Sant Gadge Baba Amravati University, Amravati

Department of Mathematics

Programme Outcomes, Programme Specific Outcomes and Course Outcomes

2.6 Student Performance and Learning Outcomes

2.6.1 Program outcomes, program specific outcomes and course outcomes for all programs

Expected Program Objective & Outcomes

At the end of the program, keeping the current National & International status of the program, the student will be able to:

- Apply the knowledge of mathematical concepts in interdisciplinary fields.
- Pursue research in challenging areas of pure/applied mathematics.
- Professionally inclined Mathematics educators who have sound knowledge of subject matter and specialized in constructivist & alternate pedagogy.
- Qualify national level tests like NET/GATE and other competitive examinations.
- Model the real-world problems in to mathematical equations and draw the inferences by finding appropriate solutions
- Communicate mathematical ideas with clarity and coherence, both written and verbally.

M.Sc. Mathematics

(Two year program)

Programme Educational Objectives:

PEO1: To train students to develop their positive attitude, skills which will enable them to become a multi facet personality shining in any chosen field.

PEO2: To prepare them to go for higher level studies and pursue research.

PEO3: Enhances Logical reasoning skills, arithmetic skills, aptitude skills, communication skills, self confidence for better employability.

PEO4: To introduce the fundamentals of Mathematics to strengthen the students logical and analytical ability.

Programme Outcomes (PO):

PO1: Investigate mathematical problems and solutions in a variety of contexts related

to science, technology, business and industry, and illustrate these solutions using symbolic, numeric, or graphical methods.

PO2: Apply the knowledge of mathematics to address real life problems.

PO3: Gain the knowledge of software which will be useful in Research.

PO4: Acquire the strong foundation of knowledge which will benefit to them become a good academician.

PO5: Qualify various competitive exams like CSIR-UGC NET, SET, SLET, GATE, MPSC, UPSC, GRE, TOFFEL, G-PAT, G-MAT, JAM etc.

Programme Specific Outcomes (PSO):

PSO1: To enhance self learning and improve own performance.

PSO2: To perform research in conjunction with others as well as individually.

PSO3: To imbibe effective scientific and technical communication in both oral and writing.

PSO4: To develop problem solving skills, thinking and creativity.

PSO5: To produce next generation researchers in mathematics.

M.Sc.-I (Semester-I)

Paper- I (101) : Real Analysis

Course Objective: This course is intended to expose you to the basic ideas of Real Analysis. In particular the concept of convergence, uniform convergences, power series and the application of function of several variables.

Course Outcomes:

After completion of this course, student will be able to

CO1:Define Riemann Stieltjes integral and illustrate the properties of integration and differentiation.

CO2: Acquire the knowledge of sequence, series and uniformly convergence of series by different Test.

CO3: To understand the statement and prove of important theorems.

CO4: Apply the Taylors, Inverse function and Implicit function theorems to solve the problems.
CO5: Apply the differentiation to find out the maximum and minimum value of a functions.

M.Sc.-I (Semester-I)

Paper- II (102) : Advanced Abstract Algebra

Course Objective: This course is aimed to provide an introduction of normal subgroups, permutation groups, concept and to develop working knowledge of Ideals , Principle Ideal Domain, Euclidean Domain, Unique Factorization Domain and Modules.

Course Outcomes:

The successful completion of this course, student will be able to

CO1: Gain knowledge of normal subgroups, permutation group, normal series, solvable group and nilpotent group.
CO2: Apply the sylows first, second and third theorems.
CO3:.To simplify algebraic expression, using the commutative , associative and distributive properties.
CO4: Apply the concept and properties of group, rings to module.

M.Sc.-I (Semester-I)

Paper- III (103) : Complex Analysis

Course Objective: The objective of this course is to introduce the fundamental ideas of the functions of complex variables and developing a clear understanding of the fundamental concepts of Complex Analysis such as analytic functions, complex integrals and a range of skills which will allow students to work effectively with the concepts. It begins with the exploration of the algebraic, geometric and topological structures of the complex number field.

