

Sammilani Mahavidyalaya

Baghajatin, E. M. Bypass, Kolkata - 700094

Department of Mathematics

Program Specific Outcomes

For B.Sc. Under-Graduate Mathematics Honours and General course, 2018 (Duration 3 years) under CBCS system

PSO-1: Gain of Academic Knowledge

Extension of knowledge which the students have already acquired in +2 level in several areas of Mathematics such as classical algebra, abstract algebra, linear algebra, real and complex analysis, geometry and vectors, differential and integral calculus.

PSO-2: Development of Logical Sense

The syllabus is so designed that the students are to go through abstract mathematics. In this journey they have to logically prove several theorems, corollary etc. from hypothesis. So hypothetical and logical sense have been grown in the minds of the students so that they can prove any arbitrary theorem. Also mathematical logic is a part of the syllabus to develop the logical sense of the students.

PSO-3: Reasoning and Interactive Mind

Reasoning is very much required to understand and solve mathematical problems. Throughout the study of undergraduate programmes students practice reasoning to set up a reasonable mind to clear their doubts in mathematics by interaction.

PSO-4: Skill Development

In the study of the course there are some to train the students about computer software which enhances the technical and computer skills of the students, which are very essential to solve mathematical problems easily.

PSO-5: Interdisciplinary Sense

The course is so designed that there are some parts like Boolean algebra, logic gates, discrete mathematics, statistics which are common to related subjects like Physics, Computer Science, Chemistry, Statistics and Engineering. So the students will acquire interdisciplinary knowledge which can make a pathway to their future study in any branch of science technology.

PSO-6: Hands-on Training on Problem Solving

The practical part of the course aims that the students get hands-on training to solve various problems of numerical analysis and statistics using C language. After training, students are able to solve various problems by writing programmes.

PSO-7: Research Oriented Self-Directed Learning

In theoretical and practical parts of the course, the students have to prepare projects and practical note books in algebra, analysis, geometry, vectors, discrete mathematics, numerical analysis etc. To prepare these kinds of projects the students have to identify the topics or problems, then study about it and then formulate and solve it, which is self-directed and makes the students research oriented.

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Department of Mathematics

Course Outcomes

Core Course	Topic	Course Outcomes(CO)
Honours Papers		
CC-1 (Under CCF) For SEM 1	Calculus, Geometry & Vector Analysis Unit – I: Calculus Unit – II: Geometry Unit – III: Vector Analysis	CO-1 The learners mainly gain the nature of curves in Cartesian or polar coordinates. Moreover, (a) there is a scope to obtain higher order derivatives and apply further wherever necessary. (b) the students learn the reduction formula of integration and L Hospital's rule of limit to find hard integration and limit. (c) they obtain the knowledge of curve tracing and to obtain different curve characteristic terms like length of curve, curvature, envelope curve etc. (d) students acquire the knowledge of the behaviour of plane, line and surface in space. (e) students obtain skill to classify conics in 2D and 3D Geometry. (f) get idea of vector product, vector function, limit, continuity, differentiation and integration. (g) obtain the ability to apply vector concept in different brunch of applied mathematics. (h) they are able to solve various problems related to vector equations, application to geometry and mechanics of vector analysis, which has useful applications in various branches of Mathematics and Physics.
CC-2 (Under CCF) For SEM 2	Algebra Unit – I: Classical Algebra Unit – II: Abstract Algebra Unit – III: Linear Algebra	CO-2 On completion of this course, students gain the knowledge about 1. Complex number, polynomials, inequality which will be needed in studies of real and complex analysis in coming semesters. 2. Sets, relation, mapping and notions of integer, congruence relation are foundation of Modern Algebra as well as discrete mathematics, which is also in UG Course. Moreover they have important implications in practical field like to prepare Credit card, Debit Card, ISBN, ISSN etc. 3. application to linear system of equations will help students in linear algebra course in semesters 4,5,6. Matrix theory plays one of the most important role in various other subjects like computer science, operational research etc. which have nowadays direct implications in almost every aspect of life.

