ರಾಣಿ ಚನ್ನಮ್ಮ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಬೆಳಗಾವಿ

RANI CHANNAMMA UNIVERSITY, BELAGAVI

विद्वान् सर्वत्र पूज्यते

RANI CHANNAMMA UNIVERSITY

VIDYASANGAMA, NATIONAL HIGHWAY-04,
BELAGAVI-591156

- **PROGRAMME OUTCOMES(POs)**
- **PROGRAMME SPECIFIC OUTCOMES(PSOs)**
- **COURSE OUTCOMES(COs)**

DEPARTMENT OF MATHEMATICS

(2019-20)

ರಾಣಿಚನ್ನಮ್ಮ ವಿಶ್ವವಿದ್ಯಾಲಯ, ವಿದ್ಯಾಸಂಗಮ, ಬೆಳಗಾವಿ–591156

Rani Channamma University, Vidyasangam, Belagavi- 591156

School of Mathematics and Computing Sciences

Department of Mathematics

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M.Sc. Mathematics Programme outcomes:

Students of **M.Sc. programme is expect to possess the following abilities,**

- **Attainment of Program Outcomes**

Students of M.Sc. programme is expect to possess the following abilities,

1. To develop observational skills, formulate, evaluate and validate hypothesis based on critical and rigorous reasoning and provide novel solution to challenges that appear in their professional career.
2. To encourage pursuing higher education and research in Mathematics and allied fields,
3. To imbibe in them an attitude of lifelong learning and acquisition of relevant knowledge and skills.

- **Program Specific Outcomes**

M.Sc. Mathematics Programme Specific outcomes:

1. To develop rigorous logical reasoning and Mathematical intuition.
2. To understand fundamental aspects of Mathematics and ability to develop ideas based on them.
3. To provide knowledge and skills to identify potential fields for application of Mathematics.
4. Empower students to face competitive exams like NBHM JRF; CSIR-UGC JRF/NET, SLET and Civil services exams.

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- **Course Outcomes for each Semester and paper wise**

Semester	Course Paper	Course Outcomes
Semester-1 Revised Syllabus 2017-18	**1.1 Algebra-I**	1. To introduce a process of abstraction of basic arithmetic in Elementary number systems to that of a algebraic structure called Groups and discuss I. various class of example of groups II. Results like Sylow theorems structure theorem of finite abelian groups and Jordan-Holder theorem. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	1.3 Real Analysis-I	1. To introduce basic concepts such as GLB and LUB and Euclidean metric for real number system and their abstraction to general metric space. The course discusses a. Bolzano- Weierstrass Theorem and Heine-Borel Theorem. b. Continuity, Uniform Continuity and Differentiability of real valued function of a real variable. c. Intermediate and mean value theorems, Taylors' expansion for differentiable functions. Total variations. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics

	1.2 Topology	1. To introduce a process of abstraction of notion of open sets and continuous maps in Euclidean spaces. The course discusses a. Notions of Connected and Compact Spaces, countable and separation axioms. b. Results like Urysohn Metrization Theorem, Tietze Extention Theorem, Tychonoff Theorem. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	1.4 Linear Algebra	1. The course discusses, a. Vector space theory concepts and Linear Transformation and Functional, Dual Spaces. b. Results likeDirect-Sum Decompositions; Invariant Direct Sums, The Primary Decomposition Theorem. Gram-Schmidt orthonormalization and spectral Theorem. 2. To Expose and imbibe axiomatic theory building including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course forresolution of problems both within and outside of Mathematics
	1.5 Ordinary Differential Equations	1. The course discusses, a. Existence and uniqueness solutions of differential equations. b. Solution to linear ODE using power series methods, introduction to special functions and Phase space analysis. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification.

