(University of Delhi)

Shyam Lal College

Programme Specific Outcomes and Course Outcomes

B.Sc. (H) Mathematics

Programme Specific Outcomes

Programme	Programme Specific Outcomes
B.Sc. (H) Mathematics	**PSO-1:** Students will be enabled to communicate mathematics effectively by written, computational and graphic means. **PSO-2:** Students will be enabled to create mathematical ideas from basic axioms. **PSO-3:** Students will be enabled to gauge the hypothesis, theories, techniques and proofs provisionally. **PSO-4:** Students will learn to utilize mathematics to solve theoretical and applied problems by critical understanding, analysis and synthesis. **PSO-5:** Students will identify applications of mathematics in other disciplines and in the real-world, leading to enhancement of career prospects in a plethora of fields and research. **PSO-6:** Course will empower the students with the skills and together with the liberty of exploring their interests within the main subject. **PSO-7:** Students will be capable to use ICT tools in solving problems or gaining knowledge and to use appropriate softwares and programming skills to solve problems in mathematics. **PSO-8:** Students will acquire knowledge and skills through self- learning that helps in personal development and skill development for changing demands of work place. **PSO-9:** Students develop the ability to think critically, logically and analytically and hence use mathematical reasoning in everyday life. **PSO-10:** Students will be equipped with knowledge of basic concepts and ideas in mathematics and its subfields and will be able to apply the applications of the subject to other disciplines. **PSO-11:** It would also help in making responsible citizens and facilitate character building.

Course Outcomes
(Semester 1)

Course Name	Course Objectives	Learning Outcomes
DSC-1 Algebra	The primary objective of this course is to introduce: • The basic tools of theory of equations, number theory, and group theory. • Symmetry group of a plane figure, basic concepts of cyclic groups. • Classification of subgroups of cyclic groups.	This course will enable the students to: • Determine number of positive/negative real roots of a real polynomial. • Solve cubic and quartic polynomial equations with special condition on roots and in general. • Employ De-Moivre's theorem in a number of applications to solve numerical problems. • Use modular arithmetic and basic properties of congruences. • Recognize the algebraic structure, namely groups, and classify subgroups of cyclic groups.
DSC-2 Elementary Real Analysis	The course will develop a deep and rigorous understanding of: • Real line $\mathbb{R}$ with algebraic. • Order and completeness properties to prove the results about convergence and divergence of sequences and series of real numbers.	This course will enable the students to: • Understand the fundamental properties of the real numbers, including completeness and Archimedean, and density property of rational numbers in $\mathbb{R}$. • Learn to define sequences in terms of functions from $\mathbb{N}$ to a subset of $\mathbb{R}$ and find the limit. • Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate the limit superior and limit inferior of a bounded sequence. • Apply limit comparison, ratio, root, and alternating series tests for convergence and absolute convergence of infinite series of real numbers.

DSC-3 Probability and Statistics	The Learning Objectives of this course are as follows: • To make the students familiar with the basic statistical concepts and tools which are needed to study situations involving uncertainty or randomness. • To render the students to several examples and exercises that blends their everyday experiences with their scientific interests to form the basis of data science.	This course will enable the students to: • Understand some basic concepts and terminology - population, sample, descriptive and inferential statistics including stem-and-leaf plots, dotplots, histograms and boxplots. • Learn about probability density functions and various univariate distributions such as binomial, hypergeometric, negative binomial, Poisson, normal, exponential and lognormal. • Understand the remarkable fact that the empirical frequencies of so many natural populations, exhibit bell-shaped (i.e., normal) curves, using the Central Limit Theorem. • 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.
SEC-Statistics with R	The Learning Objectives of this course are as follows: • To enable students to handle data in the R software thereby helping them to understand meaningful statistical analysis performed on the data. • To enable students to extract data, and perform basic statistical operations entailing data analysis such as – data cleaning, data visualisation, data summarisation, and regression amongst others.	The Learning Outcomes of this course are as follows: • After studying this course, students will be able to extract and Read data into R, manipulate, and analyse it • After studying this course, students will be able Tto debug, organize, and comment R code • After studying this course, students will be able to understand the R environment for downloading, installing, and using packages • After studying this course, students will be able to do basic programming to write own

