 1958.

3. A. Page and A. L. Brown – Elements of Functional Analysis.

4. George Bachman and Lawrence Narici – Functional Analysis, Dover Publications, Inc., Mineola, New York.

5. J. B. Conway – A Course in Functional Analysis, GTM, Vol. 96., Springer, 1985.

Course code MAC 020	**Topology I**

Course Outcome

Students are able to

CO1 Deliberate in details with application, if applicable, topological spaces, basis for a topology, the order topology

CO2 Write down in depth the product topology on X x X, the subspace topology

CO3 Deliberate the characteristics of Closed sets and limit points

CO4 Learn in depth continuous functions

CO5 Learn in details with examples the product topology, the metric topology, the quotient topology

CO6 Specify the details of connected spaces, connected sets on the real line

CO7 Understand in depth path connectedness

CO8 Deliberate the classification and characteristics of compact spaces, compact sets on the line

CO9 Learn the characteristics of limit point compactness, local compactness.

COURSE CONTENT

Unit I

Set theoretic preliminaries. Topological spaces and continuous maps - topological spaces, basis for a topology, the order topology, the product topology on X x X, the subspace topology.

Unit II

Closed sets and limit points, continuous functions, the product topology, the metric topology, the quotient topology.

Unit III

Connectedness - connected spaces, connected sets on the real line, path connectedness.

Unit IV

Compactness - compact spaces, compact sets on the line, limit point compactness, local compactness.

Books for Reference:

1. J. R. Munkres – A First Course in Topology, Prentice Hall India, 2000, 2nd Ed.,

2. G. F. Simmons – Introduction to Topology and Modern Analysis, McGraw-Hill, Kogakusha, 1968.

3. S. Willard – General Topology, Addison Wesley, New York, 1968.

4. J. Dugundji – Topology, Allyn and Bacon, Boston, 1966.

5. J. L. Kelley – General Topology, Van Nostrand and Reinhold Co., New York, 1955.

Course code MAC 210	**Commutative Algebra**

Course Outcome

Students are able to

CO1 Understand in depth commutative ring

CO2 Deliberate in details with examples local rings

CO3 Understand the characteristics of nil radical and Jacobson radical

CO4 Learn the details of The prime spectrum of a ring

CO5 Specify the characteristics of Noetherian and Artinian module

CO6 Identify in details with examples Free modules, Finitely generated modules, Simple modules, Exact sequences of modules

CO7 Specify the characteristics of Noetherian rings and Artinian rings
.

COURSE CONTENT

Unit I

Rings and ideals - Rings and ring homomorphisms, Ideals, Quotient rings, zero-divisors, nilpotent elements, units, prime ideals and maximal ideals.

Unit II

The prime spectrum of a ring, the nil radical and Jacobson radical, operation on ideals, extension and contraction.

Unit III

Modules - Modules and modules homomorphisms, submodules and quotient modules, Direct sums, Free modules Finitely generated modules, Nakayama Lemma, Simple modules, Exact sequences of modules.

Unit IV

Modules with chain conditions - Artinian and Noetherian modules, modules of finite length, Artnian rings, Noetherian rings, Hilbert basis theorem.

Books for Reference:

1. M. F. Atiyah and I. G. Macdonald – Introduction to Commutative Algebra, Addison-Wesley.

2. C. Musili – Introduction to Rings and Modules, Narosa Publishing House.

3. Miles Reid – Under-graduate Commutative Algebra, Cambridge University Press.

4. N. S. Gopalakrishnan, Commutative Algebra, Oxonian Press.

Course code MAC 220	Theory of Numbers

Course Outcome

Students are able to

CO1 Write down in details with examples Fermat and Mersenne numbers. Farey series

CO2 Deliberate the classification and characteristics of Irrational numbers-Irrationality of mth root of N, e and π.

CO3 Understand in details with application, if applicable, Arithmetical Functions

CO4 Deliberate in depth The average orders of d(n), σ(n), φ(n), μ(n).

