RANI CHANNAMMA UNIVERSITY, BELAGAVI

Department of Mathematics

Syllabus

for

Master of Science in Mathematics

I to II Semester

(with effect from 2017 – 18)

Choice based credit system (CBCS)

Course structure

Sl. No.	Paper & Title	Credit	No of Hrs/week Theory/ Practical	Duration of exam in Hrs Theory/ Practical	IA Marks Theory/ Practical	Marks at the Exams	Total Marks
I Semester							
1.1	Algebra -I	4	4	3 Hrs	20	80	100
1.2	Topology	4	4	3 Hrs	20	80	100
1.3	Real Analysis	4	4	3 Hrs	20	80	100
1.4	Linear Algebra	4	4	3 Hrs	20	80	100
1.5	Ordinary Differential Equations	4	4	3 Hrs	20	80	100
1.6	Discrete Mathematical Structures	4	4	3 Hrs	20	80	100
II Semester							
2.1	Algebra – II	4	4	3 Hrs	20	80	100
2.2	Complex Analysis	4	4	3 Hrs	20	80	100
2.3	Partial Differential Equations	4	4	3 Hrs	20	80	100
2.4	Functions of Several Variables	4	4	3 Hrs	20	80	100
2.5	Classical Mechanics	4	4	3 Hrs	20	80	100
2.6	**Open Elective Course** I. Set Theory (Arts & Commerce stream) II. Integral Transforms (Science stream)	4	4	3 Hrs	20	80	100

III Semester							
3.1	Measure Theory & Lebesgue Integration	4	4	3 Hrs	20	80	100
3.2	Differential Geometry	4	4	3 Hrs	20	80	100
3.3	Numerical Analysis	4	4	3 Hrs	20	80	100
3.4	Elective- I I. Mathematical Finance II. Fluid Mechanics III. Commutative Algebra IV. Coding Theory	4	4	3 Hrs	20	80	100
3.5	Elective- II I. Algebraic Topology II. Number Theory and Cryptology III. Fourier Analysis IV. Fuzzy Sets and Fuzzy Systems	4	4	3 Hrs	20	80	100
3.6	Open Elective Course I. Statistics (Arts & Commerce stream) II. Computational Methods (Science stream)	4	4	3 Hrs	20	80	100
IV Semester							
4.1	Functional Analysis	4	4	3 Hrs	20	80	100
4.2	Mathematical Methods	4	4	3 Hrs	20	80	100
4.3	Probability Theory	4	4	3 Hrs	20	80	100
4.4	Elective-I I. Riemannian Geometry II. Advance Graph Theory III. Mathematical modeling IV. Galois Theory	4	4	3 Hrs	20	80	100
4.5	Elective-II I. Advanced Numerical Methods II. Banach Algebra III. Operations Research IV. Computation Complexity	4	4	3 Hrs	20	80	100
4.6	Project	4	The candidate shall submit a dissertation carrying 80 marks and appear for viva-voce carrying 20 marks				100
	Total	96					2400

SEMESTER – I

1.1. ALGEBRA – I

Unit 1:

Division algorithm, HCF, LCM, Euclid's Algorithm, Fundamental theorem of Arithmetic, Congruence, Chinese reminder theorem, Euler phi function, Group, Subgroup, Normal subgroup and Quotient group

Unit2:

Group homomorphism, Isomorphism theorems and the correspondence theorem, Center and Commutator subgroup of a group, cyclic group, Lagrange theorem.

Unit3:

Euler's and Fermat's theorems as consequences of Lagrange's theorem, Symmetric group Sn. Structure theorem for symmetric groups, Action of a group on a set, Examples, orbit and stabilizer of an element.

Unit 4:

Class equation for a finite group, Cauchy theorem for finite groups, Sylow theorems, Applications, Wilson's theorem.

Unit 5:

Subnormal series for a group, Solvable group, Solvability of Sn. Composition series for a group. Jordan-Holder theorem

REFERENCES

1. J.B.Fraleigh, Abstract Algebra, Narosa Publications
2. Joseph A. Gallian, Contemporary Abstract Algebra, Narosa Publications
3. N.S.Gopalakrishnan, University Algebra,
4. I.N.Herstein,Topics in Algebra, Wiley
5. Mukopadhyaya and M.K.Sen,Ghosh Shamik, Topics in Abstract Algebra, University Press
6. I.B.S.Passi and I.S.Luther, Algebra Vol-I, Narosa Publications.