		functions • After studying this course, students will be able to use loops • After studying this course, students will be able to create standard and customized graphics • After studying this course, students will be able to perform basic statistical operations and regression.
VAC-Vedic Mathematics 1	The Learning Objectives of the course are: • Foster love for maths and remove its fear through Vedic Mathematics • Enhance computation skills in students through Vedic Mathematics1 • Develop logical and analytical thinking • Promote joyful learning of mathematics • Discuss the rich heritage of mathematical temper of Ancient India	The Learning Outcomes of the course are • Overcome the fear of maths • Improved critical thinking • Familiarity with the mathematical underpinnings and techniques • Ability to do basic maths faster and with ease. • Appreciate the Mathematical advancements of Ancient India.
GE-Fundamental of Calculus	The Learning Objectives of this course is as follows: • Understand the quantitative change in the behaviour of the variables and apply them on the problems related to the environment.	Upon completion of this course, students 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 and its applications. • Learn about Maclaurin's series expansion of elementary functions. • Use derivatives to explore the behavior of a given function, locating and classifying its

		extrema, and graphing the polynomial and rational functions.

(Semester 2)

CourseName	Course Objectives	Learning Outcomes
DSC-4 Linear Algebra	The objective of the course is to introduce: • The concept of vectors in $RRnn$, and their linear independence and dependence. • Rank and nullity of linear transformations through matrices. • Various applications of vectors in computer graphics and movements in plane.	This course will enable the students to: • Visualize the space $RRnn$ in terms of vectors and their interrelation with matrices. • Familiarize with basic concepts in vector spaces, linear independence and span of vectors over a field. • Learn about the concept of basis and dimension of a vector space. • Basic concepts of linear transformations, dimension theorem, matrix representation of a linear transformation with application to computer graphics.
DSC-5 Calculus	The primary objective of this course is: • To introduce the basic tools of calculus, also known as 'science of variation'. • To provide a way of viewing and analyzing the real-world.	This course will enable the students to understand: • The notion of limits, continuity and uniform continuity of functions. • Geometrical properties of continuous functions on closed and bounded intervals. • Applications of derivative, relative extrema and mean value theorems. • Higher order derivatives, Taylor's theorem, indeterminate forms and tracing of curves.
	The main objective of this course is to introduce the students:	The course will enable the students to: • Learn the basics of differential

DSC-6 Ordinary Differential Equations	• The exciting world of differential equations. • Their applications and mathematical modeling.	equations and compartmental models. • Formulate differential equations for various mathematical models. • Solve first order non-linear differential equations, linear differential equations of higher order and system of linear differential equations using various techniques. • Apply these techniques to solve and analyze various mathematical models.
SEC-Statistics with R	The Learning Objectives of this course are as follows: • To enable students to handle data in the R software thereby helping them to understand meaningful statistical analysis performed on the data. • To enable students to extract data, and perform basic statistical operations entailing data analysis such as – data cleaning, data visualisation, data summarisation, and regression amongst others.	The Learning Outcomes of this course are as follows: • After studying this course, students will be able to extract and Read data into R, manipulate, and analyse it • After studying this course, students will be able Tto debug, organize, and comment R code • After studying this course, students will be able to understand the R environment for downloading, installing, and using packages • After studying this course, students will be able to do basic programming to write own functions • After studying this course, students will be able to use loops • After studying this course, students will be able to create standard and customized graphics • After studying this course, students will be able to perform basic statistical operations and