Sammilani Mahavidyalaya

Baghajatin, E. M. Bypass, Kolkata - 700094

Department of Mathematics

CC-5 For SEM 3	Theory of Real Functions Unit I: Limit and Continuity of functions Unit II: Differentiability of functions.	CO-5 Limit and Continuity This course will help students to know about Very important notions of limit, continuity, uniform continuity of a real function with $\epsilon - \delta$ approach. Many important results including Sequential criterion will help students in due courses. Differentiability Differentiability of a real function at a point, relation between continuity and differentiability of a function and related theorems, Rolle's theorem, Cauchy's MVT to be specially mentioned with. The concept of maxima, minima of a function in an interval and their application. This portion plays important role in applied sciences, specially on ODE and Multivariate Calculus which is also in the UG course. This course is the base for any further studies of analysis and many other fields and also help them to grow analytical ideas in real field and make mathematical arguments within this system.
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Sammilani Mahavidyalaya

Baghajatin, E. M. Bypass, Kolkata - 700094

Department of Mathematics

CC-6 For SEM 3	Ring Theory & Linear Algebra I Unit – I: Ring Theory. Unit – II: Linear Algebra	CO-6 Ring Theory Ring is an ordered structure with two operators and it is a generalization of group theory which the students have already read in CC4 (semester 1). In this course the students 1. Get to study ring as arbitrary set with two operators. Definition, examples, properties of subring, subfield, integral domains and field and their properties. 2. Acquire knowledge about some well-known theorems such as isomorphism theorem, correspondence theorem. 3. These ideas are very important to study advanced algebra, linear algebra in semester 5 of undergraduate course as well as for further study of any branch of mathematics. Linear algebra The students already had preliminary ideas of vectors and its analysis in semester 1, but in this course they study its algebra. They 1. Get knowledge about vector spaces and its algebra, subspaces of $\mathbb{R}^n$ and its geometric significance which helps them to connect algebra with geometry. 2. Get to know linear transformations, its algebra and representations, Eigen values, Eigen vectors, characteristic equations, Cayley-Hamilton theorem which gives a new method for finding the inverse of a matrix.
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Sammilani Mahavidyalaya

Baghajatin, E. M. Bypass, Kolkata - 700094

Department of Mathematics

CC-7 For SEM 3	Ordinary differential equation & Multivariate calculus I Unit – I Ordinary differential equation Unit – II Multivariate Calculus – I	CO-7 On completion of this course, the students will acquire knowledge on 1. acquire elementary knowledge and skill of solving problems on certain types of linear and non- linear ordinary differential equations, also acquire knowledge on certain types of second order ordinary differential equations and their applications in Applied Science. 2. solving various problems related to Power series solution, Biological & Mechanical model, vector calculus which has useful applications in various branches of Mathematics and Physics. 3. solving various problems related to multivariate calculus, which is a powerful tool for understanding the geometry of real n-dimensional space. 4. Obtain the knowledge on limit, continuity and differentiability of n-dimensional space curves and surfaces.
CC-8 For SEM IV	Riemann Integration & Series of functions Unit – I: Riemann Integration Unit – II: Improper Integral Unit – III: Series of functions	CO-8 This course will help students to acquire knowledge about 1. Riemann integration which is a generalisation of definite integration. Concept of negligible set, primitive, application of Lebesgue theorem and many important properties and theorems. 2. Improper integral and existence of their finite values and Beta Gamma functions with their application. 3. Sequence and series of functions, power series and their pointwise convergence, uniform convergence to limit function. All these concepts are widely applied in integral and differential calculus, differential equations to physics problems.
CC-9 For SEM IV	Partial Differential Equation & Multivariate Calculus-II Unit – I: Partial Differential Equation Unit – II: Multivariate Calculus-II	CO-9 On completion of this course, the students will acquire 1. elementary knowledge and skill for solving problems of certain types of linear and non-linear partial differential equations, also acquire knowledge on certain types of second order partial differential equations and their applications in Mathematical Physics. 2. Concept of Cauchy problem, Cauchy-Kowalewskaya theorem, Cauchy problem of finite & infinite string and their applications in Mathematical Physics. 3. elementary knowledge and skill of solving problems on multiple integral and centre of gravity, surface and volume of revolution. knowledge on vector calculus and their applications in Mathematical Physics.

Sammilani Mahavidyalaya

Baghajatin, E. M. Bypass, Kolkata - 700094

Department of Mathematics

CC-10 For SEM IV	Mechanics Unit – I: Statics Unit – II: Particle Dynamics Unit – III: Many Particle System	CO-10 On completion of this course, the students will acquire knowledge on (a) Reduction of forces in 2D and 3D system. (b) condition of stability and instability of a system by a system of forces (c) how the frictional force work with the interaction two bodies and also the stability in the environment of frictional force (d) virtual work and one can check the condition of stability using virtual work done. (e) rectilinear motion of a particle in straight line and in two and three dimension (f) orbital motion and its stability. It will help in research of artificial satellite. (g) work, power, energy and energy conservation maintain in different systems. (h) linear and angular momentum principal and energy conservation in many particle systems. (i) over all study help to research in particle physics.
CC-11 For SEM V	Probability and Statistics. Unit I: Probability Unit II: Statistics.	CO-11 This course will introduce students to 1. the theory of probability, basic knowledge about one and two dimensional probability distribution, distribution function, conditional probability, expectation, some special distributions, generating functions etc. and problems related to all these topics. 2. the statistical theory build up on the basis of probability theory and help students in solving problems on parameter estimation viz., point and interval estimation, level of significance, concept of hypothesis and their various applications based on real life data. This course lay foundation to one of the most beautiful and practically oriented subject Statistics.

