**Programme Outcome,Programme Specific Outcome & Course Outcome of**



**DEPARTMENT OF MATHEMATICS, GOALPARA COLLEGE,**

**GOALPARA, ASSAM**

 **Program Outcomes of B.Sc course**

 After completion of B.Sc course, the students are expected to:

1. Gain knowledge about the scientific and mathematical facts related to various subjects in pure and applied sciences
2. Understand the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their occurrences as well as significances in everyday life
3. Develop the skill of observations and the ability to draw logical inferences from the scientific facts, figures, data and experiments
4. Acquire the skills in handling scientific instruments, mathematical software, planning and performing in laboratory experiments
5. Acquire the ability to think creatively to propose novel ideas useful to the society at large
6. Realize that the interdisciplinary approach will help in providing better solutions and create new ideas for the sustainable development of the world and the mankind
7. Imbibe ethical, moral and social values in personal and social life leading to highly cultured and civilized personality
8. Develop various communication skills such as reading, listening, speaking, etc., which will help in expressing ideas and views clearly and effectively
9. Develop flair by participating in various social and cultural activities voluntarily, in order to spread knowledge, create awareness about the social evils, blind faith, etc.
10. Realize that pursuit of knowledge is a lifelong activity and in combination with untiring efforts and positive attitude and other necessary qualities lead towards a successful life.

**Program Specific Outcomes (PSOs) of B.Sc Mathematics**

 After completion of B.Sc Mathematics course,

* 1. The students will get an introduction to the basic tools of calculus which are helpful in understanding their applications in the real-world problems.
	2. The students will learn the basic tools of set theory, functions, induction principle, theory of equations, complex numbers, number theory, matrices and determinant to understand their connection with the real-world problems.
	3. The students will develop a deep and rigorous understanding of real line 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.
	4. The students will be introduced to the exciting world of differential equations, mathematical modeling and their applications.
	5. The students will learn about the fundamental theory of groups and their homomorphisms, Symmetric groups and group of symmetries, and Fermat’s Little theorem as a consequence of the Lagrange’s theorem on finite groups.
	6. The students will be familiar with the basic tools of two-dimensional coordinates systems, general conics, and three-dimensional coordinate systems.
	7. The students will get an introduction to the fundamental theory of rings and their corresponding homomorphisms. Also they will be introduced to the basic concepts of ring of polynomials and irreducibility tests for polynomials over ring of integers.
	8. The students will get an introduction to the fundamental theory of vector spaces. They will be emphasized on the application of techniques using the adjoint of a linear operator and their properties to least squares approximation and minimal solutions to systems of linear equations.
	9. The students will get an introduction to the basic ideas of analysis for complex functions with visualization through relevant practicals. They will get acquainted with Cauchy’s theorem, series expansions and calculation of residues.
	10. The students will be able to solve partial differential equations and use them in solving some physical problems.
	11. The students will be able to carry out the hands-on sessions in Computer lab using various computer algebra system (CAS) software giving them a deep conceptual understanding of the above tools to widen the horizon of students’ self-experience.
	12. Students will develop the ability to think critically, logically and analytically and hence use mathematical reasoning in everyday life.
	13. Students will be made acquainted to a number of interesting and useful ideas in preparations for a number of mathematics careers in education, research, government sector, business sector and industry.
	14. Students will understand and apply the programming concepts of C.
	15. Students will learn to create and typeset a LaTeX document.
	16. Students will learn various mathematical models such as Growth model, Decay model etc. and will able to solve these models numerically using CAS.
	17. Students will know about methods to solve systems of linear equations and Interpolation techniques using CAS.
	18. Students will develop their communication skills and develop the confidence and art of speaking/delivering on a public platform

**Course Outcomes of B.Sc Mathematics under FYUG Programme**

 **1st Semester**

|  |  |  |
| --- | --- | --- |
| Course |  Course Outcome | Bloom’s taxonomy level |
| Classical Algebra | 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. | * Remember,
* Understand
* Apply
 |

 **2nd Semester**

|  |  |  |
| --- | --- | --- |
| Course |  Course Outcome | Bloom’s taxonomy level |
| Calculus | The students will be able to: • Understand continuity and differentiability in terms of limits. • Describe asymptotic behavior in terms of limits involving infinity. • Understand the importance of mean value theorems. | * Remember,
* Understand
* Apply
* Analyze
* Evaluate
 |