CO5 Learn the details of , Representation of a number by two or four squares, Definition g(k) and G(k),

CO6 Deliberate in details with application, if applicable, Continued fractions

COURSE CONTENT

Unit I

Prime numbers, the Fundamental theorem of Arithmetic, the series of Reciprocals of primes, the Euclidean Algorithm. Fermat and Mersenne numbers. Farey series, Farey dissection of the continuum, Irrational numbers-Irrationality of m^{th} root of N, e and π.

Unit II

Arithmetical Functions – The Mobius function, The Euler' function and Sigma function, The Dirichlet product of Arithmetical functions, Multiplicative functions. Averages of Arithmetical functions – Euler summation formula, Some elementary asymptotic formulas, The average orders of d(n), σ(n), φ(n), μ(n). An application to the distribution of lattice points visible from the origin.

Unit III

Approximation Irrational numbers, Hurwitz's Theorem, Representation of a number by two or four squares, Definition g(k) and G(k), Proof of g(4)<50, Perfect numbers. The series of Fibonacci and Lucas.

Unit IV

Continued fractions - Finite continued fractions, Convergent of a continued fraction, Continued fractions with positive quotients. Simple continued fractions, The representation of an irreducible rational fraction by a simple continued fraction. The continued fraction algorithm and Euclid's algorithm. The difference between the fraction and its convergents, Infinite simple continued fractions, the representation of an irrational number by an infinite continued fraction, Equivalent numbers and periodic continued fractions, some special quadratic surds.

Books for Reference:

1. G. H. Hardy and E. M. Wright – An Introduction to Theory of Numbers, Oxford University Press, 1979, 5th Ed.,

2. I. Niven, H. S. Zuckerman and H. L. Montgomery – An Introduction to the Theory of Numbers, New York, John Wiley and Sons, Inc., 2004, 5th Ed.,

3. Bruce C. Berndt – Ramanujan's Note Books Volume-1 to 5, Springer.

4. G. E. Andrews – Number Theory, Dover Books, 1995.

5. T. M. Apostol – Introduction to Analytic Number Theory, Narosa Publishing House, New Delhi.

OPEN ELECTIVE (For others)

Course code MCC/BCC/BTC/BOC/ZOC/CSC 580	**Basic Mathematics**

Course Outcome

Students are able to

CO1 Specify the characteristics of Mathematical Logic: Connection – Normal Forms

CO2 Deliberate the classification and characteristics of Mathematical Logic: Connection – Normal Forms Theory of Inferences –Predicate Calculus

CO3 Deliberate the classification and characteristics of Operations on Sets – Basic Set Identities

CO4 Understand the classification and characteristics of Relations and Orderings, Functions

CO5 Understand the classification and characteristics of formulation of LP problems, Graphical solution of LP problems

CO6 Specify the characteristics of Simplex, revised simplex methods and Dual simplex, Game theory

CO7 Deliberate the characteristics of Basic Concepts of Graph Theory- Paths – Connectedness

CO8 Deliberate the classification and characteristics of Matrix Representation of Graphs

CO9 Understand in depth Trees – List structures and Graphs

COURSE CONTENT

Unit I

Mathematical Logic: Connection – Normal Forms – Theory of Inferences –Predicate Calculus.

Unit II

Set Theory: Operations on Sets – Basic Set Identities – Relations and Orderings, Functions.

Unit III

Introduction: formulation of LP problems, Graphical solution of LP problems. Introduction to Simplex, revised simplex methods and Dual simplex, Game theory.

Unit IV

Graph Theory: Basic Concepts of Graph Theory- Paths – Connectedness – Matrix Representation of Graphs – Trees – List structures and Graphs.

