FYUGP in Mathematics

Programme Outcomes (POs):

Disciplinary Knowledge : Being able to demonstrate comprehensive knowledge and coherent understanding of both the theoretical and applied components of mathematics as well as chosen interdisciplinary areas of study in a broad multidisciplinary context; ability to connect relevant disciplines, as well as recent innovations, with the learning disciplines of choice.

Communication Skills: Ability to communicate various mathematical concepts effectively using examples and their geometrical visualization. The skills and knowledge gained in this programme will lead to the proficiency in analytical reasoning which can be used for modelling and solving of real life problems.

Critical Thinking and Analytical Reasoning: The students undergoing this programme acquire ability of critical thinking and logical reasoning and capability of recognizing and distinguishing the various aspects of real life problems.

Problem Solving: The Mathematical knowledge gained by the students through this programme develop an ability to analyse the problems, identify and define appropriate computing requirements for its solutions. This programme enhances students overall development.

Research Related Skills: The completing this programme develop the capability of inquiring about appropriate questions relating to the Mathematical concepts in different areas of Mathematics.

Information/Digital Literacy: The completion of this programme will enable the learner to use appropriate software to compute various types of numerical calculations.

Cooperation/Team Work: Ability to collaborate with diverse teams in an effective and respectful manner; capacity to cooperate with people from varied backgrounds in the interests of a common goal.

Lifelong Learning: This programme provides self-directed learning and lifelong learning skills. This programme helps the learners to think independently and develop algorithms and computational skills for solving real world problems.

Reflective Thinking: An understanding of how a researcher or an investigator influences and shapes the information one creates; ability to formulate appropriate questions pertaining to the ideas in various branches of mathematics in order to propose new solutions using the domain knowledge of mathematics; ability to interpret the findings and use them to solve a variety of problems found in numerous fields of mathematics and real-life.

Course Objectives and Course Learning Outcomes:

Semester: First

Course Name: Classical Algebra (MAT-101) (Core Course)

Course Objective:

The primary objective of this course is to introduce the basic tools of complex numbers, theory of equations, matrices and matrix method of solution of homogeneous linear equations up to four variables.

Course Learning Outcomes:

This course will enable the students to:

- Employ De Moivre's theorem in a number of applications to solve numerical problems.

- Learn the basic concepts of exponential, logarithmic and hyperbolic functions of complex numbers.

- Learn how to find the nature of the roots of a given polynomial equation by Descartes' rule, also learn about symmetric functions of the roots for cubic and biquadratic equations.

- Learn how to solve cubic and biquadratic equations.

- Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix. Finding inverse and rank of a matrix.

Semester: Second

Course Name: Calculus (MAT-151) (Core Course)

Course Objective:

Calculus is referred as 'Mathematics of Change' and is concerned with describing the precise way in which changes in one variable relate to the changes in another. Through this course, students can understand the quantitative change in the behaviour of the variables and apply them on the problems related to the environment.

Course Learning Outcomes:

The students who take this course will be able to:

- Understand continuity and differentiability in terms of limits.
- Describe asymptotic behaviour in terms of limits involving infinity.
- Understand the importance of mean value theorems.

Semester: Third

Course Name: Ordinary Differential Equations (MAT-201) (Core Course)

Course Objective:

The main objective of this course is to introduce the students to the exciting world of differential equations and their solutions methods.

Course Learning Outcomes:

The students who take this course will be able to:

- Learn basics of 1st order ordinary differential equations and 2nd order linear differential equations
- Learn different techniques for solving the differential equations.

Semester: Fourth

Course Name: Real Analysis (MAT-251)

Course Objective:

The course will develop a deep and rigorous understanding of real line **R** and of defining terms to prove the results about convergence and divergence of sequences and series of real numbers. These concepts have wide range of applications in real life scenario.

Course Learning Outcomes:

The students who take this course will be able to:

- Understand many properties of the real line **R**, including completeness and Archimedean properties.

- Learn to define sequences in terms of functions from **N** to a subset of **R**.

- Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.

- Apply limit comparison tests for convergence, the ratio, root, Raabe's, integral tests for convergence of an infinite series of real numbers.

- Alternating series and absolute convergence of an infinite series of real numbers.

Course Name: Complex Analysis (with practical) (MAT-252)

Course Objective:

The main objective of this course is to develop a deep understanding of the complex plane together with various related concepts. These concepts have wide applicability in different aspects.

Course Learning Outcomes:

The students who take this course will be able to:

- Learn the significance of differentiability of complex functions leading to the understanding of Cauchy–Riemann equations.

- Learn some elementary functions and evaluate the contour integrals.

- Understand the role of Cauchy–Goursat theorem and the Cauchy integral formula.

Course Name: Analytical Geometry (MAT-253)

Course Objective:

The primary objective of this course is to introduce some basic tools of two-dimensional and three-dimensional coordinate systems and also to familiarise the use of Vector Algebra in Coordinate Geometry.

Course Learning Outcomes:

The students who take this course will be able to:

- transform coordinate systems

- learn about pair of straight lines

- have a clear understanding of the conic sections and related properties

- recognise three dimensional surfaces represented by equations of the second degree

- learn two different systems of coordinates which are very useful to define the position of a point in space

- acquire basic concepts of Vector Algebra and understand the use of geometric view of vectors in Coordinate Geometry.

Course Name: Number Theory (MAT-254)

Course Objective:

The primary objective of this course is to develop students' understanding of integers, with a focus on their properties and representations, as well as their understanding of number theoretic analysis.

Course Learning Outcomes:

The students who take this course will be able to:

- Explain division algorithm, Euclid's algorithms and greatest common divisor.

- Explain the concepts of congruences, linear congruences.

