

WAIKHOM MANI GIRLS' COLLEGE, THOUBAL. MATHEMATICS DEPARTMENT

PROGRAMME OUTCOMES & COURSE OUTCOMES UNDERGRADUATE COURSES (B.A./B.Sc.) UNDER MANIPUR UNIVERSITY

Programme Outcomes:

1. Programme Outcomes for B.A./B.Sc. Mathematics as one of the Elective Subjects :

The Undergraduate Courses (B.A./B.Sc.) with Mathematics as one of their elective subjects will lead to award to the students on the basis of knowledge, understanding, skills, attitudes, values and achievements to think logically and apply them in their personal and professional life. It will develop a creative and logical mind to make a solution of a critical and complex problems in their day-to-day life. In fact Mathematics is the study of quantity, structure, space and change. As a part of effort to enhance employability of mathematics graduate, the courses has been designed to include learning experiences which offer them opportunities in various sectors of human activities.

- 1.1 **Disciplinary knowledge :** Bachelors degree in Mathematics is the culmination of in-depth knowledge of Algebra, Calculus, Differential Equation, Trigonometry, Geometry, Vectors, Mechanics, Theory of Probability and several other branches of pure and applied mathematics.
- 1.2 **Communication Skills :** Ability to communicate the various mathematical concepts effectively using variety of examples mostly having real life application. The skills and knowledge gained in this programme will lead to the proficiency to express reasoning thoughts logically correct statements.
- 1.3 **Critical thinking and analytical reasoning :** The students acquired the ability of critical thinking and logical reasoning and will apply formulating specific hypothesis, conclusion. The learner will be able to recognize the various aspects of real life problems.

- 1.4 **Problem solving** : The Mathematical knowledge gained by the students through this programme develops an ability to solve the problems, identify and define appropriate computing requirements for its solution. This programme will enhance the overall development.

2. Programme Outcomes for B.A./B.Sc. (Honours) in Mathematics:

Obtaining the degree of B.A./B.Sc.(Honours) in Mathematics subject, every graduate may achieve the programme learning outcome with equal opportunity irrespective of class, gender, community and regions, The learning experiences and assessment procedures, he/she will have ability to

- a) demonstrate fundamental systematic knowledge of mathematics and its applications in physical sciences, environmental sciences, life sciences, social sciences, science & technology etc. It should also enhance in creating jobs in various sectors.
 - b) apply knowledge, understanding and skills to identify a difficult problems in any area using appropriate methodologies.
 - c) apply disciplinary knowledge and skills to obtain well-defined solution.
- 2.1 **Information/digital literacy** : The completion of this programme will enable the learner to use appropriate software to solve the system of algebraic and differential equations,
- 2.2 **Self-directed learning** : After completion of the programme, the student will be able to work independently, make an in-depth search of various areas of Mathematics and resources for self learning in order to enhance knowledge in Mathematics.
- 2.3 **Moral and ethical awareness/reasoning** : The student after the completion of the course will develop an ability to identify unethical behavior such as fabrication, falsification or misinterpretation of data adopting objectives, unbiased and truthful action in all aspects of life in general and Mathematical studies in particular.
- 2.4 **Research related skills** : After completion of this programme, the student will develop the capability of enquiring about appropriate questions relating to Mathematical concepts. He/she will be able to define the problems, formulate hypothesis, proofs, write the results obtained clearly.
- 2.5 **Lifelong learning** : This programme provides self directed learning and lifelong skills. With these skills, the learner will be able to think independently, improve personal development.