Books for Reference:

1. C. L. Liu – Elements of Discrete Mathematics, McGraw-Hill, 1986.

2. Kenneth H. Rosen – Discrete Mathematics and its Applications, McGraw-Hill, 2002.

3. F. Harary – Graph Theory, Addition Wesley Reading Mass, 1969.

4. N. Deo – Graph Theory With Applications to Engineering and Computer Science, Prentice Hall of India, 1987.

5. K. R. Parthasarathy – Basic Graph Theory, Tata McGraw-Hill, New Delhi, 1994.

6. G. Chartand and L. Lesniak – Graphs and Diagraphs, wadsworth and Brooks, 2^{nd} Ed.,

7. Clark and D. A. Holton – A First Look at Graph Theory, Allied publishers.

8. D. B. West – Introduction to Graph Theory, Pearson Education Inc.,2001, 2nd Ed.,

9. J. A. Bondy and U. S. R. Murthy – Graph Theory with applications, Elsevier, 1976.

10. S. D Sharma- Operations Research.

Fourth Semester

Course code MAD 010	Measure and Integration

Course Outcome

Students are able to

CO1 Understand in details with examples Lebesgue measure, outer measure

CO2 Learn the characteristics of measurable sets

CO3 Identify the characteristics of measurable functions

CO4 Deliberate in details with examples Integration of measurable functions

CO5 Learn in details with examples , functions of bounded variation, differentiation of an integral, absolute continuity

CO6 Understand in depth measure theory

COURSE CONTENT

Unit I

Lebesgue measure - outer measure, measurable sets and Lebesgue measure, a non measurable set, measurable functions.

Unit II

The Lebesgue integral – the Lebesgue Integral of a bounded function over as set of finite measure, the integral of a non-negative function, the general Lebesgue integral.

Unit III

Differentiation and integration - Differentiation of monotonic functions, functions of bounded variation, differentiation of an integral, absolute continuity.

Unit IV

Measure and integration - Measure spaces, Measurable functions, integration, Signed measures, the Radon - Nikodym theorem, Measure and outer measure, outer measure and measurability, the extension theorem, product measures.

Books for Reference:

1. H. L. Royden – Real Analysis, Prentice Hall, 3rd Ed.,

2. G. de Barra – Measure Theory and Integration, Wiley Eastern Limited.

3. Inder K. Rana – An Introduction to Measure and Integration, Narosa, 1997.

Course code MAD 020	**Topology II**

Course Outcome

Students are able to

CO1 Deliberate the classification and characteristics of the countability axioms, the separation axioms

CO2 Specify in depth normality of a compact Hausdorff space

CO3 Understand in details with application, if applicable, Urysohn's lemma, Tietze's extension theorem, Urysohn's metrization theorem

CO4 Deliberate the details of Partitions of unity

CO5 Learn the classification and characteristics of Tychonoff's theorem on the product of compact spaces

CO6 Understand in details with examples Local finiteness, Paracompactness

CO7 Learn in depth Normality of a paracompact space

CO8 Deliberate the characteristics of The Fundamental group and the Fundamental group of a circle

CO9 Understand in details with examples , The Fundamental group of the punctured plane, Essential and Inessential Maps, The Fundamental Theorem of Algebra

COURSE CONTENT

Unit I

Countability and Separation axioms - the countability axioms, the separation axioms, normality of a compact Hausdorff space.

Unit II

Urysohn's lemma, Tietze's extension theorem, Urysohn's metrization theorem, Partitions of unity.

Unit III

Tychonoff's theorem on the product of compact spaces. Local finiteness, Paracompactness, Normality of a paracompact space.

Unit IV

The Fundamental group and the Fundamental group of a circle, The Fundamental group of the punctured plane, Essential and Inessential Maps, The Fundamental Theorem of Algebra.