Course Outcomes:

At the end of this course a student will be able to :

CO1: Becoming familiar with the concepts Complex numbers and their properties and operations with Complex number.
CO2: Evaluating limits and checking the continuity of complex function.
CO3: Checking differentiability and Analyticity of functions.

CO4: Evaluate Complex integrals and applying Cauchy integral.
CO5: Understand how complex numbers provide a satisfying extension of the real numbers.

CO6: To understand certain theorems like Casorti-wierstrass theorems, Hadamards three circle theorem, Hurwitz theorem.

M.Sc.-I (Semester-I)

Paper- IV (104) : Topology-I

Course Objective: The objective of this course is to introduce the fundamental ideas of Topological Spaces and developing a clear understanding of the fundamental concepts of Topology such as Connectedness, Compactness, continuity, separation and countability axioms. Topology is concerned with the properties of a geometric object that are preserved under continuous deformations, such as stretching, twisting, crumpling and bending, but not tearing or gluing .

Course Outcomes:

The successful completion of this course, student will be able to

CO1: Define and illustrate the concept of topological spaces and continuous functions.

CO2: Define and illustrate the concept of the separation axioms.

CO3: Define connectedness and compactness, and prove related theorems.

CO4: Define and illustrate the concept of the countability axioms.

M.Sc.-I (Semester-I)

Paper- V (105) : Differential Geometry (Optional)

Course Objective: Our course will focus on the geometry of curves and surfaces in 3-dimensional Euclidean space. We'll learn about such things how to find the shortest distance between two points, how to measure curvature, and how to find and use the shortest paths on a surface. We'll explore the relationship between the length of a curve and the area bounded by it (the isoperimetric inequality),

applications to soap bubbles, and the relationship between the curvature and the topology of a surface (the Gauss-Bonnet theorem).

Course Outcome (CO) :

At the end of this course a student will be able to :

CO1: Use geometric quantities such as length, curvature, and torsion associated to planar and spatial curves

CO2: Prove the isoperimetric inequality and the "Four vertex theorem" for convex curves

CO3: Define, use, and articulate the differences between normal curvature, geodesic Curvature, Gaussian curvature, and mean curvature

CO4: State, apply, and prove parts of the Gauss-Bonnet theorem

CO5: Discuss Gauss Bonnet theorem and its implication for a geodesic triangle

CO6: To understand surfaces of revolution with constant negative and positive Gaussian curvature.

CO7: Introduced to Christoffel symbols and their expression in terms of metric coefficients and their derivatives.

M.Sc.-I (Semester-I)

Paper- V (106) : Advanced Discrete Mathematics (Optional)

Course Objective: The objective of this course is to provide the fundamentals and the concepts of discrete mathematical structures with applications to computer Sciences including Mathematical Logic, Boolean Algebra and its Applications, Switching circuit & Logic Gates, Graphs and Trees. Important theorems with constructive proofs, real life problems & graph theoretic algorithms and help the students to understand the computational and algorithmic aspects of Semigroups, Monoids, Mathematical Logic, Lattice Theory , Boolean Algebra, Graphs, Trees and Algebraic Structure in the field of Computer sciences and its applications.

Course Outcome (CO) :

At the end of this course a student will be able to:

CO1: Demonstrate knowledge of how Tautologies, Quantifiers, Predicates and Validity are defined.

CO2: Explain the homomorphism of semigroups and monoides and Direct products.

CO3: Explain Boolean algebra and circuit design.

CO4: Describe Lattices and Posets and their use.

CO5: Application of Boolean algebra of switching theory using AND, OR and NOT gates.

M.Sc.-I (Semester-II)

Paper- VI (201) : Measure and Integration Theory

Course Objective: The aim of thiscourse is to introduce the Lebesgue integral, which does not suffer from these draw-backs and agrees with the Riemann integral whenever the latter is defined. It introduces abstract integration theory for functions on measure spaces. Also, this course will improve problem solving and logical thinking abilities of the students.