Sammilani Mahavidyalaya

Baghajatin, E. M. Bypass, Kolkata - 700094

Department of Mathematics

CC-12 For SEM V	Group theory II & Linear Algebra II Unit I: Group theory. Unit II: Linear Algebra	CO-12 Group theory II The students who had preliminary ideas of definition and properties of groups, now in this course 1. Acquire conceptual knowledge about automorphism group and its properties and applications of factor group to automorphism groups. 2. Can extend their skills to study further about external and internal direct product of groups, the existence of some well-known theorems such as Cauchy theorem, converse of Lagrange's theorem and Fundamental theorem only on finite Abelian groups. Linear Algebra II This course is an extension of Linear Algebra I in CC6. In this course the students go through the study of advanced linear algebra such as 1. Inner product spaces, Gram-Schmidt process of orthogonalization and orthonormalization of vectors, Bessel's inequality, linear operators, linear bilinear quadratic form of vectors, Sylvester's law of inertia etc. 2. Dual spaces, transpose of linear transformation and its matrix in the dual basis, annihilators, eigen spaces, diagonalizability, inverse and subspaces, Jordan and rational canonical form. These concepts are very essentials for further studies as well as for competitive examinations.
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Sammilani Mahavidyalaya

Baghajatin, E. M. Bypass, Kolkata - 700094

Department of Mathematics

CC-13 For SEM VI	Metric space & Complex analysis Unit I: Metric space. Unit II: Complex analysis	CO-13 Metric space Metric space is a generalization of Real line. On completion of study of metric space, the students 1. get the idea of abstraction of modulus distance function from real line to abstract field to form a metric space by axiomatic approach. 2. acquire knowledge of extension of real analysis i.e., open set, interiors, closure, convergence of sequence, continuity, uniform continuity, various types of compactness, connectedness, contraction maps, etc. in arbitrary Meric space. 3. know about Banach Fixed Point theorem which has an application for solving ordinary differential equations. These ideas help the students to study arbitrary vector spaces and topological spaces. Complex analysis: In semester 2, the students already had ideas of real analysis and a set of complex numbers in a superset of real numbers. Here, in this course, students get to know about 1. Well-known stereographic projection, complex plane, differential calculus and integral calculus of complex numbers 2. Uniform and absolute convergence of power series, radius of convergence Difference between real analysis and complex analysis.
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Department of Mathematics

9

Sammilani Mahavidyalaya

Baghajatin, E. M. Bypass, Kolkata - 700094

Department of Mathematics

DSE-A1 For SEM V	Advanced Algebra Unit – I: Group Theory Unit – II: Ring Theory	CO-17 After successful completion of this particular course the students has extended their knowledge about 1. Group action & permutation representation associated with a given group action, basic applications of group actions, Generalised Cayley's theorem and Index theorem 2. Generalised theory of Ring, basic idea of which they have already read in CC6. In this part of ring theory they also acquire knowledge about Principal Ideal Domain and Its properties Euclidean domain, Factorisation domain, Unique factorisation Domain & inter relations among them. 3. Polynomial ring as an example of Factorisation domain, Euclidean algorithm, Eisenstein criterion etc. 4. Regular rings, its examples & properties ideals etc. which are very much essential to study higher course of pure mathematics as well as in the research field.
DSE-B1 For SEM V	Linear Programming & Game Theory	CO-18 On completion of this course, the students will acquire 1. fundamental knowledge on the theory of basic and basic feasible solutions and their properties, convex sets based on the knowledge of linear algebra studied in previous semesters. 2. the skills on the solution of a Linear Programming Problem by Simplex Method. Also acquire knowledge on duality, transportation problem, assignment problem and travelling salesman problem. This course is very much important in present day Mathematics, like in the field of Operation Research, Modelling, Financial Mathematics.
DSE-A2 For SEM VI	Mathematical Modelling	CO-19 On completion of this course, the students will acquire knowledge 1. Concept of power series solution of Bessel's & Legendre's equation, Laplace transform and their application in Mathematical Physics.