3. Course Outcomes :

Course structure of B.A./B.Sc.(Mathematics) :

<i>Semester</i>	<i>Course</i>	<i>Subjects Code/Topic</i>
I	Elective	BMATH- 101 : ALGEBRA - I Classical Algebra Modern Algebra Trigonometry
II	Elective	BMATH- 202 : CALCULUS & ODE Differential Calculus Integral Calculus Ordinary Differential Equations.
III	Elective	BMATH- 303 : Geometry, Vectors, Theory of Probability
IV	Elective	BMATH- 404 : MECHANICS Statics Dynamics Rigid Dynamics
V	Core	BMATH- H505 : ALGEBRA - II Abstract Algebra Linear Algebra
		BMATH- H506 : Analysis - I Real Analysis
		BMATH- H507 : Computer C – Programming Practical Numerical Analysis
VI	Core	BMATH- H605 : Partial Differential Equations Laplace Transform Calculus of Variation
		BMATH- H606 : Analysis - II Metric Space
		BMATH- H607 : Optional Papers (Any One) 1. Higher Mechanics 2. Fluid Mechanics 3. Theory of probability 4. Spherical Trigonometry 5. Special Theory of Relativity & Tensor

3.1 Course Outcomes of Semester-I (BMath- 101 : ALGEBRA – I : Classical Algebra, Modern Algebra and Trigonometry)

After completion of the course, a student will be able to

- CO1 :** find out Arithmetic Mean and Geometric Mean and understand some basic concepts of inequalities like Cauchy-Schwarz, Holder's and Minkowski's inequalities.
- CO2 :** learn about the Theory of equations like Descarte's rule of signs, Symmetric functions of roots, Transformation of equations, solve the cubic equations by Cardan's method and biquadratic equations by Ferrari's methods.
- CO3 :** apply various test to determine convergence and absolute convergence of infinite series and learn about the Cauchy's general principle for convergence, Comparison Test, Cauchy's root test, D'Alembert's ratio test, Raabi's test, Logarithmic test, D'Morgan & Bertrand test, Leibnitz's test.
- CO4 :** understand mapping, equivalence relations and partitions, groups, subgroups, normal subgroup, abelian group and non-abelian group, cyclic group, permutation groups, symmetric groups, alternating groups, coset decomposition, Lagrange's theorem, Fermat's and Wilson's theorem. Isomorphism of groups and Cayley's theorem.
- CO5 :** understand some types of Matrices, Inverse of a matrix, Linear independence of row and column matrices, Row rank, Column rank and rank of a matrix, Eigenvalues and eigenvectors and characteristic equation of a matrix, Cayley Hamilton theorem and its use in finding inverse of a matrix.
- CO6 :** know De Moivre's theorem and its applications, Expansion of Trigonometric functions, Exponential values for circular functions, Gregory's series, Hyperbolic functions, summation of series including $C + iS$ method.

3.2 Course Outcomes of Semester-II (BMath- 202 : Calculus & Ordinary Differential Equations)

After completion of the course, a student will be able to

- CO1 :** calculate the limit and continuity of functions using $(\epsilon - \delta)$ definition, successive differentiation, Leibnitz's Theorem and its application
- CO2 :** know about the Rolle's theorem, Lagrange's and Cauchy's Mean Value Theorems, Taylor's and Maclaurin's theorem, Indeterminate form, L – Hospital's rule etc.

- CO3 :** solve the limits and continuity for functions of two and three variables, Partial Differentiation, Successive partial differentiation, Euler's theorem on Homogeneous functions of two and three variables, Maxima and Minima of functions of two variables. With these applications, find out the curvature, radius of curvature for the Cartesian, parametric, implicit and polar equations, Asymptotes.
- CO4 :** understand the integration as the limit of a sum, Fundamental theorem of integral calculus, Definite Integrals, Reduction formulae. With these application, find the Quadrature and Rectification.
- CO5 :** know the working knowledge of double integrals, Jacobian, and its application for finding out the Volume and surface area of solid of revolution.
- CO6 :** gain the knowledge on ordinary differential equations of first order and first degree, exact equation, integrating factors, linear equations and equations reducible to linear form, total differential equations, method of solutions and their geometrical interpretations and orthogonal trajectory.
- CO7 :** gain the knowledge on ordinary differential equations of first order and but not of first degree and equations solvable for x , y , p and Clairaut's equation Singular solutions.
- CO8 :** Solve the Second order linear differential equations with constant coefficients, Homogeneous linear equations, Complementary functions and Particular integrals, Power series solutions.