Course Outcome (CO) :

From this course a student will be able to :

CO1: Acquire the knowledge and understanding of basic concepts of measure and integration theory.

CO2: Explain measure and outer measure, extension of measure.

CO3: Reflection of understanding of the theory on the basis of examples of application.

CO4: It includes Transferable skills such as ability to use abstract methods to solve problems and ability to use a wide range of references and critical thinking.

CO5: Understand the L^P uniqueness of extension and derived proof of some theorems.

M.Sc.-I (Semester-II)

Paper- VII (202) : Advanced Linear Algebra and Field Theory

Objectives: The focus of this course is to understand the concept of eigen values and eigenvectors which are applicable for diagonalization. Also we will study fields, Galois theory of field extensions and applications to geometry and theory of equations.

Course Outcome (CO) :

Upon successful completion of this course student, will be able to :

CO1: Construct, or give examples of, mathematical expressions that involve vectors, matrices, and linear systems of linear equations.

CO2: Evaluate mathematical expressions to compute quantities that deal with linear systems and eigenvalue problems.

CO3: Analyze mathematical statements and expressions (for example, to assess whether a particular statement is accurate, or to describe solutions of systems in terms of existence and uniqueness).

Co4: Solve linear systems represented as linear transform

CO5: Explain the fundamental concepts of field extensions and Galois theory and their role in modern mathematics and applied context

CO6: Demonstrate accurate and efficient use of field extensions and Galois Theory
CO7: Demonstrate capacity for mathematical reasoning through analyzing, proving and explaining concepts from field extensions and Galois theory.

M.Sc.-I (Semester-II)

Paper- VIII (203) : Integral Equation

Objectives: The objective of the course is to study integral equations and to know that what is the relationship between the integral equations and ordinary differential equations and how to solved the linear and non linear integral equations by different methods with some problems which give rise to Integral Equations.

Course Outcome (CO) :

The Successful completion of this course the student, will be able to :

CO1: Solve linear Volterra and Fredholm integral equations using appropriate methods.

CO2: Understand the relationship between integral and differential equations and transform one type into another.

CO3: Formulate and solve initial and boundary value problems for the heat and wave equations in spherical and cylindrical coordinates.

CO5: Find out the iterate kernel and Resolvent kernel of Volterra, Fredholm integral equation.

CO6: Application of integral equation and greens function to solve ordinary differential equation.

M.Sc.-I (Semester-II)

Paper- IX (204) : Topology-II

Objectives: This course is aimed to introduce the fundamental ideas of metric spaces and developing a clear understanding of the fundamental concepts of metric spaces such as product space, metrization and paracompactness.

Course Outcome (CO) :

The Successful completion of this course the student, will be able to :

CO1: Define and illustrate the concept of product topology and quotient topology.

CO2: Define complete metric space, product space and prove the related theorems.

CO3: Understand theorems like the Urysohn's Lemma , Urysohn's Metrization Theorems.

CO4: Demonstrate knowledge and understanding of concepts such as point wise convergence and uniform convergence of Topology.

M.Sc.-I (Semester-II)
Paper- X (205): Riemannian Geometry (Optional)

Objectives: The aim of this course is to cover the basics of Riemannian geometry. Express the kinds of christoffel symbols with tensor and study the Bianchi identity along with derivation of equation of Geodesic.

Course Outcome (CO):

At the end of this course the students, should be able to:

CO1: Understand the types of Christoffel's symbol and calculate the Christoffel's symbol of different line element.
CO2: Derived and apply the equation of geodesic curve.
CO3: Reproduce the key results on Riemannian geometry, their curvature and their geodesics, and give rigorous and detailed proofs of them.
CO4: Compute the Einstein's tensor for static and non-static spherically symmetric RW-space time, Bianchi identity.
CO5: Define and illustrate the Riemannian Curvature.

M.Sc.-I (Semester-II)
Paper- X (206): Advanced Discrete Mathematics-II (Optional)

Objectives: Focus of this course, to develop the knowledge of basic graphs, spanning trees and core idea in computability theory. Apply concept of matrix representation of graphs.