1.2. TOPOLOGY

Unit 1:

Definition and examples, open and closed sets, Neighborhood, Limit points. closure, Interior, Boundary of a set. Bases and sub-bases, Continuity and homeomorphism.

Compact Spaces, Compact in the real Line, Compactness, Sequential compactness, locally compact spaces, Compactification, Alexandroff's one point compactification.

Unit 2:

Connected spaces, Definition and examples, components and path components local connectedness and path connectedness. The axioms of countability, First axiom space, Second countable space, separability and the Lindelof of property, Limit point compact spaces.

Unit3:

Separation axioms: T_0 space and T_1 spaces definitions and examples, The properties are hereditary and topologica, Normal Spaces, Characterization of T_0 T_1 spaces. T_2- space, Regularity and

T_3 – axioms. Metric spaces are T_2 and T_3.

Unit4:

The product Topology, The Metric Topology, the Quotient Topology, Product invariant properties for finite products, Projection Maps. Compact Hausdorff space, regular lindelof spaces, normal.

Unit5:

Urysohn's lemma. Tietze's Extension Theorem. complete normality and the T_5- axiom, Local finiteness, Tychnoff's Theorem, Para-compactness, Metrizability, Urysohn metrization theorem.

REFERENCES:

1. J.R.Munkers : Topology –A first course,PHI(2000)
2. M.A.Armstrong, Basic Topology
3. James Dugundji :Topology,PHI(2000)
4. J.L.Kelley : General Topology,Van Nostrand (1995).

1.3. REAL ANALYSIS

Unit:1

The field axioms, order axioms, Cauchy- Schwarz inequality, countable and uncountable sets, completeness property of R; The least upper bound property and greatest lower bound property. Archimedean Property.

Unit:2

Euclidean space R^n, open ball and open Sets in R^n. Limit point, Adherent Points, Closed Sets, Bolzano- Weierstrass Theorem, The Cautor intersection theorem, lindelof covering theorem, Heine- Borel covering theorem, compactness in R^n.

Unit:3

Metric space. Point Set Topology in Metric space, compact Subset of a metric space, Sequences, Subsequences, Convergent and Cauchy Sequences in a metric space, Complete metric space.

Unit:4

Limit, Continuity, Continuity of composite functions, continuity and inverse image of open and closed sets. Functions continuous on compact sets. Connectedness, Uniform continuity, Fixed point theorem for contractions.

Unit:5

Differentiation, Algebra of derivatives, chain rule, One Sided derivatives and infinite derivatives, Rolle's theorem, Mean- value Theorem for derivatives. Intermediate- value theorem, Taylor's formula with remainder. Functions of bonded variation, Total variation, Continuous functions of bounded variations, Rectifiable paths and arc length, Additive and continuity properties of arc length, Equivalence of path.

REFERENCES:

1. Apostol T.M- Introduction to Mathematical Analysis,
2. W.Rudin, Introduction to Mathematical Analysis, Wiley.
3. Terence Tao, Analysis- I and Analysis- II, TRIM series, HBA.
4. Richard,Goldberg, Real Analysis, Oxford and IBH.
5. S.R.Ghorpade and B.V.Limaye, A Course in Calculus and Real Analysis,UTM,Springer

1.4 LINEAR ALGEBRA

Unit1:

Definition and examples of vector spaces, subspaces , Sum and direct sum of subspaces. Linear span , Linear dependence, independence and their basic properties . Basis, Finite dimensional vector spaces. Existence theorem for bases , Invariance of number of elements of a basis set. Dimension, Existence of complementary subspace of a finite dimensional vector space, Dimension of sums of subspaces. Quotient space and its dimension.

Unit 2:

Linear transformations and their representation as matrices. The algebra of Linear Transformations. The rank nullity theorem . Change of basis. Dual space , Bidual space and natural isomorphism, Adjoint of linear transformation.

Unit 3:

Eigen values and eigenvectors of a linear transformation, Diagonalization. Annihilator of a subspace. Bilinear, Quadratic and Hermitian forms.

Unit 4:

Solutions of homogeneous systems of linear equations. Canonical forms, Similarity of linear transformations. Invariant subspaces, Reduction to triangular forms.

Unit 5:

Nilpotent transformations, Index of nilpotency. Invariants of a linear transformation, Primary decomposition theorem. Jordan blocks and Jordan forms. Inner product spaces;

REFERENCES:

1. Hoffeman and Kunze, Linear Algebra
2. N.Herstein,Topics in Algebra,Wiley Eastern Ltd,New York (1975)
3. S.Lang,Introduction to Linear Algebra 2nd Edition Springer-Verlag (1986)
4. Greub,Werner, Linear Algebra, Universities Press.