- Explore the Chinese Remainder theorem to solve simultaneous linear congruences.

- Explain Fermat's theorem and Wilson's theorem.

- Solve a range of problems in number theory

- Apply mathematical ideas and concepts within the context of number theory.

- Communicate number theoretic techniques to a mathematical audience.

Semester: Fifth

Course Name: Abstract Algebra (MAT-301)

Course Objective:

The primary objective of this course is to introduce abstract mathematical objects, viz. groups, rings and fields and study their properties. It is also focussed to study the consequences of these mathematical structures.

Course Learning Outcomes:

The students who take this course will be able to:

- Recognize the mathematical objects called group, ring and fields.

- Link the fundamental concepts of groups and symmetries of geometrical objects.

- Explain the significance of the notion of Permutation groups, cosets, cyclic groups, normal subgroups, factor groups.

- Analyse consequences of Lagrange's theorem and Fermat's Little theorem.

- Describe structure preserving mappings between groups and their consequences.

- Describe the fundamental concepts in ring theory such as of the subrings, integral domains, ideals, factor rings and fields.

Course Name: Multivariate Calculus (MAT-302)

Course Objective:

To understand the extension of the studies of single variable differential and integral calculus to functions of two or more independent variables. Also, the emphasis will be on the use of Computer Algebra Systems by which these concepts may be analyzed and visualized to have a better understanding. This course will facilitate to become

aware of applications of multivariable calculus tools in physics, economics, optimization, and understanding the architecture of curves and surfaces in plane and space etc.

Course Learning Outcomes:

The students who take this course will be able to:

- Learn the conceptual variations when advancing in calculus from one variable to multivariable discussion.

- Understand the maximization and minimization of multivariable functions subject to the given constraints on variables.

- Learn about inter-relationship amongst the line integral, double and triple integral formulations.

- Familiarize with Green's, Stokes' and Gauss divergence theorems.

Course Name: Theory of Real Functions (MAT-303)

Course Objective:

The primary objective of this course is to study limit point of set and limit of a function. The discussion on continuous functions and differentiability with some related theorems will also be focused in this course.

Course Learning Outcomes:

The students who take this course will be able to:

- Have a rigorous understanding of the concept of limit of a function.

- Learn about continuity and uniform continuity of functions defined on intervals.

- Understand geometrical properties of continuous functions on closed and bounded intervals.

- Learn extensively about the concept of differentiability using limits, leading to a better understanding for applications.

- Know about applications of mean value theorems and Taylor's theorem

Course Name: Numerical Analysis (with practical) (MAT-304)

Course Objective:

To comprehend various computational techniques to find approximate value for possible root(s) of non-algebraic equations, to find the approximate solutions of system of linear equations and Quadratic equations.

Course Learning Outcomes:

The students who take this course will be able to:

- Learn some numerical methods to find the zeroes of nonlinear functions of a single variable and solution of a system of linear equations, up to a certain given level of precision.

- Know about iterative and non-iterative methods to solve system of linear equations

- Know interpolation techniques to compute the values for a tabulated function at points not in the table.

- Integrate a definite integral that cannot be done analytically.

- Find numerical differentiation of functional values.

- Solve differential equations that cannot be solved by analytical methods.

Semester: Sixth

Course Name: Linear Algebra (MAT-351)

Course Objective:

The objective of this course is to introduce the students with the fundamental theory of linear spaces and also emphasizes the application of techniques using the adjoint of linear operator and minimal solutions to systems of linear equations.

Course Learning Outcomes:

The students who take this course will be able to:

- Learn about linear spaces and their general properties, linear dependence and linear independence of vectors, bases and dimensions of vector spaces

- Basic concepts of linear transformations, dimension theorem, matrix representations of linear transformations, and the change of coordinate matrix.

- Compute the characteristic polynomial, eigenvalues, eigenvectors and eigenspaces, as well as the geometric and the algebraic multiplicities of an eigenvalue and apply the basic diagonalization result.

- Compute inner products and determine orthogonality on vector spaces including Gram-Schmidt orthogonalization to obtain orthonormal basis.

Course Name: Partial Differential Equations (with practical) (MAT-352)

Course Objective:

The main objectives of this course are to teach students to form and solve partial differential equations and use them in solving some physical problems.

Course Learning Outcomes:

The students who take this course will be able to:

- Formulate, classify and transform first order PDEs into canonical form.

- Learn about method of characteristics and separation of variables to solve first order PDE's.

- Classify and solve second order linear PDEs.

- Learn about Cauchy problem for second order PDE and homogeneous and non-homogeneous wave equations.

- Apply the method of separation of variables for solving many well-known second-order PDEs.

Course Name: Metric Spaces (MAT-353)

Course Objective:

The objective is to develop the usual idea of distance into an abstract form on any set of objects, maintaining its inherent characteristics, and the resulting consequences.

Course Learning Outcomes:

The students who take this course will be able to:

- Learn various natural and abstract formulations of distance on the sets of usual or unusual entities. Become aware one such formulations leading to metric spaces.
- Analyse how a theory advances from a particular frame to a general frame.
- Appreciate the mathematical understanding of various geometrical concepts, viz. Balls or connected sets etc. in an abstract setting.
- Learn about the two important topological properties of metric spaces, namely connectedness and compactness.

Course Name: Mechanics (MAT-354)

Course Objective:

The course aims at understanding the various concepts of physical quantities and the related motion of bodies under the action of forces.

Course Learning Outcomes:

The students who take this course will be able to:

- Know about the concepts in statics such as moments, couples, equilibrium in both two and three dimensions.

- Understand the theory behind friction and center of gravity.

- Know about conservation of mechanical energy and work-energy equations.

- Learn about translational and rotational motion of rigid bodies.