		regression.
SEC-Document Preparation and Presentation System Latex	The Learning Objectives of the course are: • To develop proficiency in the use of document preparation software such as document LaTeX, LibreOffice. • To make a presentation using LaTeX, LibreOffice. • To serve as a tool for conveying/communicating one's ideas, views, and observations.	On completion of the course, a student will be able to • Create a text document using LaTeX using a standard template. • Incorporate well-formatted mathematical equations, algorithms, figures, tables and references in a document. • Use Zotero for reference management. • Format text, including alignment, emphasis and fonts. • Handle basic aspects of document structure, including sections, subsections paragraphs, and bulleted and enumerated lists. • Page set a document including header, footer, and page numbering. • Make a presentation.
VAC-Vedic Mathematics 1	The Learning Objectives of the course are: • Foster love for maths and remove its fear through Vedic Mathematics • Enhance computation skills in students through Vedic Mathematics1 • Develop logical and analytical thinking • Promote joyful learning of mathematics • Discuss the rich heritage of mathematical temper of Ancient India	The Learning Outcomes of the course are • Overcome the fear of maths • Improved critical thinking • Familiarity with the mathematical underpinnings and techniques • Ability to do basic maths faster and with ease. • Appreciate the Mathematical advancements of Ancient India.

VAC-Vedic Mathematics 2	The Learning Objectives of the course are: • Foster the love for mathematics by creating a positive attitude through Vedic and Ancient Indian Mathematics • Help students appreciate ancient Indian Mathematics and its contribution to the world. • Enhance computational proficiency by involving procedures in Linear and Matrix Algebra • Improve geometrical thinking by understanding the basic tenets of geometry such as construction of line segments, angles, triangles and circles as used in Ancient India • Develop conceptual knowledge of mathematical concepts • Appreciate the need of conceptual knowledge over procedural processes	After completion of the course, students shall be able to • Think critically • Find mathematical solution of algebraic expressions • Solve system of linear equations and matrices faster and with ease. • Appreciate the Mathematical advancements of Ancient India.
GE-Introduction to Linear Algebra	The objective of the course is: • To introduce the concept of vectors in $RRnn$. • Understand the nature of solution of system of linear equations. • To view the $mm×nn$ matrices as a linear function from $RRnn$ to $RRmm$ and vice versa. • To introduce the concepts of linear independence and dependence, rank and linear transformations has been explained through matrices.	This course will enable the students to: • Visualize the space $RRnn$ in terms of vectors and the interrelation of vectors with matrices. • Understand important uses of eigenvalues and eigenvectors in the diagonalization of matrices. • Familiarize with concepts of bases, dimension and minimal spanning sets in vector spaces. • Learn about linear transformation and its corresponding matrix.

(Semester 3)

Course Name	Course Objectives	Learning Outcomes
DSC 7: Group Theory	The objective of the course is: • Symmetric groups, normal subgroups, factor groups, and direct products of groups. • The notions of group homomorphism to study the isomorphism theorems with applications. • Classification of groups with small order according to isomorphisms.	This course will enable the students to: • Analyse the structure of 'small' finite groups, and examine examples arising as groups of permutations of a set, symmetries of regular polygons. • Understand the significance of the notion of cosets, Lagrange's theorem and its consequences. • Know about group homomorphisms and isomorphisms and to relate groups using these mappings. • Express a finite abelian group as the direct product of cyclic groups of prime power orders. • Learn about external direct products and its applications to data security and electric circuits.

DSC 8: Riemann Integration	The objective of the course is: • Understand the integration of bounded functions on a closed and bounded interval and its extension to the cases where either the interval of integration is infinite, or theintegrand has infinite limits at a finite number of points on the interval of integration. • Learn some of the properties of Riemann integrable functions, its generalization andthe applications of the fundamental theorems of integration. • Get an exposure to the utility of integration for practical purposes.	This course will enable the students to: • Learn about some of the classes and properties of Riemann integrable functions, and the applications of the Riemann sums to the volume and surface of a solid of revolution. • Get insight of integration by substitution and integration by parts. • Know about convergence of improper integrals including, beta and gamma functions.