Books for Reference:

1. James R. Munkres - A First Course in Topology , Prentice Hall India, 2000, 2nd Ed.,

2. G. F. Simmons – Introduction to Topology and Modern Analysis, McGraw-Hill, Kogakusha, 1968.

3. S. Willard – General Topology, Addison Wesley, New York, 1968.

4. J. Dugundji – Topology, Allyn and Bacon, Boston, 1966.

5. J. L. Kelley – General Topology, Van Nostrand and Reinhold Co., New York, 1955.

Course code MAD 230	Differential Geometry

Course Outcome
Students are able to

CO1 Learn the details of Plane curves and Space curves

CO2 Identify in details with examples Tangents, Normals and Orientability

CO3 Deliberate the classification and characteristics of Fundamental form

CO4 Understand in details with examples Curvature of surfaces

CO5 Specify in details with examples Gaussian Curvature and The Gauss' Map

COURSE CONTENT

Unit I

Plane curves and Space curves – Frenet-Serret Formulae. Global properties of curves – Simple closed curves, The isoperimetric inequality, The Four Vertex theorem. Surfaces in three dimensions – Smooth surfaces, Tangents, Normals and Orientability, Quadric surfaces.

Unit II

The First Fundamental form – The lengths of curves on surfaces, Isometries of surfaces, Conformal mappings of surfaces, Surface area, Equiareal Maps and a theorem of Archimedes.

Unit III

Curvature of surfaces – The Second Fundamental form, The Curvature of curves on a surface, Normal and Principal Curvatures.

Unit IV

Gaussian Curvature and The Gauss' Map – The Gaussian and The mean Curvatures, The Pseudo sphere, Flat surfaces, Surfaces of Constant Mean Curvature, Gaussian Curvature of Compact surfaces, The Gauss' Map.

Books for Reference:

1. A. Pressley – Elementary Differential Geometry, Under-graduate Mathematics Series, Springer.

2. T. J. Willmore – An Introduction to Differential Geometry, Oxford University Press.

3. D. Somasundaram – Differential Geometry: A First Course, Narosa, 2005.

Course code MAD 220	Theory of Partitions

Course Outcome

Students are able to

CO1 Learn the characteristics of Partitions

CO2 Learn in details with application, if applicable, , Jacobi's triple product identity and its applications.

CO3 Understand the characteristics of 1ψ1 - summation formula and its applications

CO4 Write down in details with application, if applicable, , Euler's pentagonal number theorem

CO5 Understand the details of Congruence properties of partition function, the Rogers - Ramanujan Identities

CO6 Identify in details with application, if applicable, Elementary series

COURSE CONTENT

Unit I

Partitions - partitions of numbers, the generating function of p(n), other generating functions, two theorems of Euler, Jacobi's triple product identity and its applications.

Unit II

${}_1\psi_1$ - summation formula and its applications, combinatorial proofs of Euler's identity, Euler's pentagonal number theorem, Franklin's combinatorial proof.

Unit III

Congruence properties of partition function, the Rogers - Ramanujan Identities.

Unit IV

Elementary series - product identities, Euler's, Gauss', Heine's, Jacobi's identities. Restricted Partitions – Gaussian, Frobinius partitions.

Books for Reference:

1. G. H. Hardy and E. M. Wright – An Introduction to Theory of Numbers, Oxford University Press, 1979, 5th Ed.,

2. I. Niven, H. S. Zuckerman and H. L. Montgomery – An Introduction to the Theory of Numbers, New York, John Wiley and Sons, Inc., 2004, 5th Ed.,

3. Bruce C. Berndt – Ramanujan's Note Books Volumes-1 to 5.

4. G. E. Andrews – The Theory of Partitions, Addison Wesley, 1976.

5. A. K. Agarwal, Padmavathamma, M. V. Subbarao – Partition Theory, Atma Ram & Sons, Chandigarh, 2005.

Question Paper pattern

Time: 3 Hours **Max Marks: 70**

Instructions to Candidates :

1.Answer all questions

2.All questions carry equal marks

1. 2X7= 14

a).
b).
c).
d).
e).
f).
g).

2. 14

a).

OR

b).

3. 14

a).

OR

b).

4. 14

a).

OR

b).

5. 14

a).

OR

b).