 **3rd Semester**

|  |  |  |
| --- | --- | --- |
| Course |  Course Outcome | Bloom’s taxonomy level |
| Ordinary Differential Equations | The course will enable the students to: • Learn basics of 1st order ordinary differential equations and 2nd order linear differential equations • Learn different techniques for solving the differential equations | * Remember,
* Understand
* Apply
* Analyze
* Evaluate
 |

 **4th Semester**

|  |  |  |
| --- | --- | --- |
| Course |  Course Outcome | Bloom’s taxonomy level |
| Paper-I : Real analysis | This course will enable the students 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 number | * Remember,
* Understand
* Apply
* Analyze
 |
| Paper-II Complex Analysis (with practical) | The completion of the course will enable the students to: • Learn the significance of differentiability of complex functions leading to the understanding of Cauchy−Riemann equations. • Learn some elementary functions and valuate the contour integrals. • Understand the role of Cauchy−Goursat theorem and the Cauchy integral formula | * Remember,
* Understand
* Apply
* Analyze
 |
| Paper-III Analytical Geometry | This course will enable the students to: • transform coordinate systems • learn about pair of straight lines • have a clear understanding of the conic sections and related properties • recognize 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. | * Remember,
* Understand
* Apply
* Analyze
* Evaluate
 |
| Paper-IV Number Theory | On successful completion of the course students 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. | * Remember,
* Understand
* Apply
* Analyze
* Evaluate
 |

 **5th Semester**

|  |  |  |
| --- | --- | --- |
| Course |  Course Outcome | Bloom’s taxonomy level |
| Paper-I Abstract Algebra | On successful completion of the course students 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. • Analyze 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. | * Remember
* Understand
* Apply
* Analyze
 |
| Paper-II Multivariate Calculus | This course will enable the students 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 | * Remember
* Understand
* Apply
* Analyze
 |
| Paper-III Theory of Real Functions | This course will enable the students 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 | * Remember
* Understand
* Apply
* Analyze
 |
| Paper-IV Numerical Analysis (with practical) | The course will enable the students 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 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
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 **6th Semester**

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| Course |  Course Outcome | Bloom’s taxonomy level |
| Paper-I Linear Algebra | This course will enable the students 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 | * Remember,
* Understand
* Apply
* Analyze
 |
| Paper-II Partial Differential Equations (with practical) | The course will enable the students 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. | * Remember,
* Understand
* Apply
 |
| Paper-III Metric Spaces | The course will enable the students 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. • Analyze 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. | * Remember
* Understand
* Apply
* Analyze
 |
| Paper-IV Mechanics | The course will enable the students 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. | * Remember
* Understand
* Apply
 |

**Course Outcomes of CBCS course**

 **1st Semester**

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| --- | --- | --- | --- |
| Paper  | Course |  Course Outcome | Bloom’s taxonomy level |
| MAT-HC-1016 | Calculus (including practical)  | After the completion of this course, students will be able to:* Learn first and second derivative tests for relative extremum and apply the knowledge in problems in business, economics and life sciences.
* Sketch curves in a plane using its mathematical properties in different coordinate systems.
* Compute area of surfaces of revolution and the volume of solids by integrating over cross-sectional areas.
* Understand the calculus of vector functions and its use to develop the basic principles of planetary motion.
 | * Remember,
* Understand
* Apply
* Analyze,
 |
| MAT-HC-1026 | Algebra | After the completion of the course, students will be able to:* Employ De Moivre’s theorem in a number of applications to solve numerical problems.
* Learn about equivalent classes and cardinality of a set.
* Use modular arithmetic and basic properties of congruences.
* Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix.
* Learn about the solution sets of linear systems using matrix method and Cramer’s rule.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |
| MAT-HG-1016/ MAT-RC-1016 | Calculus | After the completion of the course, students will be able to:* Understand continuity and differentiability in terms of limits.
* Describe asymptotic behavior in terms of limits involving infinity.
* Use derivatives to explore the behavior of a given function, locate and classify its extrema, and graph the function.
* Understand the importance of the Mean value theorem.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |

 **2nd Semester**

|  |  |  |  |
| --- | --- | --- | --- |
| Paper  | Course |  Course Outcome | Bloom’s taxonomy level |
| MAT-HC-2016 | Real Analysis | Upon successful completion of this course it is intended that a student 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 the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |
| MAT-HC-2026 | Differential Equations(including practical) | After the completion of the course, students will be able to:* Learn the basics of differential equations and mathematical modeling.
* Formulate differential equations for various mathematical models.
* Solve first order nonlinear differential equations and linear differential equations of
* higher order using various techniques.
* Apply these techniques to solve and analyze various mathematical models.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |
| MAT-HG-2016/MAT-RC-2016 | Algebra | Upon successful completion of this course it is intended that a student will be able to:* Learn how to solve the cubic and biquadratic equations, also learn about symmetric functions of the roots for cubic and biquadratic.
* Employ De Moivre’s theorem in a number of applications to solve numerical problems.
* Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, finding inverse of a matrix with the help of Cayley- Hamilton theorem.
* Recognize the mathematical objects that are groups, and classify them as abelian, cyclic and permutation groups, rings etc.
* Learn about the concept of linear independence of vectors over a field, and the dimension of a vector space.
 | * Remember,
* Understand
* Apply
* Analyze
 |

 **3rd Semester**

|  |  |  |  |
| --- | --- | --- | --- |
| Paper  | Course |  Course Outcome | Bloom’s taxonomy level |
| MAT-HC-3016 | Theory of Real Functions | After the completion of the course, students 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.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |
| MAT-HC-3026 | Group Theory - I | After the completion of the course, students will be able to:* Recognize the mathematical objects that are groups, and classify them as abelian, cyclic and permutation groups, etc.
* Link the fundamental concepts of groups and symmetrical figures.
* Analyze the subgroups of cyclic groups and classify subgroups of cyclic groups.
* Explain the significance of the notion of cosets, normal subgroups and factor groups.
* Learn about Lagrange’s theorem and Fermat’s Little theorem.
* Know about group homomorphisms and group isomorphisms.
 | * Remember,
* Understand
* Apply
* Analyze
 |
| MAT-HC-3036 | Analytical Geometry | After the completion of the course, students will be able to:* Learn conic sections and transform coordinate systems.
* Learn polar equation of a conic, tangent, normal and properties.
* Have a rigorous understanding of the concept of three dimensional coordinates.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |
| MAT-HG-3016/MAT-RC-3016 | Differential Equations | After the completion of the course, students will be able to:* Learn the basics of differential equations and mathematical modeling.
* Solve first order nonlinear differential equations and linear differential equations of higher order using various techniques
 | * Remember,
* Understand
* Apply
 |
| MAT-SE-3014 | Computer Algebra Systems and Related Software | This course will enable the students to:* Use of softwares; Mathematica/MATLAB/Maxima/Maple etc. as a calculator, for plotting functions and animations.
* Use of CAS for various applications of matrices such as solving systems of equations and finding eigenvalues and eigenvectors.
* Understand the use of the statistical software R as a calculator and learn to read and get data into R.
* Learn the use of R in summary calculation, pictorial representation of data and exploring relationships between data.
* Analyze, test, and interpret technical arguments on the basis of geometry.
 | * Remember,
* Understand
* Apply
 |

 **4th Semester**

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| --- | --- | --- | --- |
| Paper  | Course |  Course Outcome | Bloom’s taxonomy level |
| MAT-HC-4016 | Multivariate Calculus | After the completion of the course, students 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.
* Learn about inter-relationship amongst the line integral, double and triple integral formulations.
* Familiarize with Green's, Stokes' and Gauss divergence theorems.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |
| MAT-HC-4026 | Numerical Methods (including practical) | Upon successful completion of this course it is intended that a student will be able to:* Learn some numerical methods to find the zeros 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 methods to solve systems of linear equations, such as False position method, Fixed point iteration method, Newton’s method, Secant method and LU decomposition.
* Interpolation techniques to compute the values for a tabulated function at points not in the table.
* Applications of numerical differentiation and integration to convert differential equations into difference equations for numerical solutions.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |
| MAT-HC-4036 | Ring Theory | After the completion of the course, students will be able to:* Appreciate the significance of unique factorization in rings and integral domains.
* Learn about the fundamental concept of rings, integral domains and fields.
* Know about ring homomorphism and isomorphism theorems of rings.
* Learn about the polynomial rings over commutative rings, integral domains, Euclidean domains, and UFD.
 | * Remember,
* Understand
* Apply
* Analyze
 |
| MAT-HG-4016/ MAT-RC-4016 | Real Analysis | Upon successful completion of this course it is intended that a student 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 R 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 the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.
 | * Remember,
* Understand
* Apply
 |
| MAT-SE-4046 | LaTeX and HTML | After the completion of the course, students will be able to learn:* Create and typeset a LaTeX document.
* Typeset a mathematical document using LaTex.
* Learn about pictures and graphics in LaTex.
* Create beamer presentations.
 | * Remember,
* Understand
* Apply
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 **5th Semester**