DSC 9: **Discrete Mathematics**	The objective of the course is: • Make students embark upon a journey of enlightenment, starting from the abstractconcepts in mathematics to practical applications of those concepts in real life. • Make the students familiar with the notion of partially ordered set and a level up with thestudy of lattice, Boolean algebra and related concepts. • Culminate the journey of learning with practicalapplications using the knowledge attainedfrom the abstract concepts learnt in the course.	This course will enable the students to: • Understand the notion of partially ordered set, lattice, Boolean algebra with applications. • Handle the practical aspect of minimization of switching circuits to a great extent with the methods discussed in this course. • Apply the knowledge of Boolean algebras to logic, set theory and probability theory.
DSE-1 (i): Graph Theory	The objective of the course is: • Problem-solving techniques using various concepts of graph theory. • Various properties like planarity and chromaticity of graphs. • Several applications of these concepts in solving practical problems.	This course will enable the students to: • Learn modelling of real-world problems by graphs. • Know characteristics of different classes of graphs. • Learn representation of graphs in terms of matrices. • Learn algorithms to optimize a solution. • Understand some properties of graphs and their applications in different practicalsituations.

DSE-1 (ii): Mathematical Python	The objective of the course is: • To be able to model and solve mathematical problems using Python Programs. • To experience utility of open-source resources for numerical and symbolic mathematical software systems.	This course will enable the students to: • For numerical and symbolic computation in mathematical problems from calculus, algebra, and geometry. • To tabulate and plot diverse graphs of functions and understand tracing of shapes, geometries, and fractals. • To prepare smart documents with LaTeX interface.
DSE-1 (iii): Number Theory	The objective of the course is: • The number theoretic techniques of computations with the flavour of abstraction. • The Euclidean algorithm, linear Diophantine equations, congruence equations, arithmetic functions and their applications, Fermat's little, Euler's and Wilson's theorems. • Primitive roots, quadratic residues and nonresidues, the Legendre symbol and the law of Quadratic Reciprocity. • Introduction to cryptography, public-key cryptosystems and applications.	This course will enable the students to: • Use modular arithmetic in solving linear and system of linear congruence equations. • Work with the number theoretic functions, their properties and their use. • Learn the forms of positive integers that possess primitive roots and the Quadratic • Reciprocity Law which deals with the solvability of quadratic congruences. • Understand the public-key cryptosystems, in particular, RSA.

SEC-Statistics with R	The Learning Objectives of this course are as follows: • To enable students to handle data in the R software thereby helping them to understand meaningful statistical analysis performed on the data. • To enable students to extract data, and perform basic statistical operations entailing data analysis such as – data cleaning, data visualisation, data summarisation, and regression amongst others.	The Learning Outcomes of this course are as follows: • After studying this course, students will be able to extract and Read data into R, manipulate, and analyse it • After studying this course, students will be able Tto debug, organize, and comment R code • After studying this course, students will be able to understand the R environment for downloading, installing, and using packages • After studying this course, students will be able to do basic programming to write own functions • After studying this course, students will be able to use loops • After studying this course, students will be able to create standard and customized graphics • After studying this course, students will be able to perform basic statistical operations and regression.
SEC-Document Preparation and Presentation System Latex	The Learning Objectives of this course are as follows: • To develop proficiency in the use of document preparation software such as documentLaTeX, LibreOffice. • To make a presentation using LaTeX, LibreOffice. • To serve as a tool for conveying/communicating one's ideas, views, and	On completion of the course, a student will be able to • Create a text document using LaTeX using a standard template. • Incorporate well-formatted mathematical equations, algorithms, figures, tables and references in a document. • Use Zotero for reference management.