1.5 ORDINARY DIFFERENTIAL EQUATIONS

Unit 1:

Linear-differential equation of n^{th} order differential equation, fundamental sets of solution, Wronskian – Abel's Identity, theorem on linear dependence of solutions, Adjoint, self-adjoint linear operator, Green's formula.

Unit 2:

Adjoint equations, the n^{th} order non-homogenous linear equations. Variation of parameters-zeros of solutions, comparison and separation theorem, Fundamental existence and uniqueness theorem, dependence of solution on initial conditions, existence and uniqueness for higher order system of differential equations.

Unit 3:

Eigen value problems, Strum-Liouville's problem, Orthogonality of Eigen functions, Eigen functions, expansion in a series of orthogonal functions, Green's function method.

Unit 4:

Power series solution of linear differential equations- ordinary and singular points of differential equations, Classification into regular and irregular singular points, series solution for Bessel's and Legendre differential Equations.

Unit 5:

Series solution about an ordinary point and a regular singular point – Frobenius method-Hermite, Lagrange, Chebyshev and Gauss Hypergeometric equations and their general solutions. Generating function, Recurrence relations, Rodrigue's formula-Orthagonality properties. Behavior of solution at irregular singular points and the point at infinity.

REFERENCES

1. E.Coddington, Introduction to Ordinary Differential Equations.
2. G.F.Simmons, Introduction to Differential Equations, Tata McGraw.
3. Boyce and Diprima, Elementary Differential Equations and Boundary Value Problems, J.Wiley.

1.6 DISCRETE MATHEMATICAL STRUCTURES

Unit 1:

Boolean algebra and lattices, partially ordered sets lattices complete, distributive, complimented lattices, Boolean functions and expressions, Propositional calculus, logical connectives , truth values and tables, Boolean algebra to digital networks and switching circuits.

Unit 2:

Coding Theory: Coding of binary information and error detection, Group codes, decoding and error correction.

Unit 3:

Recurrence Relations and Recursive Algorithms - Introduction: Recurrence relations, linear recurrence relations with constant coefficients, Homogeneous solutions, particular solutions, total solutions, solution by a method of generating functions.

Unit4:

Graph theory - Basic Concepts: Different types of graphs, sub-graphs, walks and connectedness. Degree sequences, directed graphs, distances and self complimentary graphs. Blocks: Cut points, bridges and blocks, block graphs and cut –point graphs.
Trees and connectivity: Characterization of Trees, Spanning trees, centers and centroids, connectivity, edge connectivity.

Unit 5:

Traversibility and Planarity:Eulerian and Hamiltonian graphs, Planar graphs: Maximal planar, outeplanar graphs, Nonplanar graphs, graphs with crossing number 1 and 2 Characterization theorem.

REFERENCES:

1. C. L. Liu, Elements of Discrete Mathematics, McGraw Hill.
2. B. K. Kolman, R.C.Busby and S.Ross, Discrete mathematical structures, PHI
3. K. D. Joshi, Foundations of Discrete Mathematics, Wiley eastern.
4. N. L. Biggs, Discrete Mathematics, Oxford University Press.
5. Ralpha P. Grimaldi and B. V. Ramana, Discrete abd Combinatorial Mathematics, Pearson Education, 5th Edition

SEMESTER – II

2.1 ALGEBRA-II

Unit 1:

Rings, subrings, ideals, factor ring(all definitions and examples). Homomorphism of Rings, Isomorphism theorems. Integral domain, field and embedding of an integral domain in a field. Prime ideal, maximal ideal of a ring. Polynomial ring R(X) over a Ring in an indeterminate X.

Unit 2:

Principal Ideal Domain(PID). Euclidean domain. The ring of Gaussian integers as an Euclidean domain. Fermat's theorem. Unique factorization domain. Primitive polynomial. Gauss lemma.

Unit 3:

F(X) is a unique factorization domain for afield. Eisenstein's criterion of irreducibility for polynomials over a unique factorization domain.

Unit 4:

Field, subfield, Prime fields-definition and examples Characteristic of a field Characteristic of a finite field. Field extensions, Algebraic extension. Transitivity theorem. Simple Extensions

Unit 5:

Roots of Polynomials. Splitting field of a polynomial. Existence and uniqueness theorems. Existence of a field with prime power elements.