Department of Mathematics

11

Sammilani Mahavidyalaya

Baghajatin, E. M. Bypass, Kolkata - 700094

Department of Mathematics

SEM III CC3/GE3	Unit-1 : Integral Calculus Unit-2 : Numerical Methods Unit-3 : Linear Programming	CO-23 Integral Calculus From this course, students acquire knowledge of integral calculus and its application in geometry, numerical analysis and linear programming problems, each of which is very necessary for further study in any field of science as well as in the competitive examinations. Numerical Methods Nowadays, application of numerical analysis spreads in various areas in social sciences. Those problems are difficult to solve in an analytic method but it can be solved through a numerical method. On completion of this course, the students will acquire knowledge on (a) numerical calculation, which gives most of the time some errors. Here is a scope to learn different types of errors that appear during calculation. (b) different interpolation, numerical differentiation and numerical integration rule. (c) finding roots of polynomial and transcendental equations in different methods. In general, we cannot find the roots of transcendental equations in an analytic method. (d) to find the solution of a system of linear equations in different numerical methods. All the above said numerical methods are hugely used in solving different research problems in the real world. So it gained serious attention to the students of science Background. Linear Programming On completion of this course, the students will acquire 1. fundamental knowledge on the theory of basic and basic feasible solutions and their properties, convex sets based on the knowledge of linear algebra studied in previous semesters. 2. the skills on the solution of a Linear Programming Problem by Simplex Method. Also acquire knowledge on duality, transportation problem, assignment problem and travelling salesman problem. This course is very much important in present day Mathematics, like in the field of Operation Research, Modelling, Financial Mathematics.
SEM IV CC4/GE4	Unit-1 : Algebra-II Unit-2 : Computer Science & Programming Unit-3 : Probability & Statistics	CO-24 In this course students study modern algebra, computer science and methods of programming and also probability and statistics which play important roles in present day mathematics.

Sammilani Mahavidyalaya

Baghajatin, E. M. Bypass, Kolkata - 700094

Department of Mathematics

SEM V DSE – A (Any one)	Particle Dynamics	CO-25 Students acquire the knowledge of (a) rectilinear motion of a particle in straight line and in two and three dimension (b) orbital motion and its stability. It will help in research of artificial satellites. (c) work, power, energy and energy conservation are maintained in different systems. (d) linear and angular momentum principle and energy conservation in many particle systems.
	Graph Theory	CO-26 On Completion of This Course, the students will acquire knowledge of basic graph theory, paths, circuits, trees and their application in Mathematical algorithms. To find the shortest path using Dijkstra's algorithm, Floyd-Warshall algorithm.
SEM VI DSE B	Advanced Calculus	CO-27 This course is an extension of Real Analysis. Here students will study the concept of point-wise and Uniform convergence of sequence of functions and series of functions. They also learn periodic Fourier series and it's convergence, Laplace Transform, it's properties and application to the solution of ordinary Differential equations.
SEM VI SEC - B	Boolean Algebra	CO-28 Boolean algebra as a skill enhancement course is very helpful for students to develop skill about Boolean algebra as a distributive lattice, Boolean polynomials, Karnaugh diagram, switching circuits which plays a very crucial role in present day Mathematics and Computer science.

Sammilani Mahavidyalaya

Baghajatin, E. M. Bypass, Kolkata - 700094

Department of Mathematics

Mapping of PSO and CO

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	√		√		√		√
CO2	√	√	√		√		√
CO3	√	√	√		√		√
CO4	√	√	√		√		√
CO5	√	√	√		√		√
CO6	√	√	√		√		√
CO7	√		√		√		√
CO8	√	√	√				√
CO9	√		√		√		√
CO10	√		√		√		√
CO11	√		√	√	√		√
CO12	√		√		√		√
CO13	√	√	√		√		√
CO14	√	√	√	√	√		√
CO15	√	√	√	√	√	√	
CO16	√		√	√	√	√	
CO17	√	√	√				√
CO18	√		√	√	√		√
CO19	√		√	√	√		√
CO20	√	√	√				√

Sammilani Mahavidyalaya

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Department of Mathematics

Attainment of Course & Programme Outcomes

The target of the Mathematics Department is to implement the methodology of teaching learning process based on the syllabus of each course and programs framed by the affiliating University. For attainment of Course and Programme outcomes the institution adopts several methods of assessing the students. The methods fall under two categories: Direct and Indirect.