	observations.	• Format text, including alignment, emphasis and fonts. • Handle basic aspects of document structure, including sections, subsections, paragraphs, and bulleted and enumerated lists. • Page set a document including header, footer, and page numbering. • Make a presentation.
VAC-Vedic Mathematics 1	The Learning Objectives of the course are: • Foster love for maths and remove its fear through Vedic Mathematics • Enhance computation skills in students through Vedic Mathematics1 • Develop logical and analytical thinking • Promote joyful learning of mathematics • Discuss the rich heritage of mathematical temper of Ancient India	The Learning Outcomes of the course are • Overcome the fear of maths • Improved critical thinking • Familiarity with the mathematical underpinnings and techniques • Ability to do basic maths faster and with ease. • Appreciate the Mathematical advancements of Ancient India.
VAC-Vedic Mathematics 2	The Learning Objectives of the course are: • Foster the love for mathematics by creating a positive attitude through Vedic and Ancient Indian Mathematics • Help students appreciate ancient Indian Mathematics and its contribution to the world. • Enhance computational proficiency by involving procedures in Linear and	After completion of the course, students shall be able to • Think critically • Find mathematical solution of algebraic expressions • Solve system of linear equations and matrices faster and with ease. • Appreciate the Mathematical advancements of Ancient India.

	Matrix Algebra • Improve geometrical thinking by understanding the basic tenets of geometry such as construction of line segments, angles, triangles and circles as used in Ancient India • Develop conceptual knowledge of mathematical concepts • Appreciate the need of conceptual knowledge over procedural processes	
VAC-Vedic Mathematics 3	The Learning Objectives of the course are: • Foster the love for mathematics by creating a positive attitude through Vedic and Ancient Indian Mathematics • Help students appreciate ancient Indian Mathematics and its contribution to the world. • Enhance conceptual as well as computational proficiency in trigonometric ratios and complex numbers • Understand the conceptual ideas of coordinate geometry as developed and used in Ancient and medieval India • Discuss the rich heritage of mathematical temperament of Ancient India	After completion of the course, students shall be able to • Improved critical as well as logical thinking • Familiarity with the mathematical procedures of geometry • Ability to perform calculations in trigonometric ratios with ease. • Appreciate the Mathematical advancements of Ancient India.

GE: Differential Equations	The primary objective of this course is to introduce: • Ordinary and partial differential equations. • Basic theory of higher order linear differential equations, Wronskian and its properties. • Various techniques to find the solutions of above differential equations which provide a basis to model complex real-world situations.	This course will enable the students to: • Solve the exact, linear, Bernoulli equations, find orthogonal trajectories and solve rate problems. • Apply the method of undetermined coefficients and variation of parameters to solve linear differential equations. • Solve Cauchy-Euler equations and System of linear differential equations. • Formulate and solve various types of first and second order partial differential equations.

(Semester 4)

Course Name	Course Objectives	Learning Outcomes
DSC 10: Sequence and Series of Functions	The Learning Objectives of the course are: • The sequences and series of real-valued functions as a generalization to the sequences and series of real numbers. • The situations under which the process of convergence of a sequence and series of realvalued functions may commute with the processes of calculus while taking differentiation, or integration. • An important class of series functions (i.e., power series), and the definitions of theelementary functions- exponential, logarithmic and trigonometric.	This course will enable the students to: • Learn about Cauchy criterion for uniform convergence and Weierstrass M-test for uniform convergence of series of real-valued functions. • Know about the constraints for the inter-changeability of differentiability and integrability with infinite sum. • Approximate transcendental functions in terms of power series as well as, differentiation and integration of power series.