Course Outcome (CO):

The Successful completion of this course:

CO1: Students will understand the language of graphs and trees.
CO2:Students will understand the use of graphs as models.
CO3**:** Students will understand various types of trees and methods for traversing trees.
CO4: Students will understand the ideas of finite state machines and their transition table diagrams.
CO5: Student will define and illustrate the turing machine and partial recursive function.
CO6: Student will describe and solve some real time problems using concepts of graph theory .

M.Sc.-II (Semester-III)
Paper- XI (301): Functional Analysis-I

Objectives: The aimed of this course is to introduce students to the ideas and some of the fundamental theorems of functional analysis. To provide a working knowledge of the basic properties of Banach spaces, Hilbert spaces, bounded linear operators, compact linear operator and inner product space.

Course Outcome (CO):

On successful completion of this course, students will be able to:

CO1: Appreciate how functional analysis uses and unifies ideas from vector spaces, the theory of metrics, and complex analysis.

CO2: Understand and apply fundamental theorems from the theory of normed and Banach spaces, including the Hahn-Banach theorem, the open mapping theorem and the closed graph theorem.

CO3: Appreciate the role of Inner product space.

CO4: Understand and apply ideas from the theory of Hilbert spaces to other areas.

CO5: Understand the fundamentals of spectral theory, and appreciate some of its power.

M.Sc.-II (Semester-III)
Paper- XII (302): Advanced Mechanics

Objectives: The objectives of this course are to introduce the concept of Legenders transformation and canonical transformation. In particular, derived the the Hamiltonian Jacobi equation in in all coordinates and explain the perturbation theory.

Course Outcome (CO):

At the end of this course the students, should be able to:

CO1: Derived the Lagrange's equation and Hamilton principle.

CO2: Understand the concept of Legendre's transformation and apply to derived the Hamilton's Equation.

CO3: Understand the concept of canonical transformation and apply to derived Poisson's Identity.

CO4: Demonstrate knowledge and understanding of Perturbation Theory.

M.Sc.-II (Semester-III)
Paper- XIII (303): Operations Research

Objectives: This course aim to introduce students to use quantitive methods and techniques for effective decisions–making; model formulation and applications that are applied to problems in business, industry and society.

Course Outcomes:
At the end of this course a student will be able to :

CO1: Solve many financial decision making problems by using linear programming technique.

CO2: Explain the graphical solution of linear programming problem by different method.

CO3: Develop all skill and technique of problem solving.

CO4: Acquire the knowledge and understanding of Queing system.

CO5: Define and illustrate Game and strategies.

M.Sc.-II (Semester-III)
Paper- XIV (304): Fluid Dynamics –I (Optional)

Objectives: The objectives of this course is to introduce fundamental aspects of fluid flow behaviour and to develop steady state mechanical energy balance equation for fluid flow systems, estimate pressure drop in fluid flow systems and determine performance characteristics of fluid machinery.

Course Outcomes:
At the end of this course a student will be able to :

CO1: Develop appreciation properties of fluids.

CO2: Derived Euler's equation, Bernoulli's equation and Discuss the case of steady motions under conservative body forces.

CO3: Apply concepts of mass, momentum and energy conservation to flows,

CO4: Prove Milne- Thomson Circle theorem and derived some application.

CO5: Understand the concept of elements of thermodynamics and explain Entropy-Maxwell's Thermodynamics relation.

M.Sc.-II (Semester-III)
(305): General Relativity (Optional)

Objectives: The focus of this course to introduce students to the field of general relativity. To provide conceptual skills and analytical tools necessary for astrophysical and cosmological applications of the theory.

Course Outcomes:
Upon successful completion of this course it is intended that a student will be able to:

CO1: Familiar with the fundamental principles of the general theory of relativity. They shall know the meaning of basic concepts like the equivalence principles, inertial frames and time dilation.

CO2: Understand the concept of constant relative motion of different bodies in different frames of reference.