3.3 Course Outcomes of Semester-III (BMath- 303 : Geometry, Vectors and Theory of Probability)

After completion of the course, a student will be able to

- CO1 :** understand the change of origin and direction of the axes of co-ordinates. Pair of straight lines, homogeneous equation of second degree
- CO2 :** know system of conics, centre of a conic, reduction of the general second degree equation into a central and non-central conic, tangent to a conic, pole and polar, conjugate diameters, feet of the normals, intersection of two conics, pair of tangents. Confocal Conics and their properties
- CO3 :** make the clear concept of Sphere, Cone, Cylinder, Central conicoids and Paraboloids, Confocal conicoids.
- CO4 :** understand the scalar and vector product of three and four vectors, differentiation of vectors, Gradient, Divergence and Curl of a vectors, vector integration of Line, Surface, and Volume integrals. Gauss, Green Stokes theorems and related problems.

CO5 : understand the concept of Theory of Probability, probability distribution, Poisson, Geometric. Expectation and moments, probability inequalities, convergence in probability, Chebychev's inequality, De-Moivre's, Laplace, Liapunov's equations.

3.4 Course Outcomes of Semester-IV (BMath- 404 : Dynamics, Statics & Rigid Dynamics)

After completion of the course, a student will be able to

CO1 : understand the components of velocity and accelerations along radial, transversal, tangential and normal. And clear the concept of motion of a particle under the square law of motion, Kepler's laws of planetary motion, motion in resisting medium including projectile, acceleration in different co-ordinate systems.

CO2 : understand about the coplanar forces and their equilibrium conditions, Equilibrium of string which can be applied in our day-to-day life. Make the ideas of catenary of uniform strength.

CO3 : gain the ideas of Force in 3- dimension, the stable, unstable and neutral equilibrium.

CO4 : understand about the rigid dynamics : Moments and products of inertia, Momental ellipsoid, Equilibrium system.

CO5 : know the D'Alembert's Principle and its application to the equation of motion of rigid bodies about a fixed axis, expression of kinetic energy and moment of momentum and motion relative to the centre of inertia.

CO6 : understand the compound pendulum and its point of suspension and oscillation. Motion in two-dimension under impulsive force .

3.5 Course Outcomes of Semester-V (BMath- H505 : Abstract Algebra and Linear Algebra)

After completion of the course, a student will be able to

CO1 : learn the concept of Normal subgroup, Quotient group, Homomorphism and Isomorphism of groups, Kernel of a homomorphism, Isomorphism theorems, Auto-morphisms groups, Cayley's Theorem, Class equation of a finite group, Centre of a group, Normalizer, Centralizer, Cauchy's Theorem, Sylow theorem with p-Sylow subgroup..

CO2 : understand the concept of Rings and its elementary properties, Division Rings, Fields and related theorems, Quotient Rings, Homomorphism and Isomorphism of Rings, Maximal, Prime, Principal Ideal, Euclidean Rings, Polynomial Rings, Eisenstein's Irreducibility criterion, Unique Factorisation Domain.

- CO3 :** learn the concept of Vector Space over a field K , n -tuple space, subspaces, Linear Span, Linear Dependence and Independent with their basic properties. Finite dimensional vector spaces, Quotient Space and its dimension, Linear Transformation, Representation of linear transformation as matrices, Rank and Nullity of a Linear Transformation, Dual Space, Quadratic and Hermitian Forms.
- CO4 :** understand the inner product spaces, Cauchy-Schwarz Inequality. Orthogonal vectors, complements, sets, basis. Bessel's inequality for finite dimensional vector spaces, Gram-Schmidt Orthogonalization process.

3.6 Course Outcomes of Semester-V (BMath- H506 : Analysis-I :Real Analysis)

After completion of the course, a student will be able to

- CO1 :** understand the Order completeness and compactness in real number system, Archimedean property, Bounded sets, Limit points. Bolzano-Weierstrass theorem, Heine-Borel theorem. Bounded sequences, Cauchy sequences, convergent sequences, monotonic sequences and their properties. Subsequences, Nested interval theorem. Properties of continuous function in a closed interval and uniform continuity.
- CO2 :** learn about Riemann Integrability of bounded functions, Darboux's theorem, Inequalities for integrals, Mean value theorem,
- CO3 :** make the clear concept of Partial derivatives of higher order, Young's and Schwarz's theorem
- CO4 :** understand the different types of improper integrals, evaluation of Beta and Gamma functions. Abel's test Dirichlet's test and Frullani's integrals.
- CO5 :** know concepts of multiple integrals such as line integrals, Double and repeated integrals, Green's theorem in a plane, find out Surface area, surface integrals, Stoke's theorem, Volume integrals, Triple integrals Gauss divergence theorem and its application.