DSC 11: Multivariate Calculus	The Learning Objectives of the course are: • The extension of the studies of single variable differential and integral calculusto functions of two or more independent variables. • The geometry and visualisation of curves and surfaces in two dimensions (plane) and three dimension (space). • The techniques of integration to functions of two and three independent variables. • The applications ofmultivariate calculus tools to physics, economics, optimization etc.	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.
DSC 12: Numerical Analysis	The Learning Objectives of the course are: • Various computational techniques to find approximate value for possible root(s) of algebraic and non-algebraic equations. • Methods to solve system of linear equations and ordinary differential equations. • The use of computer algebra system (CAS) by which the numerical problems can be solved both numerically and analytically, and to enhance the problem-solving skills.	This course will enable the students to: • Learn some numerical methods to find the zeroes of nonlinear functions of a single variable, up to a certain given level of precision. • Learn Gauss-Jacobi, Gauss-Seidel methods to solve system of linear equations. • Compute the values for a tabulated function at points not in the table using interpolation techniques. • Learn applications of numerical differentiation and integration to convert differential equations into difference equations for numerical solutions.

DSE 2 (i): Biomathematics	The Learning Objectives of the course are: • Develop and analyse the models of the biological phenomenon with emphasis on population growth and predator-prey models. • Interpret first-order autonomous systems of nonlinear differential equations using the Poincaré phase plane. • Apply the basic concepts of probability to understand molecular evolution and genetics.	This course will enable the students to: • Get a better comprehension of mathematical models, utilised in biology. • To identify and explain the findings from models of population studies, species' communication, adaptation, and dynamics of disorder. • Create a basic model of molecular evolution by making use of probability and matrices.
DSE 2 (ii): Mathematical Modeling	The Learning Objectives of the course are: • Mathematical modelling as the representation of a system by a set of mathematical relations or equations. • Mathematical epidemiological models susceptible-infectious-recovered (SIR) and its variant SEIR (S-Exposed-IR) for the spread of diseases. • Monte Carlo simulation techniques, and simplex method for solving linear programming problems.	This course will enable the students to: • Understand the methodology of solving SIR models for disease spread. • Learn significance of dieting model that provides important insights and guides to a biomedical issue that is of interest to the general public. • Understand nonlinear systems and phenomena with stability analysis ranges from phase plane analysis to ecological and mechanical systems. • Use Monte Carlo simulation technique to approximate area under a given curve, and volume under a given surface.

DSE 2 (iii): Mechanics	The Learning Objectives of the course are: • Give the know-how of the concept of mechanics to the students. • Make the students familiar with the notion of statics and a level up with the dynamics, hydrostatics, and related concepts. • Finally winds up the journey with meaningful usage of the knowledge attained.	This course will enable the students to: • Notion of statics, dynamics, and hydrostatics with applications. • Methods discussed in this course and maneuver the practical aspect of couples, projectiles, and fluid pressure. • Applicability of the knowledge of the friction, harmonic oscillators as well as thrust on plane surfaces.
SEC-Statistics with R	The Learning Objectives of this course are as follows: • To enable students to handle data in the R software thereby helping them to understand meaningful statistical analysis performed on the data. • To enable students to extract data, and perform basic statistical operations entailing data analysis such as – data cleaning, data visualisation, data summarisation, and regression amongst others.	The Learning Outcomes of this course are as follows: • After studying this course, students will be able to extract and Read data into R, manipulate, and analyse it • After studying this course, students will be able Tto debug, organize, and comment R code • After studying this course, students will be able to understand the R environment for downloading, installing, and using packages • After studying this course, students will be able to do basic programming to write own functions • After studying this course, students will be able to use loops • After studying this course, students will be able to create standard and

		customized graphics • After studying this course, students will be able to perform basic statistical operations and regression.
SEC-Document Preparation and Presentation System Latex	The Learning Objectives of this course are as follows: • To develop proficiency in the use of document preparation software such asdocument LaTeX, LibreOffice. • To make a presentation using LaTeX, LibreOffice. • To serve as a tool for conveying/communicating one's ideas, views, and observations.	On completion of the course, a student will be able to • Create a text document using LaTeX using a standard template. • Incorporate well-formatted mathematical equations, algorithms, figures, tables and references in a document. • Use Zotero for reference management. • Format text, including alignment, emphasis and fonts. • Handle basic aspects of document structure, including sections, subsections, paragraphs, and bulleted and enumerated lists. • Page set a document including header, footer, and page numbering. • Make a presentation.