CO3: Solve Einstein's field equations for static spherically symmetric problems and for isotropic and homogeneous cosmological models.

CO4: Find out the Schwarzschild Exterior and Schwarzschild Interior solutions.

CO5: Give a mathematical description of gravitational waves in context of Einstein's relativity.

M.Sc.-II (Semester-III)

(306): Difference Equation-I (Optional)

Objectives: The aimed of this course to introduced difference calculus and use of difference equation as approximation to ordinary and partial differential equation. Also we apply z-transforms to the solution of certain types of difference equation.

Course Outcomes:
Upon successful completion of this course it is intended that a student will be able to:

CO1: Invert z-transforms using partial fractions or residues where appropriate
CO2: Solve constant coefficient linear difference equations using z-transforms

CO3: Understand the key aspect in the inversion of the z-transform as well as demonstrating the use of partial fractions.

CO4: Find out the solution of first order difference equation by successive calculation.
CO5: Understand the concept of Asymptotic methods, apply into linear and nonlinear equation.

M.Sc.-II (Semester-III)
(307): Advanced Complex Analysis (Optional)

Objectives: This course is aimed to provide an introduction to the theories for functions of a complex variable. It begins with the exploration of the algebraic, geometric and topological structures of the complex number field.

Course Outcomes:

On completion of this course students should be able to:

CO1: Explain Riemann mapping theorem and derived Weierstrass factorization theorem.

CO2: Understand Gamma and Zeta functions, their properties and relationships.

CO3: Understand the Harmonic functions on a disc and concerned results.

CO4: Explain the relationship between Poisson-Jensen's formula and Derived Hadamard's factorization theorem.

CO5: Acquire the knowledge of range of analytic function and derived theorems.

M.Sc.-II (Semester-III)
(308): Banach Algebra-I (Optional)

Objectives: The focus of this courseto give sufficient knowledge of the subject, which can be used by student for further applications in their respective domains of interest.

Course Outcomes:

The students are expected to thoroughly grasp the following:

CO1: Understand and illustrate the concept of Banach algebra.

CO2: Define Spectral radius and derived Spectral mapping theorems.

CO3: Understand and illustrate C* - algebra .

CO4: Described the C* - algebra and its properties.

M.Sc.-II (Semester-IV)
Paper- XVI (401): Functional Analysis-II

Objectives: The aimed of this course is to focus students on adjoint operator and reflexivity. To provide a working knowledge of spectral theory in bounded self adjoint linear operator and demonstrate significant applications of the theory of functional analysis.

Course Outcome (CO):

On successful completion of this course, students will be able to:

CO1: Define and illustrate the concept of reflexivity of Hilbert space.
CO2: Understand the fundamentals of spectral theory, and appreciate some of its theorems..
CO3: Understand the statement and proofs of important theorems and be able to explain the key steps in proofs, sometimes with variation.
CO4: Define and illustrate the projection operators.

M.Sc.-II (Mathematics)
Paper- XVII (402): Partial Differential Equation

Objectives: This course will focus on the formulation of first and second order partial differential equations (PDEs) for three basic types of hyperbolic, parabolic and elliptic equations. Also problem solving of PDEs which include heat, wave and Laplace' s equation that arise in various physical systems.

Course Outcome (CO):

Upon successful completion this course, the student will be able to:

CO1: Find solutions of partial differential equations and determine the existence, uniqueness of solution of partial differential equation.
CO2: Find out the complete integral by Charpits method and also find the particular integral, singular integral
CO3: Solve simple eigenvalue problems of Sturm-Liouville type.
CO4: Classify partial differential equations into Linear equation, Semi linear, Quasi-linear and nonlinear equations..
CO5: Understand the Dirichlet problem, Neumann problem and apply to solve problem for half plane.
CO6: Derived the Heat conduction problem and prove Kelvin's inversion theorem.

M.Sc.-II (Mathematics)

Paper- XVIII (403): Numerical Analysis

Objectives: The primary objective of the course is to develop the basic understanding of numerical analysis and skills to implement methods to solve mathematical problems and the overall goal of the numerical analysis is to design and analysis of techniques to give approximate but accurate solutions to hard problems.