		3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	1.6 Discrete Mathematical Structures	1. The course discusses, a. Sets, Posets, Lattice, Boolean Algebras and Switching Networks, Group codes, error detection and correction. b. Basic concepts and various class of examples of graphs, Matrix representation of graphs and its properties. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
II- Semester	**2.1 Algebra-II**	1. To introduce a process of abstraction of basic arithmetic in Elementary number systems to that of a algebraic structure called Rings and Fields and discuss a) Various class of example of Rings and Fields. Principal Ideal Domain (PID). Euclidean domain, Polynomial Rings b) Finite fields and field extension. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	2.2 Complex Analysis	1. The course introduces Holomorphic maps, Analytical function and Complex integration and discusses,

		a. Open mapping theorem, Singularities and Residue theorem. b. Normal families and Riemann mapping theorem. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	2.3 Partial Differential Equations	1. The course discusses in detail theory and application of first and second order PDE's, prominently a. Cauchy Method of Characteristic and Monge's Method. b. Existence and Uniqueness results. Parabolic, Elliptic and Hyperbolic equations. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	2.4 Functions of several variables	1. This course is extension of Real Analysis-I and introduces and discusses, a. Integration Theory, Uniform convergence of sequence of functions, Stone- Weierstrass theorem. b. Continuity and differentiability for Vector valued functions of vector variables, Inverse function Theorem, Implicit function Theorem. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification.

		3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	2.5 Classical Mechanics	1. The course discusses in detail a. Coordinate transformations, Fluid Continuum Hypothesis, Stress components and Stress tensors. b. Fundamental basic physical laws, Equations of fluid mechanics. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	2.6 OEC	The course introduces basic concepts of Mathematics.
III-Semester	**3.1 Measure Theory and Integration**	1. The course introduces, a. Lebesgue Measure on real line and corresponding Integration theory. b. Egoroff's theorem, Fatou's lemma, Lebesgue General (Dominated) convergence theorem, Fubini theorems, Radon-Nikodym theorem. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	3.2 Differential Geometry	1. The course introduces, a. Geometry of Paths and Surfaces, Frennet frame fields, Curvature and Torsion.

		b. Manifolds, tangent and normal vector fields, Shape operators, Gaussian curvature.
	3.3 Numerical Analysis	1. The course introduces, a. Solving linear and non-linear system of equations, Gauss-Seidel, LU decomposition methods – Crout's, Cholesky method, Partition method. b. Lagrange, Hermite, Cubic-spline's, Method based on interpolation, Gaussianquadrature, Gauss-Legendre, Gauss-Chebeshev formulas. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	3.4 Elective- I **I - Mathematical Finance**	1. The course introduces, a. Mathematical aspect of financial markets, Methods of Hedging a Stock or Portfolio, Pricing and hedging, Interest Rate Models in discrete and continuum setting. b. I to Calculus and Stochastic Models, Black Scholes formula. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	3.4 Elective- I **II-Fluid Mechanics**	1. The course introduces, a. Euler's Equations of motion. Bernoulli's equation.Kelvin's theorem. b. Two dimensional flows of inviscid fluids, Energy equation, Boundary layer concept. 2. To Expose and imbibe axiomatic theory building,

		including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	3.4 Elective- I III-Commutative Algebra	1. The course introduces, a. Power series ring, Modules, Nakayama lemma, Rings and modules of fractions. b. Noetherian and Artinian modules and rings, Hilbert basis theorem. Hilbert Nullstellensatz. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	3.4 Elective- I IV-Coding Theory	1. The courses introduces, a. Block Codes, Linear Codes and Hamming Codes, BCH Codes and Reed -Solomon Codes, Quadratic Residue codes Codes over Z4, Quaternary codes. b. RiemannRoch Theorem, applications. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	3.5 Elective- II I- Algebraic Topology	1. The course introduces several functors from the category of pointed topological spaces and some category of algebraic system and relevant morphism these include,

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		a. Fundamental group, Singular Homology b. The course also discusses covering space theory and results like Brouwer Fixed Point Theorem and Borsuk-Ulam Theorem. Van Kampen's Theorem. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	3.5 Elective- II **II-Number Theory and Cryptography**	1. The course introduces, a. Legendre symbol, quadratic reciprocity. b. RSA cryptosystem, Fermat factorization, Elliptic curves over finite fields and char 0 fields. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	3.5 Elective- II **III-Fourier Analysis**	1. The course introduces, a. Basic Properties of Fourier Series, Example of Continuous functions with divergent Fourier series, Distributions and Fourier Transforms, Riemann Lebesgue lemma, Fourier Inversion Theorem. b. Tempered Distributions, Convolutions,Applications to PDEs Schrodinger-Equation, Paley-Wienner Theorems, Poisson Summation Formula,Bessel's functions. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification.