SEC: ITSkills and Data Analysis 1	The primary objectives of the course will be to: • Familiarise the student with the quantitative skills required for representing and interpreting data for the purpose of decision making. • Equip the student with some fundamental concepts, which play a critical role in understanding and visualizing real world data. • Enable the student to analyze data and problem situations using relevant IT tools.	By the end of the course students will be able to • Represent and interpret data in tabular and graphical forms • Understand and interpret the measures of central tendency and dispersion. • Use IT tools such as spreadsheets to visualise and analyse data.
SEC: Latex Typesetting for Beginners	The objective of this course is to introduce: • LaTeX, a high-quality open-source typesetting software that produces professional prints and PDF files for research articles and books in all subjects, and languages. • Typesetting in Indian languages using LaTeX by transliteration and ITRANS packages.	After completion of the course the learner will be able to: • Prepare a LaTeX document with title page including contents, references, and index. • Understand the Indian language transliteration package (ITRANS-processor) for typesetting Sanskrit, Hindi, Punjabi, Malayalam, etc. using LaTeX.

VAC-Vedic Mathematics 1	The Learning Objectives of the course are: • Foster love for maths and remove its fear through Vedic Mathematics • Enhance computation skills in students through Vedic Mathematics1 • Develop logical and analytical thinking • Promote joyful learning of mathematics • Discuss the rich heritage of mathematical temper of Ancient India	The Learning Outcomes of the course are • Overcome the fear of maths • Improved critical thinking • Familiarity with the mathematical underpinnings and techniques • Ability to do basic maths faster and with ease. • Appreciate the Mathematical advancements of Ancient India.
VAC-Vedic Mathematics 2	The Learning Objectives of the course are: • Foster the love for mathematics by creating a positive attitude through Vedic and Ancient Indian Mathematics • Help students appreciate ancient Indian Mathematics and its contribution to the world. • Enhance computational proficiency by involving procedures in Linear and Matrix Algebra • Improve geometrical thinking by understanding the basic tenets of geometry such as construction of line segments, angles, triangles and circles as used in Ancient India • Develop conceptual knowledge of mathematical concepts • Appreciate the need of conceptual knowledge over	After completion of the course, students shall be able to • Think critically • Find mathematical solution of algebraic expressions • Solve system of linear equations and matrices faster and with ease. • Appreciate the Mathematical advancements of Ancient India.

	procedural processes	
VAC-Vedic Mathematics 3	The Learning Objectives of the course are: • Foster the love for mathematics by creating a positive attitude through Vedic and Ancient Indian Mathematics • Help students appreciate ancient Indian Mathematics and its contribution to the world. • Enhance conceptual as well as computational proficiency in trigonometric ratios and complex numbers • Understand the conceptual ideas of coordinate geometry as developed and used in Ancient and medieval India • Discuss the rich heritage of mathematical temperament of Ancient India	After completion of the course, students shall be able to • Improved critical as well as logical thinking • Familiarity with the mathematical procedures of geometry • Ability to perform calculations in trigonometric ratios with ease. • Appreciate the Mathematical advancements of Ancient India.
GE: Linear Programming	The primary objective of this course is to introduce: • The solution of linear programming problem using simplex method. • The solution of transportation and assignment problems. • Game theory which makes possible the analysis of the decision-making process of two interdependent subjects.	This course will enable the students to: • Learn about the simplex method used to find optimal solutions of linear optimization problems subject to certain constraints. • Write the dual of a linear programming problem. • Solve the transportation and assignment problems. • Learn about solution of rectangular games using graphical method and dominance. • Formulate game to a pair

		of associated prima-dual linear programming problems.