Direct methods are employed to assess students' knowledge and skills in their regular assessment protocols. Class test, internal assessment tests, end semester examinations, seminars, laboratory assignments, practical classes and projects based on curriculum.

Indirect methods such as Add-on /Certificate courses, Departmental seminars, Educational tours, Mathematical quiz contests, Poster presentation, Research projects etc. that enhance the students' knowledge, skill and self confidence which are essential for the progression of the students to higher studies and placements after completing graduation.

Also feedback given by each student reflects on students' views on Course and programme outcomes and their impact on learning and future applications.

Following tables show the various methods used in the assessment process that periodically documents and demonstrates the degree to which the Course Outcomes are attained. They include information on: a) Listing and description of the assessment processes used to gather the data, and b) The frequency with which these assessment processes are carried out.

Sl. No.	Direct Assessment Method	Assessment frequency	Description
1	Entry level assessment Test	Once for newly admitted 1st Sem (year) students	It is a surprise test taken at the beginning of the study of UG syllabus to assess students' knowledge at the (+2) level of study.
2	Internal Assessment Test	Once in a semester on each course	Internal Assessment is taken on full syllabus after completion. It will be for 10 marks of each course..
3	Class Test	Frequently	It is a method used to continuously assess the student's understanding capabilities.
4	End Semester Examination	Once in a semester	End Semester examinations (theory or practical) are centrally held by the University to assess the learning ability and theoretical knowledge of the student. End Semester Examinations are held ordinarily at the end of the concerned Semester, i.e., Semester-I, Semester-III, Semester-V in December-January and Semester-II, Semester-IV, Semester-VI in June-July.

Sammilani Mahavidyalaya

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Department of Mathematics

5	Practical Semester Examination	In 6th semester only	End Semester practical examinations assess whether all the students have acquired the practical applications of the particular subject by hands-on training. Examinations are held along with the theoretical schedule,
6	Tutorial Examination	Once in a semester on each course	15 % of the total marks is assigned to the tutorial exam in each course which is distributed in equal marks distribution in Project copy, project presentation and viva-voce. These are conducted to assess student's conception, communication and presentation skills along with depth of the subject knowledge.
7	Attendance	As per CU rules	Total 10 Marks is allotted for all CBCS courses: The marks obtained of every course from Class Attendance by the students is the following manner. 6 marks for attending 60% or above but less than 75% of the number of lectures delivered 8 marks for attending 75% or above but less than 90% of the number of lectures delivered 10 marks for attending 90% or above of lectures delivered, and such attendance are calculated from the date of commencement of classes or date of admission whichever is later)

1. Internal assessment dates and record of marks
2. Results of 2018,19,20,21,22

Sl. No.	Questions	Excellent		Good		Fair		Poor		Strongly Disagree				
		Weightage	No. of Response	Weightage	No. of Response	Weightage	No. of Response	Weightage	No. of Response	Weightage	No. of Response	Total Weighted Sum	Total Response	Weighted Average
1	Was the course helpful in developing your interest and liking	5	14	4	15	3	0	2	0	1	0	130	29	4.48

Sammilani Mahavidyalaya

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Department of Mathematics

	for the subject?													
2	Rate your gain of knowledge and skill development with reference to the undergraduate course you have studied.	5	10	4	18	3	0	2	1	1	0	124	29	4.28
3	Was the course or part of the course helpful in giving an interdisciplinary knowledge?	5	7	4	19	3	2	2	1	1	0	119	29	4.1
4	Rate the practical part of the course as far as applicable for real world problems?	5	9	4	18	3	1	2	1	1	0	122	29	4.21
5	How would you rate the course in terms of modern approaches and contemporary issues?	5	11	4	16	3	2	2	0	1	0	125	29	4.31
6	How much has the course been helpful for developing critical thinking and logic applicable for scientific problem solving?	5	14	4	15	3	0	2	0	1	0	130	29	4.48
7	Does the course designed according to current development of the subject of interest?	5	9	4	19	3	0	2	1	1	0	123	29	4.24
8	Does the course or part of the course have contributions to industry and technology needed for job orientation?	5	13	4	11	3	4	2	1	1	0	123	29	4.24

Sammilani Mahavidyalaya

Baghajatin, E. M. Bypass, Kolkata - 700094

Department of Mathematics

9	How would you rate the course in developing interest of students towards higher studies and research?	5	9	4	18	3	1	2	1	1	0	122	29	4.21
10	How would you rate the course in terms of relevance in the present education structure both at the national and international level?	5	7	4	19	3	1	2	2	1	0	118	29	4.07
												Overall Average=		4.26