		3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	3.5 Elective- II IV - Fuzzy Sets and Fuzzy Systems	1. The course introduces a. Introduction, Crisp sets, Fuzzy sets, Significance and Characteristics. Fuzzy relations, Crisp versus fuzzy sets. b. Fuzzy measure. Evidence theory, Possibility theory versus Probability theory. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	3.6 Open Elective Course	The course introduces basic concepts of Mathematics and Mathematical Statistics.
IV Semester	**4.1 Functional Analysis.**	1. The course introduces a. Banach space,Examples.Dual space of normed linear space, Hahn-Banach theorem and its applications. b. Open mapping theorem , Closedgraph theorem, Hilbert spaces, RieszFisher Theorem. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	4.2 Mathematical Methods	1. The course introduces a. Integral Transforms, Volterra and Fredholm integral equations.Raleigh Ritz and Galerkin

		methods. Asymptotic Methods. b. Laplaces method and Watson's lemma,Regular and singular perturbation methods. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	4.3 Probability Theory	1. The course introduces, a. Random variables, Binomial, Poissonand Normal distribution and their properties. b. Conditional expectation and variance,Analysis of Bi-variate data, fitting of distributions. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	4.4 Elective-I I- Riemannian geometry	1. The course introduces, a. Surfaces and Manifolds, TheoremaEgregium, Gauss-Bonnet formula and EulerCharacteristic. b. Riemannian metric, geodesics andnormal coordinates. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	4.4 Elective-I II-Graph Theory	1. The course introduces, a. Coverings, matchings and factorizations, Hall's

		theorem, Tutt's Theorem, Distance in graphs. b. Algebraic aspects of graph theory, domination in graphsand chemical applications of graph theory. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	4.4 Elective-I III-Mathematical Modeling	1. The course introduces, a. Shock waves and hydraulic jumps, Fundamental concepts in continuous applied mathematics. b. Weak discontinuities,Inviscid limit and Laplace's method. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	4.4 Elective-I IV-Galois Theory	1. The course introduces, a. Separable and normal field Extensions,Artin's Theorem, Norm and Trace. b. Galois groups of quadratic, cubic and quartic polynomials over the rational field. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	4.5 Elective-II I-Advanced	1. The course introduces, a. Initial value problems, Boundary- Value

	Numerical Methods	problems, Finite difference methods for Parabolic equations in one-dimension. b. A.D.I. method for two - dimensional parabolic equation, Stability and convergence analysis for hyperbolic equations. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	4.5 Elective-II II-Banach Algebra	1. The course introduces, a. Banach spaces, Weak topologies on Banach spaces,Spectral Mapping Theorem, group of invertible elements. b. Gelfand Topology,Applications to Non-Commutative Banach Algebras. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	4.5 Elective-II III-Operations Research	1. The course introduces, a. The linear programming problem,General Primal-Dual pair, simplex method. b. Transportation problem, MODI method, Game Theory, Integer Programming. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics

	4.5 Elective-II IV-Computational Complexity	1. The course introduces, a. Turing machines; determinism and non-determinism, time complexity and space complexity. b. structure of complexity classes NP, P, NL, L, PSPACE. 2. To Expose and imbibe axiomatic theory building, including Experimentation, pattern recognition, formulation of claim statement rigorous logical justification. 3. To enable students to Explore possible application of theory and result discussed in the course for resolution of problems both within and outside of Mathematics
	4.6 PROJECT	To expose students to develop abilities to understand new concepts by means of self- study.

Ph.D Programme Outcomes

- **Attainment of Program Outcomes**

Students of Ph.D programme is expect to possess the following abilities,

1. To develop observational skills, formulate, evaluate and validate hypothesis based on critical and rigorous reasoning and provide novel solution to challenges that appear in their professional career.
2. To encourage pursuing higher education and research in Mathematics and allied fields,
3. To imbibe in them an attitude of lifelong learning and acquisition of relevant knowledge and skills.

- **Program Specific Outcomes**

Ph.D Mathematics Programme Specific outcomes:

1. To develop rigorous logical reasoning and Mathematical intuition.
2. To understand fundamental aspects of Mathematics and ability to develop ideas based on them.
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Empower students to face competitive exams like NBHM JRF; CSIR-UGC JRF/NET, SLET and Civil services exams.

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