(Semester 5)

Course Name	Course Objectives	Learning Outcomes
BMATH511: Metric Spaces	The Learning Objectives of the course are: • Understand the basic concepts of metric spaces • Correlate these concepts to their counterparts in real analysis • Appreciate the abstractness of the concepts such as open balls, closed balls, compactness, and connectedness etc. beyond their geometrical imaginations. • Analyze how a theory advances from a particular frame to a general frame • Learn about Banach fixed point theorem one of the beautiful results in analysis	• Students develop an idea of distance into an abstract form onany setsof objects, maintaining its inherent characteristics and the resulting consequences
BMATH512: Group Theory	The Learning Objectives of the course are: • Automorphisms for constructing new groups from the given group • Externaldirectproduct$Z_2 \square Z_2$ applies to data security and electric circuits. • Group actions, Sylow theorems and their applications to check non simplicity. • Understand fundamental theorem of finite abelian groups • Be familiar with group actions and conjugacy in S_n.	• Students get in-depth understanding of abstract algebra. • Students able to classify all finite Abelian groups.

DSE-1 (i): Numerical Analysis	The Learning Objectives of the course are: • Some numerical methods to find the zeroes of nonlinear functions of Single variable and solution of a System of linear equations, up to a certain given level of precision. • 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.	• Students get the knowledge 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 ordinary differential equations • Students are able to apply linear algebra in real life. • Learn the use of Computer Algebra System (CAS) by which the numerical problems can be solved both numerically and analytically, and to enhance the problem solving skills.
DSE-2 (i): Probability Theory and Statistics	The Learning Objectives of the course are: • Distributions to study the joint behavior of two random variables. • To establish a formulation helping to predict one variable in terms of the other, i.e., correlation and linear regression. • Central limit theorem, which helpstounderstandtheremarkablefact that: the empirical frequencies of so many natural populations, exhibit abell shaped curve.	• Students get familiar with the basic statisticalconcepts and tools which are needed to study situations involving uncertainty or randomness. • Students solve several examples and exercises that blend their everyday experiences with their scientific interests.

(Semester 6)

Course Name	Course Objectives	Learning Outcomes
BMATH613:Complex Analysis	The Learning Objectives of the course are: • Learn the significance of differentiability of complex functions. • Understand Cauchy Riemann equations. • Learn some elementary functions and valuate the contour integral. • Understand the role of Cauchy- Goursat theorem and the Cauchy integral formula. • Expand some simple functions	• Students develop a basic idea of analysis of complex functions in complex variables.
BMATH614: Ring theoryandlinear algebra –II	The Learning Objectives of the course are: • Appreciate the significance of unique factorization in rings and integral domains. • Compute the characteristic polynomials, eigenvectors, eigen spaces. • Compute inner products and determine orthogonality on vector spaces. • Find the adjoint, normal and orthogonal operators.	• Students learn the basic concepts of ring of polynomials and irreducibility tests for polynomials over ring of integers, used in finite fields with applications in Cryptography. • Students get to know the application of techniques using the adjoint of a linear operatorandtheirpropertiesto least squares approximation and minimal solutions to Systems of linear equations.

DSE-3 (iii): Biomathematics	The Learning Objectives of the course are: • Learn the development, analysis and interpretation of bio mathematical models. • Reinforce the skills in mathematical modeling. • Appreciate the theory of bifurcation and chaos. • Learn to apply the basic concepts of probability to molecular Evolution and genetics.	• Students do scientific study of normal functions in living systems. • The basic concepts of the probability to understand molecular evolution and genetics have also been discussed.
DSE-4 (ii): Linear Programming and Applications	The Learning Objectives of the course are: • Analyze and solve linear programming models of real-life situations. • The graphical solution of LPP with only two variables, and illustrate the concept of convex set and extreme points. The theory of the simplex method is developed. • The relationships between the primal and dual problems and their solutions with applications to transportation, assignment and two- person zero-sum game problem.	• Students understand the ideas underlying the Simplex Method for Linear Programming Problem, as an important branch of Operations Research. • Students understand Linear Programming with applications to Transportation, Assignment and Game Problem. Such problems arise in manufacturing resource planning and financial sectors.