REFERENCES:

1. N.S.Gopalakrishna University Algebra, New Age International Publishers
2. Joseph A. Gallian, Contemporary Abstract Algebra, Narosa Publications
3. I.N.Herstein, Topics in Algebra 2nd Edition, John – wiley and sons,New York
4. Surjit Singhand Quazi Zameeruddin,Modern Algebra, Vikas Pulishers(1990)
5. S.K.Jain, P.B.BhattaCharya and S.R.Nagpaul, Basic Abstract Algebra, Cambridge University Press.
6. Mukhopadyaya and Sen, Modern Algebra, University Press

2.2 COMPLEX ANALYSIS

Unit-1:

Complex plane its algebra and topology, Holomorphic maps, Analytical function, power series as an analytical functions, inverse function, Zero's of Analytic function.

Unit-2:

Review of Complex integration, Basic properties of complex integral, Winding number, Cauchy-Gourasat theorem, Cauchy's theorem in a disk, triangle rectangle, Homotopy version of Cauchy's theorem, Morera's theorem, Cauchy integral formula. Laurent series.

Unit-3:

Maximum modulus Principle, Open mapping theorem , Hadamard three circle theorem and their consequences, Schwartz Lemma, Liouville's theorem

Unit-4:

Classification of singularities, Poles, Casorati- weierstrass theorem, Singularities at infinity, Residue at a finite point, Residue at the point at infinity.

Unit-5:

Residue $\int ( )$ theorem, Rouche's theorem, Intergral of types $\int ( )$, $\int ( )$, Mittag leffler's theorem, Normal families, Montel's theorem and Riemann mapping theorem.

REFERENCES:

1. L.Ahlfors, Complex Analysis, McGraw Hill.
2. J.B.Conway, Functions of One complex variable, Springer.
3. Greene,Robert.F,S.Krantz, Functions of One Complex variable, Universities Press.
4. S. Ponnusamy, Foundations of Complex Analysis

2.3. PARTIAL DIFFERENTIAL EQUATIONS

Unit 1:

First order Partial Differential Equations, the classification of solutions-Pfaffian differential equations-quasi linear equations, Lagrange's method-compatible systems,Charpit's method, Jacobi's method, integral surfaces passing through a given curve.

Unit 2:

Method of Characteristics for quasi-linear and non-linear equations, Monge's method , Monge cone, characteristic strip.

Unit 3:

Origin of second order partial differential equations, their classification, and wave equation-D'Alemberts solution, vibrations of a string of finite length, existence and uniqueness of solution-Riemann's Method.

Unit 4:

Laplace equation boundary value problems, Maximum and minimum principles,Uniqueness and continuity theorems, Dirichilet problem for a circle, Dirichilet problem for a circular annulus, Neumann problem for a circle, Theory of Green's function for Laplace equation.

Unit5:

Heat equation, Heat conduction problem for an infinite rod, Heat conduction in a finite rod existence and uniqueness of the solution Classification in higher dimensions, Kelvins inversion theorem, Equi-potential surfaces.

REFERENCES

1. I.J.Sneddon, Partial Differential equations, McGraw Hill.
2. F.John, Partial Differential Equations, Springer.
3. P.Prasad,R.Ravindran, Introduction to Partial Differential Equations, New AgeInternational
4. T.Amarnath, An Elementary Course on Partial differential Equations, Narosa Publishers.

2.4 FUNCTIONS OF SEVERAL VARIABLES

Unit 1:

Rieman-Stieltjes integral, Linear properties, Intergration by parts, Change of Variables step functions, Reduction of a Rieman-Stieltjes integral to a finite sum sufficient and Necessary conditions for existence of Riemann- Stieltjes's integrals, Mean value theorems, Second fundamental theorem of integral calculus, Second mean value theorem.

Unit 2:

Sequences and series of functions, Uniform convergence, uniform convergence and continuity, Uniform convergence and differentiation, Uniform convergence and integration. The stone- Weierstnass theorem.

Unit 3:

function of Several Variables, Directional derivative and continuity total derivative total derivative expressed in terms of partial derivatives.

Unit 4:

Matrix of a Linear Function, Jacobian matrix, Chain role, Matrix form of the chain rule, Mean value Theorems.

Unit 5:

Sufficient condition for differentiability and equality of mixed partial derivatives Tagloi's Theorem, Inverse function Theorem, Implicit function Theorem.

REFERENCES

1. Apostol T.M- Mathematical Analysis(Ch.6,7,10 and 11)
2. Apostol T.M,Calculus-2-Part 2(Non-Linear Analysis)
3. Vector Analysis (Schaum Series)

2.5 CLASSICAL MECHANICS

Unit 1:

Coordinate transformations, Cartesian tensors, Basic Properties, Transpose, Symmetric and Skew tensors, Isotropic tensors, Deviatoric Tensors, Gradient, Divergence and Curl in Tensor Calculus, Integral Theorems.