3.7 Course Outcomes of Semester-V (BMath- H507 : Numerical Analysis & Computer C- Programming)

After completion of the course, a student will be able to

- CO1 :** learn about the numerical solutions of the system, Finite difference, operations. Newton's Forward and Backward of Interpolation formulae, divided difference formulae and its properties. Lagrange's and Hermite's interpolation formula.
- CO2 :** know the concepts of numerical differentiation and integration. Trapezoidal and Simpson's Rules. Numerical solution of Ordinary Differential Equations using Picards, Euler, Runge-Kutta methods. Newton-Raphson method for finding the solution of Algebraic and transcendental equation.
- CO3 :** learn about the computer programming and understand the C++ Programming, language, algorithm, flowchart, operating systems and its application in solving several mathematical problems.

- CO4 :** understand the Decision making with a program, logical and conditional operators with various loop..
- CO5 :** learn about the arrays, one dimensional array and two dimensional array, insertion, deletion and sorting of elements from an array. Defining, accessing a function, library function within C-programming.

3.8 Course Outcomes of Semester-VI (BMath- H605 : Partial Differential Equations, Laplace Transform, Calculus of variation)

After completion of the course, a student will be able to

- CO1 :** know the ideas of First order PDE and definitions of Complete integral, Particular integral, Singular integral and General integral.
- CO2 :** learn about Lagrange's method of solving the linear PDF. Geometrical interpolation.
- CO3 :** find the solutions of Partial Differential Equations of First order but of any degree by Charpit's and Jacobi's methods.
- CO4 :** understand the higher order Partial Differential Equations and finding the solution of Linear Homogenous PDE with constant coefficients. Monge's method of integration.
- CO5 :** learn Laplace Transformation and its properties, Kernel of Integral transformation. Laplace Transformation of derivatives of order n. Inverse Laplace Transformation and its application in solving PDE.
- CO5 :** know the Fundamental Theorem on Calculus of Variation, Euler's equation, Legendre condition for extremum and Brachistochron problems.

3.9 Course Outcomes of Semester-VI (BMath- H606 :(Analysis – II : Metric Space & Complex Analysis)

After completion of the course, a student will be able to

- CO1 :** learn about Metric Space Diameter and boundedness of sets. Fundamental inequalities, subspace, open balls, open and closed sets, limit and adherent points, interior, exterior and frontier points etc.
- CO2 :** understand the complete and in-complete metric space, Cantor's intersection theorem. Compactness and Sequential compactness metric space. Bolzano Weirstrass property on metric space.
- CO3 :** understand the Limit and continuity, differentiability, method of constructing a regular function Polar form of Cauchy-Riemann equation. Complex equations of a line and circle.

- CO4 :** know the Conformal mapping, Jacobian of transformation, Bilinear transformation and fixed points. Preservation of cross ratio.
- CO5 :** know the Fundamental Theorem on Calculus of Variation, Euler's equation, Legendre condition for extremum and Brachistochron problems.

3.10 Course Outcomes of Semester-VI (BMath- H607 :(Theory of Probability)

After completion of the course, a student will be able to

- CO1 :** understand the continuous probability distribution, beta gamma distributions and probability generating functions.
- CO2 :** know the concepts of Generating functions and convergence, convergence of random variables and convergence in r^{th} mean. Probability inequalities.
- CO3 :** learn about the Normal distribution, properties, curve, area under normal curve. Application of central limit theorem, univariate distribution, Transformation, Bivariate normal distribution, DeMoivre's Laplace limit theorem, Liapunov theorem etc.

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