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| --- | --- | --- | --- |
| Paper  | Course |  Course Outcome | Bloom’s taxonomy level |
| MAT-HC-5016 | Complex Analysis (including practical) | Upon completion of the course, students 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 can evaluate the contour integrals.
* Understand the role of Cauchy−Goursat theorem and the Cauchy integral formula.
* Expand some simple functions as their Taylor and Laurent series, classify the nature of singularities, find residues and apply Cauchy Residue theorem to evaluate integrals.
 | * Remember,
* Understand
* Apply
* Analyze
* Evaluate
 |
| MAT-HC-5026 | Linear Algebra | After the completion of the course, students will be able to:* Learn about the concept of linear independence of vectors over a field, and the dimension of a vector space.
* Basic concepts of linear transformations, dimension theorem, matrix representation of a linear transformation, 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.
* Find the adjoint, normal, unitary and orthogonal operators.
 | * Remember,
* Understand
* Apply
* Analyze
* Evaluate
 |
| MAT-HE-5016 | Number Theory | After the completion of the course, students will be able to:* Learn about some fascinating discoveries related to the properties of prime numbers, and some of the open problems in number theory, viz., Goldbach conjecture etc.
* Know about number theoretic functions and modular arithmetic.
* Solve linear, quadratic and system of linear congruence equations.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |
| MAT-HE-5066 | Programming in C (including practical) | After completion of this course, students will be able to:* Understand and apply the programming concepts of C which is important to mathematical investigation and problem solving.
* Learn about structured data-types in C and learn about applications in factorization of an integer and understanding Cartesian geometry and Pythagorean triples.
* Use of containers and templates in various applications in algebra.
* Use mathematical libraries for computational objectives.
* Represent the outputs of programs visually in terms of well formatted text and plots.
 | * Remember,
* Understand
* Apply
 |
| MAT-RE-5016 | Number Theory  | After completion of this course, students will be able to:* Learn about some fascinating discoveries related to the properties of prime numbers, and some of the open problems in number theory, viz., Goldbach conjecture etc.
* Know about number theoretic functions and modular arithmetic.
* Solve linear, quadratic and system of linear congruence equations.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
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 **6th Semester**

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| --- | --- | --- | --- |
| Paper  | Course |  Course Outcome | Bloom’s taxonomy level |
| MAT-HC-6016 | Riemann Integration and Metric spaces | After the completion of the course, students will be able to:* Learn about some of the classes and properties of Riemann integrable functions, and the applications of the Fundamental theorems of integration.
* Know about improper integrals including, beta and gamma functions.
* 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.
* Analyze 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.
* Know about Banach fixed point theorem, whose far-reaching consequences have resulted into an independent branch of study in analysis, known as fixed point theory.
* Learn about the two important topological properties, namely connectedness and compactness of metric spaces.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |
| MAT-HC-6026 | Partial Differential Equations (including practical) | Upon Completion of the course students will be able to-* Formulate, classify and transform first order PDEs into canonical form.
* Learn about methods of characteristics and separation of variables to solve first order PDEs.
* Classify and solve second order linear PDEs.
* Learn about Cauchy problem for second order PDE and homogeneous as well as nonhomogeneous wave equations.
* Apply the method of separation of variables for solving second order PDEs.
 | * Remember,
* Understand
* Apply
* Analyze
 |
| MAT-HE-6046 | Hydromechanics | Upon completion of this course, students will be able to:* Know about Pressure equation, rotating fluids.
* Learn about Fluid pressure on plane surfaces, resultant pressure on curved surfaces, Gas law, mixture of gases.
* Learn about the Eulerian and Lagrangian method.
* Learn about equation of continuity, examples, acceleration of a fluid at a point.
 | * Remember,
* Understand
* Apply
* Analyze
 |
| MAT-HE-6066 | Group Theory II | Upon completion of this course, students will be able to:* Learn about automorphisms for constructing new groups from the given group.
* Learn about the fact that external direct product applies to data security and electric circuits.
* Understand fundamental theorem of finite abelian groups.
* Be familiar with group actions and conjugacy in 𝑆𝑛 *.*
* Understand Sylow theorems and their applications in checking non-simplicity.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |
| MAT-RE-6016 | Numerical Analysis  | Upon completion of this course, students 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.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |

**Course Outcome of Non-CBCS Course**

 **1st Semester**

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| --- | --- | --- | --- |
| Paper  | Course |  Course Outcome | Bloom’s taxonomy level |
| M104 | Algebra and Trigonometry | Upon completion of the course, students will be able to:* Learn about Relations ,Equivalence relations, mapping, and binary composition.
* Recognize the mathematical objects that are groups, and classify them as abelian, cyclic and permutation groups, normal groups etc.
* Employ De Moivre’s theorem in a number of applications to solve numerical problems.
* Learn how to solve the cubic and biquadratic equations, also learn about symmetric functions of the roots for cubic and biquadratic equations.
* Learn about different types of matrices viz. Symmetric, skew symmetric, Hermitian and skew Hermitian matrices and to find solution of a system of linear equations by matrix method.
 | * Remember,
* Understand
* Apply
* Analyze
 |
| M105 | Calculus | Upon completion of the course, students will be able to:* Learn first and second derivative tests for relative extremum and apply the knowledge in problems in business, economics and life sciences.
* Sketch curves in a plane using its mathematical properties in different coordinate systems.
* Compute area of surfaces of revolution and the volume of solids by integrating over cross-sectional areas.
* Understand the calculus of vector functions and its use to develop the basic principles of planetary motion.
 | * Remember,
* Understand
* Apply
* Analyze
 |
| E101 | Classical Algebra and Trigonometry | After the completion of the course, students will be able to:* Know about Inequalities involving arithmetic, geometric and harmonic means, and the Cauchy Schwarz inequality.
* Know about sequence of real numbers, convergence of sequences and the various tests for convergence.
* Know about Infinite series, statements of basic properties of infinite series(without proof). Absolute and Conditional Convergence, and Tests for convergence.
* Learn about Representation of Complex numbers, Polar form of a complex number, and De Moiver’s theorem.
* Learn about Relation between roots and coefficients of a polynomial equation of degree n, Symmetric functions of roots, Cardon’s method of solution of a cubic equation.
 | * Remember,
* Understand
* Apply
* Analyze,
 |

 **2nd Semester**

|  |  |  |  |
| --- | --- | --- | --- |
| Paper  | Course |  Course Outcome | Bloom’s taxonomy level |
| M204 | Co-Ordinate Geometry | Upon completion of the course, students will be able to:* Learn conic sections and transform co-ordinate systems
* Learn polar equation of a conic, tangent, normal and properties
* Have a rigorous understanding of the concept of three-dimensional coordinates systems
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |
| M205 | Differential Equation | Upon completion of the course, students will be able to:* Know about the origin of ordinary differential equations, degree and order of ordinary differential equations.
* Solve first order non-linear differential equations and linear differential equations of higher order using various techniques.
* Know about Simultaneous linear differential equations, and total differential equations.
* Learn about Partial differential equations, Lagrange’s solutions, Charpit’s general method of solution.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |
| E201 | Abstract Algebra and Matrices | After the completion of the course, students will be able to:* Know the definitions of groups and examples of groups, Permutation groups. Cyclic groups, Subgroups, Cosets, Quotient groups.
* Have an idea of homomorphism and Isomorphism of groups
* Learn about the definition, examples and simple properties of Rings, Integral Domains, Fields and their elementary properties.
* Know the different types of matrices, algebra of matrices, Adjoint and inverse of a matrix, and the Solution of a system of linear equations by matrix method.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |

 **3rd Semester**

|  |  |  |  |
| --- | --- | --- | --- |
| Paper  | Course |  Course Outcome | Bloom’s taxonomy level |
| M304 | Abstract Algebra | Upon completion of the course, students will be able to:* Know about group homomorphisms and group isomorphisms.
* Learn about the fundamental concept of rings, integral domains and fields
* Know about ring homomorphism and isomorphism theorems of rings.
* Learn about the polynomial rings over commutative rings, integral domains, Euclidean domains, and UFD .
 | * Remember,
* Understand
* Apply
* Analyze
 |
| M305 | Linear Algebra and Vector | Upon completion of the course, students will be able to:* Learn about the concept of linear independence of vectors over a field, and the dimension of a vector space.
* Basic concepts of linear transformations, dimension theorem, matrix representation of a linear transformation, and the change of basis
* Compute the characteristic polynomial, eigenvalues, eigenvectors, and characteristic equation of a matrix.
* Know about Scalar triple product, vector triple product, product of four vectors.
* Learn about vector integration, line, surface and volume integrals, Green, Stokes and Gauss’ theorems
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |
| E303 | Methods and applications | After the completion of the course, students will be able to:* Learn conic sections and transform co-ordinate systems
* Learn polar equation of a conic, tangent, normal and properties
* Have a rigorous understanding of the concept of three dimensional coordinates systems
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |

 **4th Semester**

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| --- | --- | --- | --- |
| Paper  | Course |  Course Outcome | Bloom’s taxonomy level |
| M404 | Real Analysis | Upon completion of the course, students will be able to:* Understand many properties of the real line *R*, including completeness and Archimedean properties.
* Know about improper integrals including beta and gamma functions.
* 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 the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.
* Understand the definition of limit and continuity of a function of single variable, as well as about sequential continuity and uniform continuity.
* Learn about the Derivability of a function of single variable, Darboux’s theorem, intermediate value theorem for derivatives, Roll’s theorem, mean value theorems, intermediate forms, Taylor’s theorem, Taylor’s and Maclaurin’s infinite series.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |
| M405 | Mechanics | Upon completion of the course, students will be able to:* Know about the concepts in statics such as Parallel forces, couples, coplanar forces, equilibrium of coplanar forces.
* Understand the theory behind friction and center of gravity.
* Know about Principle of virtual work-in two dimensions, forces in three dimensions, Poinsot’s central axis, wrenches, null lines and planes.
* Learn about motion of particles.
* Learn about Central orbit and Kepler’s laws of planetary motion.
 | * Remember,
* Understand
* Apply
* Analyze
 |
| E403 | Coordinate Geometry and Vector Analysis | After the completion of the course, students will be able to:* Get familiar with the properties of continuous functions without proofs. Differentiation, successive differentiation, Lebnitz’s theorem. Tangents and Normals.
* Learn about Rolle’s theorem, Lagrange’s Mean Value theorem, Cauchy’s Mean Value theorem, Taylor’s theorem, Maclaurin’s theorem, Maclaurin’s infinite power series for a given function
* Gain knowledge of the limit and continuity of a functions of two or more variables, and Partial differentiation.
* Know about Curvature of plane curves, Asymptotes.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |

 **5th Semester**

|  |  |  |  |
| --- | --- | --- | --- |
| Paper  | Course |  Course Outcome | Bloom’s taxonomy level |
| M501 | Real and Complex Analysis | Upon completion of the course, students will be able to:* Learn about some of the classes and properties of Riemann integrable functions, and the applications of the Fundamental theorems of integration.
* Know about improper integrals including beta and gamma functions.
* Learn the significance of differentiability of complex functions leading to the understanding of Cauchy−Riemann equations.
* Learn some elementary functions and can evaluate the contour integrals.
* Understand the role of Cauchy−Goursat theorem and the Cauchy integral formula.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |
| M502 | Topology | Upon completion of the course, students 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.
* Analyze 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.
* Know about Banach fixed point theorem, whose far-reaching consequences have resulted into an independent branch of study in analysis, known as fixed point theory.
* Learn about the two important topological properties, namely connectedness and compactness of metric spaces.
* Learn about topological spaces, metric topology, neighborhood systems, interior, bases, sub bases, subspaces and relative topology.
* Know about normed linear spaces, Banach spaces, inner product spaces and Hilbert space.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |
| M503 | Spherical Trigonometry and Astronomy | After the completion of the course, students will be able to:* Learn about the properties of spherical and polar triangles.
* Know about fundamental formulae of spherical triangles.
* Learn about the celestial sphere, circumpolar star, rate of change of zenith distance and
* azimuth.
* Learn about Keplar’s law of planetary motion, Cassini’s hypothesis, differential equation for fraction.
* Learn about the Geocentric parallax, stellar or annual parallax, lunar eclipse, solar eclipse, idea of ecliptic limits, frequency of eclipses.
 | * Remember,
* Understand
* Apply
* Analyze,
 |
| M504 | Rigid Dynamics | After the completion of the course, students will be able to:* Know how to find the moments and products of inertia.
* Learn about the motion of the center of inertia.
* Learn about the D’Alembert’s principle and Lagrange’s equations.
* Learn about motion of a body in two dimension.
 | * Remember,
* Understand
* Apply
* Analyze,
 |
| M505 | Probability | After the completion of the course, students will be able to:* Learn about probability density and moment generating functions.
* Know about various univariate distributions such as Bernoulli, Binomial, Poisson, gamma and exponential distributions.
* Learn about distributions to study the joint behavior of two random variables.
* Measure the scale of association between two variables, and to establish a formulation helping to predict one variable in terms of the other, i.e., correlation and linear regression.
* Understand central limit theorem, which helps to understand the remarkable fact that: the empirical frequencies of so many natural populations, exhibit a bell-shaped curve, i.e., a normal distribution.
 | * Remember,
* Understand
* Apply
* Analyze,
 |
| M506 | Optimization Theory Marks | After the completion of the course, students will be able to:* Learn about general linear programming problems and mathematical formulation of linear programming problems.
* Learn about the graphical solution of linear programming problem with two variables.
* Learn about the relation between basic feasible solutions and extreme points.
* Understand the theory of the simplex method used to solve linear programming problems.
* Learn about two-phase and big-M methods to deal with problems involving artificial
* variables.
* Learn about the relationships between the primal and dual problems.
* Solve transportation and assignment problems.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |
| E503 | Statics and Dynamics | After the completion of the course, students will be able to:* Learn about Parallel forces, Couple, System of coplanar forces and conditions of equilibrium.
* Learn about Centre of gravity of plane curves and areas, arc and sector of a circle and a parabola.
* Know about Friction, laws of friction, cone of friction, angle of friction, limiting friction, equilibrium of a particle on a rough inclined plane.
* Learn about Machines, Mechanical advantage, velocity ratio, three systems of pulleys.
* Know about Components of velocity and acceleration along radial and transverse direction and along tangential and normal directions, angular velocity and its relation with linear velocity, relative velocity.
* Learn about Rectilinear motion with variable acceleration, vertical motion under inverse square law and other laws of forces.
* Know about Simple harmonic motion, Motion of a projectile, range on an inclined plane, Impulse , impulsive forces, work and energy. Conservation of linear momentum and conservation of energy, Impact of elastic bodies.
 | * Remember,
* Understand
* Apply
* Analyze,
 |
| E504 | Numerical Method and Spherical Astronomy | After the completion of the course, students will be able to:* Learn about finite difference operators.
* Know about Newton’s forward and backward difference operators, Lagrange’s interpolation formula.
* Solve roots of algebraic and transcendental equations, Bisection method, Iteration method, Newton-Raphson method for non-repeated roots.
* Learn about Spherical triangle and its properties, polar triangle and its properties
* Know about Celestial sphere, three coordinate systems and their relations,
* circumpolar stars, signs of zodiac.
* Learn about Planetary motion and Kepler’s laws.
 | * Remember,
* Understand
* Apply
* Analyze,
 |