Course Outcome (CO):

At the end of this course the students, should be able to:

CO1:Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.
CO2: Apply numerical methods to obtain approximate solutions to mathematical problems.
CO3: Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
CO4: Analyse and solve several errors and approximation in numerical methods.
CO5: Apply several methods to solve Curve Fitting and Interpolation questions and its related techniques.

M.Sc.-II (Mathematics)

Paper- XIX (404): Fluid Dynamics-II

Objectives: This course is designed to reflect the wide applications of Fluid Dynamics. There is an increasing demand for Fluid Dynamics specialists with practical and technical knowledge. Also , this course will improve problem solving and logical thinking abilities of the students.

Course Outcome (CO):

On successful completion of this course, students will be able to:

CO1: Apply scientific method strategies to fluid mechanics to analyse qualitatively and quantitatively the problem situation, propose hypotheses and solutions.

CO2: Understand the compressibility effects in real fluids and derived the one, two, three dimensional wave equation.

CO3: Define and illustrate Viscous Flow, apply to solve problems.

CO4: Understand concept of Magneto hydrodynamics and derived Maxwell's electromagnetic field equation.

CO5: Acquire the knowledge of boundary layer and apply to solve problems.

M.Sc.-II (Semester-IV)
(405): Relativistic Cosmology (Optional)

Objectives: This course intends to present the scope and aims of relativistic cosmology at present, and to show that there are still a series of significant and interesting problems that are presently unsolved, and in some cases have not even been seriously addressed.

Course Outcomes:

Upon successful completion of this course it is intended that a student will be able to:

CO1: Derived De-sitter model and Explain Einstein Field equation with cosmological term.

CO2: Understand De-sitter model, there derivatives, properties and comparison with the actual universe.

CO3: Explains the cosmological principle, Hubble's law, Weyls Postulate and Steady State Cosmological Models.

CO4: Study the motion of particle and light rays in R-W model.

CO5: Understand and apply the knowledge of gravitational waves in curved space time.

CO6: Show how the Friedman-Robertson-Walker metric is an exact solution to the Einstein equations.

CO7: Describe the key ideas behind cosmology and the expanding universe.

M.Sc.-II (Semester-IV)

(406): Difference Equation-II (Optional)

Objectives: The aimed of this course to introduced difference calculus and use of difference equation as approximation to ordinary and partial differential equation.

Course Outcomes:
Upon successful completion of this course it is intended that a student will be able to:
CO1: Know the important theorems and their application.
CO2: Successfully obtain the series solution of various types of linear and nonlinear differential equations

CO3: Find out the solution of second order difference equation by successive calculation.

CO4: Explain the boundary value problem for linear and non linear equation.
CO5: Find out the solution of partial differential equation.

M.Sc.-II (Semester-IV)
(407): Lie Groups (Optional)

Objectives: The focus of this course to understand the geometry of differential equation. Also to introduced concept of Lie groups, within the wider terminology and machinery of differential geometry.

Course Outcomes:
At the end of this course a student will be able to :

CO1: Study the structure theory of Lie group and prove the theorem.

CO2: Define and illustrate the concept of Topological groups.

CO3: Understand the knowledge of transformation of Lie groups.

CO4: Explain the Taylor's theorem for Lie groups.

CO5: Explain the relationship of Maurer-Chartan forms and prove the converse of Lie first and second theorems.

M.Sc.-II (Semester-IV)
(408): Banach Algrebra-II (Optional)

Objectives: The focus of this courseto give sufficient knowledge of the subject, which can be used by student for further applications in their respective domains of interest.

Course Outcomes:

The students are expected to thoroughly grasp the following:

CO1: Derived spectral theorems and apply concept of C* - algebra.

CO2: Understand and acquire the knowledge of strong, weak operator topologies.

CO3: Prove Kaplansky Density theorems and understand the concept of commutant.

CO4: Apply Kaplansky's formula and explains various types of projections.