Unit 2:

Continuum Hypothesis, Configuration of a continuum, Mass and density, Description of motion, Material and spatial coordinates, Translation, Rotation, Deformation of a surface element, Deformation of a volume element, Isochoric deformation, Stretch and Rotation, Decomposition of a deformation, Deformation gradient, Strain tensors, Infinitesimal strain, Compatibility relations , Principal strains.

Unit 3:

Material and Local time derivatives Strain, rate tensor, Transport formulas, Stream lines, Path lines, Vorticity and Circulation, Stress components and Stress tensors, Normal and shear stresses, Principal stresses.

Unit 4:

Fundamental basic physical laws, Law of conservation of mass, Principles of linear and angular momentum, Equations of linear elasticity, Generalized Hooke's law in different forms, Physical meanings of elastic moduli, Navier's equation.

Unit 5:

Equations of fluid mechanics, Viscous and non-viscous fluids, Stress tensor for a non-viscous fluid, Euler's equations of motion, Equation of motion of an elastic fluid, Bernoulli's equations, Stress tensor for a viscous fluid, Navier-Stokes equation.

REFERENCE BOOKS

1. D.S. Chandrasekharaiah and L. Debnath: Continuum Mechanics, Academic Press, 1994.
2. A.J.M. Spencer: Continuum Mechanics, Longman, 1980.
3. Goldstein, Classical Mechanics, Addison – Wesley, 3rd Edition, 2001.
4. P. Chadwick : Continuum Mechanics, Allen and Unwin, 1976.
5. Y.C. Fung, A First course in Continuum Mechanics, Prentice Hall (2nd edition), 1977
6. A.S. Ramsey, Dynamics part II, the English Language Book Society and Cambridge University Press,(1972)
7. F. Gantmacher, Lectures in Analytical Mechanics, MIR Publisher, Mascow,1975.
8. Narayan Chandra Rana and Sharad Chandra Joag, Classical Mechanics, Tata McGraw Hill, 1991.
9. F. Chorlton, Text Book of Dynamics, (ELBS Edition), G. Van Nostrand and co.(1969.

2.6 Open Elective Course

I. SET THEORY (Arts & Commerce Stream)

Unit 1:

Logic, Proposition, Truth Values, Connectives, Truth table.

Unit 2:

Set, Subset, Cross-Product, Complement, Difference, intersection, union function, onto function, One-One function, Bijective functions, Relations, Equivalence Relations.

Unit 3:

Combinations, Properties, Binomial Theorem, Expansion using Binomial Theorem.

Unit 4:

Matrix, Determinant, Cramer's rule, Inverse, Cayley- Hamilton Theorem (Statement only) Eigen values. (Discussion & problems of 3X3 matrix only)

Unit 5:

Vectors' Representation of vectors, Properties , Scalar of Dot Product vectors, or Cross product, Scalar Triple Product, vector Triple product.

REFERENCES

1. Courant.R, Robbins ,What is Mathematics. Oxford University Press.
2. Kalyan Sinha, Rajeeva Karandikar, C.Musili and others, Understanding Mathematics,University Press.

2.6 Open Elective Course

II. Integral Transforms (Science Stream)

Unit 1:

Integral Transforms, Fourier Integral Theorem, Fourier sine and cosine integrals Fourier complex integral.

Unit 2:

Fourier Transforms, Fourier sine and cosine transforms, Properties, convolution theorem, Parseval's Identity, Parseval's identity cosine transform, Parseval's identity sine transform Fourier transforms of Derivative of a function.

Unit 3:

Solution of Boundary value problems by using integral transform Fourier transforms of partial derivative of a function, Finite Fourier transforms.

Unit 4:

Z- Transforms, Properties, Z- Transform Theorem, Change of Scale, Shifting property.

Unit 5:

Inverse Z- Transform, Solution of Difference equations.

REFERENCES :

1. B.S Grewal, Higher Engineering Mathematics 43rd Edition, Khanna Publication.
2. Lokenath Debnath, Dambaru Bhatta, Integral Transforms and Their Applications, CRC Press.
3. Gerald B. Foland, Fourier Analysis and its applications, AMS.
4. E.M. Stein and R. Shakarchi, Fourier Analysis: An instruction, Princenton University Press, Princenton – 2003.