 **6th Semester**

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| --- | --- | --- | --- |
| Paper  | Course |  Course Outcome | Bloom’s taxonomy level |
| M601 | Hydrostatics | After the completion of the course, students will be able to:* Know about Pressure equation, rotating fluids.
* Learn about Fluid pressure on plane surfaces, resultant pressure on curved surfaces.
* Learn about Equilibrium of a floating body, curves of buoyancy, surface of buoyancy, stability of equilibrium of floating bodies, meta centre, work done in producing a displacement.
* Know about Gas law, mixture of gases.
* Learn about work done in compressing a gas, isothermal atmosphere, connective equilibrium.
 | * Remember,
* Understand
* Apply
* Analyze,
 |
| M602 | Numerical Analysis | After the completion of the course, students will be able to learn about:* Normalized floating point representation of real numbers and operations using it,
* absolute and relative error, truncation and round off errors
* Calculus of finite difference, finite difference operators and their operations on function of a single variable, Newton;s formulae, Lagrange’s formula, Gauss, Bessel and sterling’s formula, Hermite interpolation.
* Numerical differentiation and integration, general quadrature formula, trapezoidal rule, Simpson’s one third and three eighth rule, Weddel’s rule, Newton-Cote’s formula, Gauss quadrature formula,Chebycheve’s formula.
* Solution of polynomial and transcendental equations: Bisection method, secant method, regula falsi method, Newton-Raphson method, rate of convergence.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |
| M603 | Computer Programming in C | After the completion of the course, students will be able to:* Understand and apply the programming concepts of C which is important to mathematical investigation and problem solving.
* Learn about structured data-types in C and learn about applications in factorization of an integer and understanding Cartesian geometry and Pythagorean triples.
* Learn the use of containers and templates in various applications in algebra.
* Learn the use of mathematical libraries for computational objectives.
* Know how to represent the outputs of programs visually in terms of well formatted text and plots.
 | * Remember,
* Understand
* Apply
 |
| M604 | Discrete Mathematics | Upon Completion of the course, students will be able to:* Learn about some fascinating discoveries related to the properties of prime numbers, and some of the open problems in number theory, viz., Goldbach conjecture etc.
* Know about number theoretic functions and modular arithmetic.
* Solve linear, quadratic and system of linear congruence equations.
* Learn about Propositional Calculus: operation on statements, truth function, laws of propositional logic, Boolean algebra of statement bundles, adequate system of connectives, binary connectives.
* Know about Boolean Algebra: disjunctive normal form(DNF), Complement of Boolean expression in DNF, construction of a Boolean function corresponding to a Boolean expression.
* Learn about conjunctive normal form(CNF), Complement of Boolean expression in CNF, transformation of normal form to the other form.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |
| M605 | Graph and Combinatorics | After completion of the course, students will:* Learn about the counting principles, permutations and combinations, Pigeonhole principle
* Understand the basics of graph theory and learn about social networks, Eulerian and Hamiltonian graphs, diagram tracing puzzles and Knight’s tour problem.
* Know about Block, Cut points. Bridges, Block graphs, Cut point graphs and Trees.
* Learn about Connectivity and Line connectivity, Graphical variation of Menger’s theorem, Travessavility, Eulerian graphs and Hamiltonian graphs.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |
| E603 | Linear Algebra and Complex analysis | After completion of the course, students will learn:* Definition and examples of vector spaces, vector spaces, subspaces of a vector space, subspace generated by a subset of vector space.
* Definition and elementary properties of linearly dependent and independent set,
* basis and dimension of a vector space, examples of finite dimensional and infinite dimensional vector space
* Linear mapping—definition and examples, algebraic properties of linear mappings.
* Elementary transformation. Reduction to echelon and normal form, rank of a matrix.
* Eigenvalues ,eigenvectors, characteristic equation, statement of Cayley-Hamilton theorem.
* Complex variable, elementary functions, limit and continuity and theorems, uniform continuity, derivatives, analytic functions, Cauchy –Riemann equations and harmonic function, Rectifiable curves, integral along a oriented curve, fundamental Cauchy theorem, Cauchy integral formula.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |
| E604 | Advanced Calculus | After completion of the course students will:* 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.
* Know about Bolzano- Weirstrass theorem, Cauchy sequences in a metric space and complete metric spaces.
* Learn about some of the classes and properties of Riemann integrable functions, and the applications of the Fundamental theorems of integration.
* Know about improper integrals including, beta and gamma functions.
* Learn about double and triple integrals, application of Beta and Gamma functions in determination of area and volume.
 | * Remember,
* Understand
* Apply
* Analyze,
* Evaluate
 |